[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 431

EERE-2017-BT-STD-0009

RIN 1904-AD79

Energy Conservation Program: Energy Conservation Standards for Walk-In Coolers and Walk-In 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 walk-in coolers and freezers ("walk-ins" or "WICFs"). 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 amended energy conservation standards for walk-ins. It has determined that the amended energy conservation standards for these products 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 amended standards established for walk-in non-display doors in this final rule is required on and after **[INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. Compliance with the amended standards established for walk-in refrigeration systems in this final rule is required on and after December 31, 2028.

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-0009*. 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. Troy Watson, 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: (240) 449-9387. Email: *ApplianceStandardsQuestions@ee.doe.gov*.

Mr. Matthew Schneider, 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: *matthew.schneider@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Synopsis of the Final Rule
A. Benefits and Costs to Consumers
B. Impact on Manufacturers
C. National Benefits and Costs
1. Annualized Benefits and Costs
a. Non-Display Doors
b. Refrigeration Systems
c. Amended Standards
D. Conclusion
II. Introduction
A. Authority
B. Background
1. Current Standards
2. History of Standards Rulemaking for Walk-Ins
III. General Discussion
A. General Comments
1. Comments Regarding the Proposed Standard Levels
2. Comments Regarding the Proposed Compliance Date
3. Comments Regarding Rulemaking Process
4. Comments Regarding Prescriptive Standards
5. Comments Regarding the Standards Equations
B. Scope of Coverage
C. Test Procedure

- D. Technological Feasibility
  - 1. General
  - 2. Maximum Technologically Feasible Levels
- E. Energy Savings
  - 1. Determination of Savings
  - 2. Significance of Savings
- F. Economic Justification
  - 1. Specific Criteria
    - a. Economic Impact on Manufacturers and Consumers
    - b. Savings in Operating Costs Compared to Increase in Price (LCC and PBP)
    - c. Energy Savings
    - d. Lessening of Utility or Performance of Products
    - e. Impact of Any Lessening of Competition
    - f. Need for National Energy Conservation
    - g. Other Factors
  - 2. Rebuttable Presumption

IV. Methodology and Discussion of Related Comments
- A. Market and Technology Assessment
  - 1. Equipment Classes
    - a. Doors
    - b. Panels
    - c. Refrigeration Systems
  - 2. Technology Options
    - a. Fully Assembled Walk-Ins
    - b. Doors and Panels
    - c. Refrigeration Systems
- B. Screening Analysis
  - 1. Screened-Out Technologies
    - a. Fully Assembled Walk-Ins
    - b. Doors and Panels
    - c. Refrigeration Systems
  - 2. Remaining Technologies
    - a. Doors and Panels
    - b. Refrigeration Systems
- C. Engineering Analysis
  - 1. Efficiency Analysis
    - a. General Feedback
    - b. Display Doors
    - c. Non-Display Doors
    - d. Panels
    - e. Dedicated Condensing Units and Single-Packaged Dedicated Systems
    - f. Unit Coolers
  - 2. Cost Analysis
    - a. Teardown Analysis
    - b. Cost Estimation Method
    - c. Low-GWP Refrigerants

d. More Efficient Single-Speed Compressors
e. Variable-Speed Compressors
f. Unit Coolers
g. Capital Expenditures Represented in MPCs
h. Manufacturer Markups and Shipping Costs
3. Cost-Efficiency Results
D. Markups Analysis
E. Energy Use Analysis
1. Trial Standard Levels
2. Energy Use of Envelope Components
3. Energy Use of Refrigeration Systems
a. Nominal Daily Run Hours
4. Estimated Annual Energy Consumption
F. Life-Cycle Cost and Payback Period Analysis
1. Consumer Sample
2. Equipment Cost
a. Application of the Low-GWP Refrigerant Transition to Specific Regions
3. Installation Cost
a. Refrigeration Systems
b. Cooler and Freezer Panels
4. Annual Energy Consumption
5. Energy Prices
a. Future Electricity Prices
6. Maintenance and Repair Costs
7. Equipment Lifetimes
8. Discount Rates
9. Energy Efficiency Distribution in the No-New-Standards Case
10. Payback Period Analysis
G. Shipments Analysis
1. Price Elasticity
2. Shipments Results
H. National Impact Analysis
1. Product Efficiency Trends
2. National Energy Savings
3. Net Present Value Analysis
I. Consumer Subgroup Analysis
1. High Warm Air-infiltration Applications
2. Small Businesses
J. Manufacturer Impact Analysis
1. Overview
2. Government Regulatory Impact Model and Key Inputs
a. Manufacturer Production Costs
b. Shipments Projections
c. Capital and Product Conversion Costs
d. Manufacturer Markup Scenarios
3. Discussion of MIA Comments

a. Conversion Costs
b. Manufacturer Markup Scenarios
c. Manufacturing Capacity Constraints
d. Cumulative Regulatory Burden
e. Refrigerant Transition Costs
K. Emissions Analysis
1. Air Quality Regulations Incorporated in DOE's Analysis
L. Monetizing Emissions Impacts
1. Monetization of Greenhouse Gas Emissions
a. Social Cost of Carbon
b. Social Cost of Methane and Nitrous Oxide
2. Monetization of Other Emissions Impacts
M. Utility Impact Analysis
N. Employment Impact Analysis
V. Analytical Results and Conclusions
A. Trial Standard Levels
B. Economic Justification and Energy Savings
1. Economic Impacts on Individual Consumers
a. Life-Cycle Cost and Payback Period
b. Consumer Subgroup Analysis
c. Rebuttable-Presumption Payback
2. Economic Impacts on Manufacturers
a. Industry Cash Flow Analysis Results
b. Direct Impacts on Employment
c. Impacts on Manufacturing Capacity
d. Impacts on Subgroups of Manufacturers
e. Cumulative Regulatory Burden
3. National Impact Analysis
a. National Energy Savings
b. Net Present Value of Consumer Costs and Benefits
c. Indirect Impacts on Employment
4. Impact on Utility or Performance of Products
5. Impact of Any Lessening of Competition
6. Need of the Nation to Conserve Energy
7. Other Factors
8. Summary of Economic Impacts
C. Conclusion
1. Benefits and Burdens of TSLs Considered for Walk-In Cooler and Walk-In Freezer Standards
a. Refrigeration Systems
b. Doors
c. Panels
d. Combined Benefits of Amended Standards
2. Annualized Benefits and Costs of the Adopted Standards
a. Non-display Doors
b. Refrigeration Systems

c. Amended Standards
VI. Procedural Issues and Regulatory Review
A. Review Under Executive Orders 12866, 13563, and 14094
B. Review Under the Regulatory Flexibility Act
1. Need for, and Objectives of, Rule
2. Significant Issues Raised by Public Comments in Response to the IRFA
3. Description and Estimated Number of Small Entities Affected
4. Description of Reporting, Recordkeeping, and Other Compliance Requirements
a. Doors
b. Panels
c. Refrigeration Systems
d. Doors and Refrigeration Systems
5. Significant Alternatives Considered and Steps Taken to Minimize Significant Economic Impacts on Small Entities
C. Review Under the Paperwork Reduction Act
D. Review Under the National Environmental Policy Act of 1969
E. Review Under Executive Order 13132
F. Review Under Executive Order 12988
G. Review Under the Unfunded Mandates Reform Act of 1995
H. Review Under the Treasury and General Government Appropriations Act, 1999
I. Review Under Executive Order 12630
J. Review Under the Treasury and General Government Appropriations Act, 2001
K. Review Under Executive Order 13211
L. Information Quality
M. Congressional Notification
VII. Approval of the Office of the Secretary

I. Synopsis of the Final Rule

The Energy Policy and Conservation Act, Pub. L. 94-163, as amended ("EPCA"),[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

[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 reflect 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 re-designated Part A-1.

variety of provisions designed to improve energy efficiency. (42 U.S.C. 6311-6317) Such equipment includes walk-in coolers and walk-in freezers ("walk-ins" or "WICFs"), the subject of this document. (42 U.S.C. 6311(1)(G)) DOE defines "walk-ins" as an enclosed storage space, including but not limited to panels, doors, and refrigeration systems, refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet; however, the terms do not include products designed and marketed exclusively for medical, scientific, or research purposes. 10 CFR 431.302. Rather than establishing standards for complete walk-in systems, DOE has established standards for the principal components that make up a walk-in (*i.e.*, doors, panels, and refrigeration systems).

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(a); 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(a); 42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

DOE has conducted this review of the energy conservation standards for walk-ins under EPCA's 6-year lookback authority described herein.

In accordance with these and other statutory provisions discussed in this document, DOE analyzed the benefits and burdens of three trial standard levels ("TSLs") for each component of walk-ins (*i.e.*, doors, panels, and refrigeration systems). The TSLs and their associated benefits and burdens are discussed in detail in sections V.A through V.C of this document. As discussed in section V.C of this document, DOE has determined that TSL 1 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified for non-display doors and that TSL 2 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified for refrigeration systems. DOE is not amending energy conservation standards for display doors or panels at this time and the existing standards will remain in effect. The adopted standards for walk-in non-display doors, which are expressed in maximum daily energy consumption in kilowatt-hours per day ("kWh/day"), are shown in Table I.1. These standards apply to all walk-in non-display doors listed in Table I.1 and manufactured in, or imported into, the United States starting on **[INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

Table I.1 Energy Conservation Standards for Walk-In Non-Display Doors (Compliance Starting [INSERT DATE])

Equipment Class	**Maximum Daily Energy Consumption*** ***kWh/day***
Non-Display Door, Manual, Medium-Temperature	$0.02 \times A_{nd} + 0.58 + 0.33 \times a + 0.07 \times b + 0.24 \times c + e$
Non-Display Door, Manual, Low-Temperature	$0.10 \times A_{nd} + 2.63 + 0.40 \times a + 0.09 \times b + 0.30 \times c + 0.85 \times d + f$
Non-Display Door, Motorized, Medium-Temperature	$0.02 \times A_{nd} + 0.77 + 0.33 \times a + 0.07 \times b + 0.24 \times c + e$
Non-Display Door, Motorized, Low-Temperature	$0.09 \times A_{nd} + 2.88 + 0.40 \times a + 0.09 \times b + 0.30 \times c + 0.85 \times d + f$
A_{nd} represents the surface area of the non-display door in square feet. a = 1 for a door with lighting and = 0 for a door without lighting. b = 1 for a door with a digital temperature display without alarms and = 0 for a door without a digital display without alarms. c = 1 for a door with a digital temperature display with alarms and = 0 for a door without a digital temperature display with alarms. d = 1 for a door with a heated pressure relief vent and = 0 for a door without a heated pressure relief vent. e = 0.06 x A_{window} + 0.10, with a maximum value of 0.25, for a door with a heated viewport window, and = 0 for a door without a heated viewport window. f = 0.54 x A_{window} + 0.23, with a maximum value of 1.50, for a door with a heated viewport window, and = 0 for a door without a heated viewport window. A_{window} represents the surface area of the viewing window in square feet.	

The adopted standards for walk-in refrigeration standards, which are expressed as annual walk-in energy factor 2 (“AWEF2”) in British thermal units per Watt-hour (“Btu/W-h”), are shown in Table I.2. These standards apply to all walk-in refrigeration systems listed in Table I.2 and manufactured in, or imported into, the United States starting on December 31, 2028.

Table I.2 Energy Conservation Standards for Walk-In Refrigeration Systems (Compliance Starting December 31, 2028)

Equipment Class	Net Capacity (q_{net})*	Minimum AWEF2* Btu/W-h
Dedicated Condensing System - High-Temperature, Indoor, Non-Ducted	< 7,000 Btu/h	$7.55 \times 10^{-4} \times q_{net} + 2.37$
	≥ 7,000 Btu/h	7.66
Dedicated Condensing System – High-Temperature, Outdoor, Non-Ducted	< 7,000 Btu/h	$1.02 \times 10^{-3} \times q_{net} + 2.40$
	≥ 7,000 Btu/h	9.55
Dedicated Condensing System - High-Temperature, Indoor, Ducted	< 7,000 Btu/h	$2.46 \times 10^{-4} \times q_{net} + 1.55$
	≥ 7,000 Btu/h	3.27
Dedicated Condensing System - High-Temperature, Outdoor, Ducted	< 7,000 Btu/h	$3.60 \times 10^{-4} \times q_{net} + 1.88$
	≥ 7,000 Btu/h	4.39
Dedicated Condensing System other than Single-Packaged - Medium-Temperature, Indoor	< 8,000 Btu/h	5.61
	≥ 8,000 Btu/h and < 25,000 Btu/h	$3.35 \times 10^{-5} \times q_{net} + 5.34$
	≥ 25,000 Btu/h	6.18
Dedicated Condensing System other than Single-Packaged - Medium-Temperature, Outdoor	< 25,000 Btu/h	$1.61 \times 10^{-5} \times q_{net} + 7.26$
	≥ 25,000 Btu/h and < 54,000 Btu/h	$7.59 \times 10^{-6} \times q_{net} + 7.47$
	≥ 54,000 Btu/h	7.88
Dedicated Condensing System other than Single-Packaged - Low-Temperature, Indoor	< 9,000 Btu/h	$4.64 \times 10^{-5} \times q_{net} + 2.18$
	≥ 9,000 Btu/h and < 25,000 Btu/h	$2.52 \times 10^{-5} \times q_{net} + 2.37$
	≥ 25,000 Btu/h and < 54,000 Btu/h	$1.45 \times 10^{-6} \times q_{net} + 2.96$
	≥ 54,000 Btu/h	3.04
Dedicated Condensing System other than Single-Packaged - Low-Temperature, Outdoor	< 9,000 Btu/h	$9.93 \times 10^{-5} \times q_{net} + 2.62$
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.14 \times 10^{-5} \times q_{net} + 3.23$
	≥ 25,000 Btu/h and < 75,000 Btu/h	$4.72 \times 10^{-6} \times q_{net} + 3.90$
	≥ 75,000 Btu/h	4.25
Single-Packaged Dedicated Condensing System - Medium-Temperature, Indoor	< 9,000 Btu/h	$1.00 \times 10^{-4} \times q_{net} + 4.91$
	≥ 9,000 Btu/h	5.81
Single-Packaged Dedicated Condensing System - Medium-Temperature, Outdoor	< 9,000 Btu/h	$3.07 \times 10^{-4} \times q_{net} + 4.73$
	≥ 9,000 Btu/h	7.49
Single-Packaged Dedicated Condensing System - Low-Temperature, Indoor	< 6,000 Btu/h	$8.00 \times 10^{-5} \times q_{net} + 1.80$
	≥ 6,000 Btu/h	2.28
Single-Packaged Dedicated Condensing System - Low-Temperature, Outdoor	< 6,000 Btu/h	$1.39 \times 10^{-4} \times q_{net} + 1.95$
	≥ 6,000 Btu/h	2.78
Unit Cooler - High-Temperature Non-Ducted	< 9,000 Btu/h	10.33
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.83 \times 10^{-4} \times q_{net} + 6.89$
	≥ 25,000 Btu/h	16.45
Unit Cooler - High-Temperature Ducted	< 9,000 Btu/h	6.64
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.70 \times 10^{-4} \times q_{net} + 3.31$
	≥ 25,000 Btu/h	12.57
Unit Cooler - Medium-Temperature	< 54,000 Btu/h	9.65
	≥ 54,000 Btu/h and < 75,000 Btu/h	$-3.10 \times 10^{-5} \times q_{net} + 11.32$
	≥ 75,000 Btu/h	9.00
Unit Cooler - Low-Temperature	All	4.57

* q_{net} is the representative value of net capacity as determined in accordance with the DOE test procedure at 10 CFR part 431, subpart R, appendix C1 and applicable sampling plans.

A. Benefits and Costs to Consumers[3]

Table I.3 through Table I.4 summarize DOE's evaluation of the economic impacts of the adopted standards on consumers of walk-ins, 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 walk-ins, which is estimated to be 8.5 years for both refrigeration systems and non-display doors (*see* section IV.F of this document).

Table I.3 Impacts of Adopted Energy Conservation Standards on Consumers of Walk-In Non-Display Doors (TSL 1)

Opening Mechanism	**Temperature**	**Average LCC Savings** ***2023$***	**Simple Payback Period** ***years***
Manual	Low	683	1.0
	Medium	270	2.0
Motorized	Low	914	0.8
	Medium	397	1.5

[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).

Table I.4 Impacts of Adopted Energy Conservation Standards on Consumers of Walk-In Refrigeration Systems

System	Temperature	Location	Average LCC Savings *2023$*	Simple Payback Period *years*
Dedicated Condensing Unit and Matched Refrigeration System	Low	Indoor	381	2.0
		Outdoor	112	4.4
	Medium	Indoor	660	3.5
		Outdoor	298	1.5
Unit Cooler	Low	n/a	1,304	1.2
	Medium		66	4.7
	High, Non-Ducted		n/a	n/a
	High, Ducted		214	1.2
Matched Refrigeration Systems and Single-Packaged Dedicated Systems	High, Non-Ducted	Indoor	161	0.8
		Outdoor	108	3.2
	High, Ducted	Indoor	368	0.7
		Outdoor	316	0.8
Single-Packaged Dedicated Systems	Low	Indoor	285	2.0
		Outdoor	101	0.2
	Medium	Indoor	132	2.7
		Outdoor	68	3.8

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 (2024) through the end of the analysis period, which is 30 years from the analyzed compliance date. For walk-in display doors, non-display doors, and panels, the analysis period is 2024–2057. For refrigeration systems, the analysis period is 2024–2058. Using a real discount rate of 9.4 percent for doors, 10.5 percent for panels, and 10.2 percent for refrigeration systems, DOE estimates that the

INPV for manufacturers of walk-in display doors, non-display doors, panels, and refrigeration systems in the case without amended standards is $218.7 million, $508.4 million, $926.0 million, and $542.0 million in 2023$, respectively. Under the adopted standards, all walk-in display door equipment classes remain at the baseline efficiency level. As a result, there are no changes to INPV and no conversion costs for display door manufacturers. Under the adopted standards, the change in INPV for non-display door manufacturers is estimated to range from -0.4 percent to 0.7 percent, which is approximately -$2.0 million to $3.5 million. Under the adopted standards, all walk-in panel equipment classes remain at the baseline efficiency level. As a result, there are no changes to INPV and no conversion costs for panel manufacturers. Under the adopted standards, the change in INPV for refrigeration system manufacturers is estimated to range from -11.3 percent to -8.4 percent, which is approximately -$61.2 million to -$45.7 million. In order to bring equipment into compliance with amended standards, it is estimated that the walk-in non-display door and refrigeration system industries would incur total conversion costs of $1.4 million and $90.1 million, respectively.

DOE's analysis of the impacts of the adopted standards on manufacturers is described in sections IV.J and V.B.2 of this document.

C. National Benefits and Costs[5]

DOE's analyses indicate that the adopted energy conservation standards for walk-ins would save a significant amount of energy. The adopted TSLs are TSL 1 for walk-in

[5] All monetary values in this document are expressed in 2023 dollars and, where appropriate, are discounted to 2024 unless explicitly stated otherwise.

non-display doors and TSL 2 for walk-in refrigeration systems. Relative to the case without amended standards, the lifetime energy savings for walk-ins purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2028-2057 for non-display doors and 2029–2058 for refrigeration systems) amount to 1.60 quadrillion British thermal units ("Btu"), or quads of-full-fuel cycle energy savings.[6] This represents a savings of 6.3 percent relative to the energy use of these products in the case without amended standards (referred to as the "no-new-standards case")

The cumulative net present value ("NPV") of total consumer benefits of the standards for walk-ins ranges from $2.00 billion USD (at a 7-percent discount rate) to $4.74 billion USD (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment and installation costs for walk-in non-display doors purchased during the period 2028–2057 and walk-in refrigeration systems purchased in 2029–2058.

In addition, the adopted standards for walk-ins 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 28.82 million metric tons ("Mt")[7] of carbon dioxide ("CO_2"), 8.8 thousand tons of sulfur dioxide ("SO_2"), 53.8

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

thousand tons of nitrogen oxides (“NO_X”), 243.2 thousand tons of methane (“CH_4”), 0.3 thousand tons of nitrous oxide (“N_2O”), and 0.06 tons of mercury (“Hg”).[8]

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 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 published in 2023 (“2023 SC-GHG”), as well as the interim SC-GHG values (in terms of benefit per ton of GHG avoided) 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.[9] 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 $6.80 billion, and the climate benefits associated with the average 2021 Interim SC-GHG estimates at a 3-percent discount rate are estimated to be $1.70 billion. DOE notes,

[8] 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* section IV.K of this document for further discussion of *AEO2023* assumptions that affect air pollutant emissions.

[9] *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)

however, that the adopted standards would be economically justified even without inclusion of the estimated monetized benefits of reduced GHG emissions.

DOE estimates 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 [10] as discussed in section IV.L of this document. DOE did not monetize the reduction in mercury emissions because the quantity is very small. DOE estimated the present value of the health benefits would be $1.37 billion using a 7-percent discount rate and, $3.33 billion using a 3-percent discount rate.[11] 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 I.5 Summary of Monetized Benefits and Costs of Adopted Energy Conservation Standards for Table I.5 summarizes the monetized benefits and costs expected to result from the amended standards for walk-ins. 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.

[10] Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21 Sectors. *https://www.epa.gov/benmap/estimating-benefit-ton-reducing-directly-emitted-pm25-pm25-precursors-and-ozone-precursors*

[11] DOE estimates the economic value of these emissions reductions resulting from the considered TSLs for the purpose of complying with the requirements of Executive Order 12866.

Table I.5 Summary of Monetized Benefits and Costs of Adopted Energy Conservation Standards for Non-Display Doors at TSL 1 Shipped During the Period 2028–2057; and for Refrigeration Systems at TSL 2 Shipped During the Period 2029–2058

	Billion \$2023
3% discount rate	
Consumer Operating Cost Savings	6.52
Climate Benefits* (2023 SC-GHG estimates)	6.80
Climate Benefits* (2021 interim SC-GHG estimates)	1.70
Health Benefits**	3.33
Total Benefits† (2023 SC-GHG estimates)	16.66
Total Benefits† (2021 interim SC-GHG estimates)	11.55
Consumer Incremental Product Costs‡	1.78
Total Net Benefits† (2023 SC-GHG estimates)	14.88
Total Net Benefits† (2021 interim SC-GHG estimates)	9.77
Change in Producer Cashflow (INPV)‡‡	(0.06) – (0.04)
7% discount rate	
Consumer Operating Cost Savings	2.96
Climate Benefits* (2023 SC-GHG estimates)	6.80
Climate Benefits* (2021 interim SC-GHG estimates)	1.70
Health Benefits**	1.37
Total Benefits† (2023 SC-GHG estimates)	11.14
Total Benefits† (2021 interim SC-GHG estimates)	6.03
Consumer Incremental Product Costs‡	0.96
Total Net Benefits† (2023 SC-GHG estimates)	10.18
Total Net Benefits† (2021 interim SC-GHG estimates)	5.07
Change in Producer Cashflow (INPV)‡‡	(0.06) – (0.04)

Note: These results include consumer, climate, and health benefits that accrue after 2057 and 2058 from the walk-in non-display doors and refrigeration systems shipped during the periods 2028−2057 and 2029-2058, respectively.

* Climate benefits are calculated using different estimates of the social cost of carbon (SC-CO2), methane (SC-CH4), and nitrous oxide (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 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 estimate and the average SC-GHG with 3-percent discount rate for the 2021 interim SC-GHG estimate.
‡ Costs include incremental product costs as well as installation costs ‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 9.4 percent for doors, 10.5 percent for panels, and 10.2 percent for refrigeration systems that is estimated in the manufacturer impact analysis (see chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-ins, the change in INPV ranges from -$63 million to -$42 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 (2023 SC-GHG estimates) for this final rule, the net benefits would range from $14.82 billion to $14.84 billion at 3-percent discount rate and would range from $10.12 billion to $10.14 billion at 7-percent discount rate.

1. Annualized Benefits and Costs

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 product purchase prices and installation costs, plus (3) the value of climate and health benefits of emission reductions, all annualized.[12]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of walk-in non-display doors and refrigeration systems shipped during the periods 2028–2057 and 2029–2058, respectively. The benefits associated with reduced emissions achieved as a result of the amended standards are also calculated based on the lifetime of walk-in non-display doors and refrigeration systems shipped during the period 2028–2057 and 2029–2058, respectively. 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 in section IV.L of this document.

a. Non-Display Doors

Table I.6 presents the total estimated monetized benefits and costs associated with the adopted standard for walk-in non-display doors, expressed in terms of annualized values. The results under the primary estimate are as follows.

[12] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2020, 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.

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 $31.2 million per year in increased equipment costs, while the estimated annual benefits are $123.4 million in reduced equipment operating costs, $117.3 million in climate benefits (using the 2023 SC-GHG estimates) or $34.8 million in climate benefits (using the 2021 interim SC-GHG estimates), and $52.0 million in health benefits. In this case, the net benefit would amount to $261.5 million per year (using the 2023 SC-GHG estimates) or $179.0 million per year (using the 2021 interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_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 is $32.0 million per year in increased equipment costs, while the estimated annual benefits are $147.9 million in reduced operating costs, $117.3 million in climate benefits (using the 2023 SC-GHG estimates) or $34.8 million in climate benefits (using the 2021 interim SC-GHG estimates), and $68.8 million in health benefits. In this case, the net benefit would amount to $302.0 million per year (using the 2023 SC-GHG estimates) or $219.5 million per year (using the 2021 interim SC-GHG estimates).

Table I.6 Annualized Benefits and Costs of Adopted Standards for Non-Display Doors at TSL 1 Shipped During the Period 2028 – 2057

	Million 2023$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	147.9	145.0	158.5
Climate Benefits* (2023 SC-GHG estimates)	117.3	116.6	119.8
Climate Benefits* (2021 interim SC-GHG estimates)	34.8	34.6	35.6
Health Benefits**	68.8	68.4	70.2
Total Benefits† (2023 SC-GHG estimates)	334.0	330.0	348.6
Total Benefits† (2021 interim SC-GHG estimates)	251.5	248.0	264.3
Consumer Incremental Product Costs‡	32.0	36.6	31.9
Net Monetized Benefits (2023 SC-GHG estimates)	302.0	293.4	316.7
Net Monetized Benefits (2021 interim SC-GHG estimates)	219.5	211.4	232.4
Change in Producer Cashflow (INPV)‡‡	(0.2) – 0.3	(0.2) – 0.3	(0.2) – 0.3
7% discount rate			
Consumer Operating Cost Savings	123.4	121.3	132.2
Climate Benefits* (2023 SC-GHG estimates)	117.3	116.6	119.8
Climate Benefits* (2021 interim SC-GHG estimates)	34.8	34.6	35.6
Health Benefits**	52.0	51.6	53.0
Total Benefits† (2023 SC-GHG estimates)	292.7	289.5	305.0
Total Benefits† (2021 interim SC-GHG estimates)	210.2	207.6	220.8
Consumer Incremental Product Costs‡	31.2	34.9	31.2
Net Monetized Benefits (2023 SC-GHG estimates)	261.5	254.7	273.8
Net Monetized Benefits (2021 interim SC-GHG estimates)	179.0	172.7	189.6
Change in Producer Cashflow (INPV)‡‡	(0.2) – 0.3	(0.2) – 0.3	(0.2) – 0.3

Note: These results include consumer, climate, and health benefits that accrue after 2057 from the products shipped during the period 2028–2057 for doors and panels. 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 constant prices rate in the Primary Estimate, a declining rate in the High Net Benefits Estimate,

and an inclining rate in the Low Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.2 and IV.H.3 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. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (*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 as well as installation costs.
‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 9.4 percent for doors that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-in doors, the annualized change in INPV ranges from -$0.2 million to $0.3 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 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 (2023 SC-GHG estimates) for this final rule, the annualized net benefits would range from $301.8 million to $302.3 million at 3-percent discount rate and would range from $261.3 million to $261.8 million at 7-percent discount rate.

b. Refrigeration Systems

Table I.7 presents the total estimated monetized benefits and costs associated with the adopted standard for walk-in refrigeration systems, expressed in terms of annualized values. The results under the primary estimate 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 $67.9 million per year in increased equipment costs, while the estimated annual benefits are $180.9 million in reduced equipment operating costs, $209.2 million in climate benefits (using the 2023 SC-GHG estimates) or $61.7 million in climate benefits (using the 2021 interim SC-GHG estimates), and $89.0 million in health benefits. In this case, the net benefit would amount to $411.2 million per year (using the 2023 SC-GHG estimates) or $263.7 million per year (using the 2021 interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_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 is $61.7 million per year in increased equipment costs, while the estimated annual benefits are $222.0 million in reduced operating costs, $209.2 million in climate benefits (using the 2023 SC-GHG estimates) or $61.7 million in climate benefits (using the 2021 interim SC-GHG estimates), and $165 million in health benefits. In this case, the net benefit would amount to \$482.5 million per year (using the 2023 SC-GHG estimates) or \$335.1 million per year (using the 2021 interim SC-GHG estimates).

Table I.7 Annualized Benefits and Costs of Adopted Standards for Refrigeration Systems at TSL 2 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	222.0	211.1	238.0
Climate Benefits* (2023 SC-GHG estimates)	209.2	205.8	215.4
Climate Benefits* (2021 interim SC-GHG estimates)	61.7	60.7	63.5
Health Benefits**	120.6	118.6	124.1
Total Benefits† (2023 SC-GHG estimates)	551.7	535.6	577.4
Total Benefits† (2021 interim SC-GHG estimates)	404.3	390.4	425.5
Consumer Incremental Product Costs‡	69.2	91.4	66.7
Net Monetized Benefits (2023 SC-GHG estimates)	482.5	444.1	510.7
Net Monetized Benefits (2021 interim SC-GHG estimates)	335.1	299.0	358.8
Change in Producer Cashflow (INPV)‡‡	(6.5) – (4.8)	(6.5) – (4.8)	(6.5) – (4.8)
7% discount rate			
Consumer Operating Cost Savings	180.9	172.3	193.8
Climate Benefits* (2023 SC-GHG estimates)	209.2	205.8	215.4
Climate Benefits* (2021 interim SC-GHG estimates)	61.7	60.7	63.5
Health Benefits**	89.0	87.5	91.4
Total Benefits† (2023 SC-GHG estimates)	479.1	465.5	500.6
Total Benefits† (2021 interim SC-GHG estimates)	331.6	320.4	348.7
Consumer Incremental Product Costs‡	67.9	85.8	65.8
Net Monetized Benefits (2023 SC-GHG estimates)	411.2	379.7	434.7
Net Monetized Benefits (2021 interim SC-GHG estimates)	263.7	234.6	282.8
Change in Producer Cashflow (INPV)‡‡	(6.5) – (4.8)	(6.5) – (4.8)	(6.5) – (4.8)

Note: These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped during the period 2029-2058 for refrigeration systems. 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 constant prices rate in the Primary Estimate, a declining rate in the High Net Benefits

Estimate, and an inclining rate in the Low Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.2 and IV.H.3 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. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (*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 as well as installation costs.
‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 10.2 percent for refrigeration systems that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-in refrigeration systems, the annualized change in INPV ranges from -\$6.5 million to -\$4.8 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 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 (2023 SC-GHG estimates) for this final rule, the annualized net benefits would range from \$476.0 million to \$477.7 million at 3-percent discount rate and would range from \$404.7 million to \$406.4 million at 7-percent discount rate.

c. Amended Standards

Table I.8 presents the total estimated monetized benefits and costs associated with the adopted standard for walk-in non-display doors (TSL 1) and refrigeration systems (TSL 2), expressed 2023$ in terms of annualized values. The results under the primary estimate 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 the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is $99.1 million per year in increased equipment costs, while the estimated annual benefits are $304.4 million in reduced operating costs, $96.5 million in climate benefits, and $140.9 million in health benefits. In this case, the net benefit would amount to $442.7 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is $101.2 million per year in increased equipment costs, while the estimated annual benefits are $369.8 million in reduced equipment operating costs, $96.5 million in climate benefits, and $189.4 million in health benefits. In this case, the net benefit would amount to $554.5 million per year.

Table I.8 Annualized Benefits and Costs of Adopted Standards for Non-Display Doors at TSL 1 Shipped During the Period 2028 – 2057; and for Refrigeration Systems at TSL 2 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	369.8	356.2	396.5
Climate Benefits* (2023 SC-GHG estimates)	326.5	322.4	335.2
Climate Benefits* (2021 interim SC-GHG estimates)	96.5	95.3	99.1
Health Benefits**	189.4	187.0	194.3
Total Benefits† (2023 SC-GHG estimates)	885.7	865.5	926.0
Total Benefits† (2021 interim SC-GHG estimates)	655.7	638.4	689.8
Consumer Incremental Product Costs‡	101.2	128.0	98.6
Net Monetized Benefits (2023 SC-GHG estimates)	784.5	737.5	827.3
Net Monetized Benefits (2021 interim SC-GHG estimates)	554.5	510.4	591.2
Change in Producer Cashflow (INPV)‡‡	(6.7) - (4.5)	(6.7) - (4.5)	(6.7) - (4.5)
7% discount rate			
Consumer Operating Cost Savings	304.4	293.6	326.0
Climate Benefits* (2023 SC-GHG estimates)	326.5	322.4	335.2
Climate Benefits* (2021 interim SC-GHG estimates)	96.5	95.3	99.1
Health Benefits**	140.9	139.1	144.4
Total Benefits† (2023 SC-GHG estimates)	771.8	755.1	805.6
Total Benefits† (2021 interim SC-GHG estimates)	541.8	528.0	569.4
Consumer Incremental Product Costs‡	99.1	120.7	97.0
Net Monetized Benefits (2023 SC-GHG estimates)	672.7	634.4	708.6
Net Monetized Benefits (2021 interim SC-GHG estimates)	442.7	407.3	472.4
Change in Producer Cashflow (INPV)‡‡	(6.7) - (4.5)	(6.7) - (4.5)	(6.7) - (4.5)

Note: Note: These results include consumer, climate, and health benefits that accrue after 2057 from the products shipped during the period 2028-2057 for non-display doors and 2058 from the products shipped during the period 2029-2058 for refrigeration systems. 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 constant prices rate in the Primary Estimate, a declining rate in the High Net Benefits Estimate, and an inclining rate in the Low Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.2 and IV.H.3 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. Climate benefits are estimated using two separate estimates of the social cost for each greenhouse gas, one published in 2023 by the Environmental Protection Agency (EPA) and another one published in 2021 as interim estimates by the Interagency Working Group on the SC-GHG (IWG) (see chapter 14 of this TSD). 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 estimate, and the climate benefits associated with the average SC-GHG at a 3-percent discount rate are shown for the 2021 interim SC-GHG estimate.

** 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 chapter 14 of this TSD 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.

‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 9.4 percent for doors, 10.5 percent for panels, and 10.2 percent for refrigeration systems that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-ins, the annualized change in INPV ranges from -$6.7 million to -$4.5 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two 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 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 (2023 SC-GHG estimates) for this final rule, the annualized net benefits would range from $777.8 million to $780.0 million at 3-percent discount rate and would range from $666.0 million to $668.2 million at 7-percent discount rate.

DOE's analysis of the national impacts of the adopted standards is described in sections IV.H, IV.J.3, and IV.L of this document.

In the September 2023 NOPR, DOE requested comment on the methodology used to present the change in producer cashflow (*i.e.,* INPV) in the monetized benefits and costs tables. In response to the September 2023 NOPR, the Air-Conditioning, Heating and Refrigeration Institute ("AHRI") stated agreement with DOE's methodology to present the change in INPV in the monetized benefits and costs tables in Table 1.6, Table 1.7, and Table V.100 of the September 2023 NOPR (which correspond to Table I.5, Table I.8, and Table V.125 in this final rule), but stated the resultant dollar amounts do not support the kinds of efficiency gains claimed, perhaps due to the errors called out in determining the baseline. (AHRI, No. 72 at pp. 8–9) Hussmann commented that it agrees with the views presented by AHRI on this topic. (Hussmann, No. 75 at p. 10)

DOE maintained its methodology from the September 2023 NOPR and presents change in INPV in the monetized benefits and costs tables in this final rule. DOE discusses baseline design assumptions throughout the engineering analysis, see section IV.C of this document. The TSLs and their associated benefits and burdens are discussed in detail in sections V.A through V.C of this document. As discussed in section V.C of this document, DOE has determined that TSL 1 for non-display doors and TSL 2 for refrigeration systems represents the maximum improvement in energy efficiency that is technologically feasible and economically justified.

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 regard to technological feasibility, equipment achieving 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 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 $99.1 million per year in increased equipment costs, while the estimated annual benefits are $304.4 million in reduced equipment operating costs, $326.5 million in climate benefits (using the 2023 SC-GHG estimates) or $96.5 million in climate benefits (using the 2021 interim SC-GHG estimates), and $136 million in health benefits. In this case, the net benefit would amount to $672.7 million per year (using the 2023 SC-GHG estimates) or $442.7 million per year (using the 2021 interim SC-GHG estimates).

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.[13] 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

[13] 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).

pronounced than the impacts of products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national full fuel cycle ("FFC") energy savings of 1.60 quad, the equivalent of the primary annual energy use of 10.7 million homes. In addition, they are projected to reduce cumulative CO_2 emissions by 28.82 Mt. over the time period of non-display doors shipped from 2028 – 2057 and refrigeration systems shipped from 2029 – 2058. 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 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 walk-ins.

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[14], 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) This equipment includes walk-ins, the subject of this document. (42 U.S.C. 6311(1)(G))

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; 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(a); 42 U.S.C. 6297) 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(a); 42 U.S.C. 6297(d))

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating

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

cost of covered equipment. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(3)(A) and 6295I) 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(a); 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(a); 42 U.S.C. 6295(s)) The DOE test procedures for walk-ins appear at title 10 of the Code of Federal Regulations ("CFR") part 431, subpart R, appendices A, B, C, and C1.

EPCA set initial prescriptive energy conservation standards for walk-ins and further required DOE to set performance standards. (42 U.S.C. 6313(f)) EPCA also required that no later than January 1, 2020, the Secretary shall publish a final rule to determine if the standards should be amended. (42 U.S.C. 6313(f)(5)) EPCA further 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 ("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(a); 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(a); 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(a); 42 U.S.C. 6295(m)(3)(A))

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including walk-ins. 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(a); 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(a); 42 U.S.C. 6295(o)(3)(B))

Moreover, DOE may not prescribe a standard if: (1) for certain equipment, including walk-ins, no test procedure has been established for the equipment, or (2) DOE determines by rule that the establishment of such standard will not result in significant conservation of energy, or is not technologically feasible or economically justified. (42 U.S.C. 6316(a); 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(a); 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:

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

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;

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

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

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

The need for national energy and water conservation; and

Other factors the Secretary considers relevant.

(42 U.S.C. 6316(a); 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 a product 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(a); 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 a covered product. (42 U.S.C. 6316(a); 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 product 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(a); 42 U.S.C. 6295(o)(4))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. A rule prescribing an energy conservation standard for a type (or class) of product must specify a different standard level for a type or class of products that has the same function or intended use if DOE determines that products within such group (A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have 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(a); 42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of products, 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(a); 42 U.S.C. 6295(q)(2))

DOE is publishing this final rule pursuant to its statutory obligations pursuant to EPCA described herein. (42 U.S.C. 6311 (f)(5); 42 U.S.C. 6316(a); 42 U.S.C. 6295(m)(1)))

B. Background

1. Current Standards

The current energy conservation standards for walk-ins are set forth in DOE's regulations at 10 CFR 431.306. The current energy conservation standards for walk-in doors are in terms of maximum daily energy consumption ("MDEC"), which is measured in kWh/day (see Table II.1). The current energy conservation standards for walk-in panels are in terms of R-value, which is measured in h-ft^2-°F/Btu (see Table II.2). The current energy conservation standards for refrigeration systems are in terms of annual walk-in energy factor ("AWEF"), which is measured in Btu/W-h (see Table II.3).

Table II.1 Federal Energy Conservation Standards for Walk-In Coolers and Walk-In Freezer Doors

Equipment Class	Equations for Maximum Daily Energy Consumption (kWh/day)*
Display door, medium-temperature	$0.04 \times A_{dd} + 0.41$
Display door, low-temperature	$0.15 \times A_{dd} + 0.29$
Passage door, medium-temperature	$0.05 \times A_{nd} + 1.7$
Passage door, low-temperature	$0.14 \times A_{nd} + 4.8$
Freight door, medium-temperature	$0.04 \times A_{nd} + 1.9$
Freight door, low-temperature	$0.12 \times A_{nd} + 5.6$

*A_{dd} or A_{nd} = surface area of the display door or non-display door, respectively, expressed in ft^2, as determined in appendix A to subpart R of 10 CFR part 431.

Table II.2 Federal Energy Conservation Standards for Walk-In Coolers and Walk-In Freezer Panels

Equipment Class	Minimum R-value (h-ft^2-°F/Btu)
Wall or ceiling panels, medium-temperature	25
Wall or ceiling panels, low-temperature	32
Floor panels, low-temperature	28

Table II.3 Federal Energy Conservation Standards for Walk-In Coolers and Walk-In Freezer Refrigeration Systems

Equipment Class	Minimum AWEF (Btu/W-h)
Dedicated Condensing System – Medium, Indoor	5.61
Dedicated Condensing System – Medium, Outdoor	7.60
Dedicated Condensing System – Low, Indoor with a Net Capacity (q_{net}) of:	
< 6,500 Btu/h	$9.091 \times 10^{-5} \times q_{net} + 1.81$
≥ 6,500 Btu/h	2.40
Dedicated Condensing System – Low, Outdoor with a Net Capacity (q_{net}) of:	
< 6,500 Btu/h	$6.522 \times 10^{-5} \times q_{net} + 2.73$
≥ 6,500 Btu/h	3.15
Unit Cooler – Medium	9.00
Unit Cooler – Low with a Net Capacity (q_{net}) of:	
< 15,500 Btu/h	$1.575 \times 10^{-5} \times q_{net} + 3.91$
≥ 15,500 Btu/h	4.15

* Where qnet is net capacity as determined in accordance with 10 CFR 431.304 and certified in accordance with 10 CFR part 429.

As previously mentioned, EPCA also specifies prescriptive energy conservation standards for walk-ins. These prescriptive standards are codified at 10 CFR 431.306(a) and (b). First, all walk-in doors narrower than 3 feet 9 inches and shorter than 7 feet must have automatic door closers that firmly close all walk-in doors that have been closed to within 1 inch of full closure, and must also have strip doors, spring hinged doors, or other methods of minimizing infiltration when doors are open. Additionally, walk-ins must contain wall, ceiling, and door insulation of at least R-25 for coolers and R-32 for freezers, excluding glazed portions of doors and structural members, and floor insulation of at least R-28 for freezers. Walk-in evaporator fan motors of under 1 horsepower ("hp") and less than 460 volts must be electronically commutated motors (brushless direct current motors) or three-phase motors, and walk-in condenser fan motors of under 1 horsepower must use permanent split capacitor motors, electronically commutated motors, or three-phase motors. Interior light sources must have an efficacy of 40 lumens per watt or more, including any ballast losses; less-efficacious lights may only be used in conjunction with a timer or device that turns off the lights within 15 minutes of when the walk-in is unoccupied. See 42 U.S.C. 6313(f)(1).

EPCA also requires that walk-in freezers with transparent reach-in doors must have triple-pane glass with either heat-reflective treated glass or gas fill for doors and windows. Transparent walk-in cooler doors must have either double-pane glass with heat-reflective treated glass and gas fill or triple-pane glass with heat-reflective treated glass or gas fill. (42 U.S.C. 6313(f)(3)(A)-(B)) For walk-ins with transparent reach-in doors, EPCA also prescribes specific anti-sweat heater-related requirements: walk-ins without anti-sweat heater controls must have a heater power draw of no more than 7.1 or 3.0 watts per square foot of door opening for freezers and coolers, respectively. Walk-ins with anti-sweat heater controls must either have a heater power draw of no more than 7.1 or 3.0 watts per square foot of door opening for freezers and coolers, respectively, or the anti-sweat heater controls must reduce the energy use of the heater in a quantity corresponding to the relative humidity of the air outside the door or to the condensation on the inner glass pane. See 42 U.S.C. 6313(f)(3)(C)-(D).

2. History of Standards Rulemaking for Walk-Ins

In a final rule published on June 3, 2014 ("June 2014 Final Rule"), DOE promulgated the energy conservation standards for walk-in doors, panels, and refrigeration systems manufactured on and after June 5, 2017. 79 FR 32050. After publication of the June 2014 Final Rule, AHRI and Lennox International, Inc. ("Lennox"), a manufacturer of walk-in refrigeration systems, filed petitions for review of DOE's final rule and DOE's subsequent denial of a petition for reconsideration of the rule (79 FR 59090 (October 1, 2014)) with the United States Court of Appeals for the Fifth Circuit. *Lennox Int'l v. Dep't of Energy*, Case No. 14–60535 (5th Cir.). A settlement agreement was reached among the parties under which the Fifth Circuit vacated energy conservation standards for six of the refrigeration system equipment classes—the two standards applicable to multiplex condensing refrigeration systems (subsequently re-named as "unit coolers") operating at medium and low-temperatures and the four standards applicable to dedicated condensing refrigeration systems operating at low-temperatures.[15] After the Fifth Circuit issued its order, DOE established a Working Group to negotiate energy conservation standards to replace the six vacated standards ("ASRAC Working Group"). 80 FR 46521 (August 5, 2015). The ASRAC Working Group assembled its recommendations into a Term Sheet (*see* Docket EERE–2015–BT–STD–0016–0056) that was presented to, and approved by, the Appliance Standards and

[15] The 13 other standards established in the June 2014 Final Rule (*i.e.,* the four standards applicable to dedicated condensing refrigeration systems operating at medium-temperature; the three standards applicable to panels; and the six standards applicable to doors) were not vacated. The compliance date for the remaining standards was on or after June 5, 2017.

Rulemaking Federal Advisory Committee ("ASRAC") on December 18, 2015. (EERE– 2015–BT–STD–0016–0055 at p. 11)

In a final rule published on July 10, 2017 ("July 2017 Final Rule"), DOE adopted energy conservation standards for the six classes of walk-in refrigeration systems with vacated standards – specifically, unit coolers and low-temperature dedicated condensing systems manufactured. 82 FR 31808. The rule required compliance with the six new standards on and after July 10, 2020.

To evaluate whether to propose amendments to the energy conservation standards for walk-ins, DOE issued a request for information ("RFI") in the *Federal Register* on July 16, 2021 ("July 2021 RFI"). 86 FR 37687. In the July 2021 RFI, DOE sought data, information, and comment pertaining to walk-ins. 86 FR 37687, 37689.

DOE subsequently announced the availability of the preliminary analysis it had conducted for the purpose of evaluating the need for amending the current energy conservation standards for walk-ins in the *Federal Register* on June 30, 2022, ("June 2022 Preliminary Analysis"). The analysis was set forth in the Department's accompanying preliminary TSD. DOE held a public meeting via webinar to discuss and receive comment on the June 2022 Preliminary Analysis on July 22, 2022.

On September 5, 2023, DOE published a NOPR in the *Federal Register* regarding energy conservation standards for walk-in coolers and freezers ("September 2023 NOPR"). 88 FR 60746. Specifically, DOE proposed amended standards for walk-in non-display doors and walk-in refrigeration systems. DOE did not propose to amend the standard for walk-in panels or display doors. The amended standards proposed for non-display doors in the September 2023 NOPR were defined in terms of maximum daily energy consumption. The amended standards proposed for refrigeration systems in the September 2023 NOPR were defined in terms of AWEF2, adopted in a test procedure final rule that published on May 4, 2023 ("May 2023 TP Final Rule"). The technical support document ("TSD") that presented the methodology and results of the September 2023 NOPR analysis ("September 2023 NOPR TSD") is available at *www.regulations.gov/document/EERE-2017-BT-STD-0009-0046*. Additionally, on September 28, 2023, DOE published a notice of data availability ("NODA" ("September 2023 NODA") summarizing additional comments received on the June 2022 Preliminary Analysis (87 FR 39008) that were considered but not discussed in the September 2023 NOPR. 88 FR 66710.

On September 27, 2023, DOE held a public webinar ("September 2023 Public Webinar") in which it presented an overview of the topics addressed in the September 2023 NOPR, allowed time for prepared general statements by participants, and encouraged all interested parties to share their views on issues affecting this rulemaking.

On March 14, 2024 DOE published a second NODA ("March 2024 NODA") presenting an updated analysis for walk-in non-display doors and refrigeration systems in light of additional data and comments received in response to the September 2023 NOPR, and as a result, presented life-cycle cost and payback period results and national impacts for TSLs that were different from those analyzed for the NOPR.[16] 89 FR 18555. DOE's final rule analysis considers these data and comments, and DOE's responses to those comments and analysis adjustments are presented in the March 2024 NODA, with no further adjustment in the final rule analysis except as discussed in this final rule. The remaining comments received in response to the September 2023 NOPR are summarized and responded to in this final rule. Additionally, DOE received comments in response to the March 2024 NODA, which it also addresses in this final rule.

DOE received comments in response to the September 2023 NOPR and March 2024 NODA from the interested parties listed in Table II.4 and Table II.5, respectively. DOE also received three anonymous comment submissions in response to the September 2023 NOPR.

[16] As discussed in section IV.E.1, the TSLs analyzed in this final rule for non-display doors and refrigeration systems are largely consistent with the TSLs analyzed in the March 2024 NODA.

Table II.4 List of Commenters with Written Submissions in Response to the September 2023 NOPR

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	72	Trade Association
Anthony International	Anthony	71	Manufacturer
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, Natural Resources Defense Council	ASAP *et al.*	77	Efficiency Organization
DuPont	DuPont	74	Manufacturer
Hussmann Corporation	Hussmann	75	Manufacturer
Isabella Ballesteros	Ballesteros	56	Individual
Kolpak	Kolpak	66	Manufacturer
Lennox International Inc.	Lennox	70	Manufacturer
Michael Ravnitsky	Ravnitsky	55	Individual
North American Association of Food Equipment Manufacturers	NAFEM	67	Trade Association
National Refrigeration & Air Conditioning Canada Corp.	NRAC	73	Manufacturer
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities	CA IOUs	76	Utilities
Refrigerated Solutions Group	RSG	69	Manufacturer
Rob Brooks and Associates, LLC	RBA	68	Individual
Senneca Holdings and Frank Door Company	Senneca and Frank Door	78	Manufacturer
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	72	Trade Association
Anthony International	Anthony	71	Manufacturer

Table II.5 List of Commenters with Written Submissions in Response to the March 2024 NODA

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
Air-Conditioning, Heating, & Refrigeration Institute	AHRI	86	Trade Association
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, Natural Resources Defense Council	ASAP *et al.*	90	Efficiency Organization
Hormann	Hormann	85	Manufacturer
Hussmann Corporation	Hussmann	88	Manufacturer
Imperial Brown	Imperial Brown	84	Manufacturer
Jamison Door Company	Jamison	83	Manufacturer
Lennox International Inc.	Lennox	87	Manufacturer
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities	CA IOUs	91	Utilities
Refrigerated Solutions Group	RSG	89	Manufacturer
Senneca Holdings	Senneca	92	Manufacturer
Representative Stephanie Bice	Rep. Bice	82	Individual

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[17] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the September 2023 Public Webinar, DOE cites the written comments throughout this final rule. DOE did not identify any oral comments provided during the September 2023 Public Webinar that are not substantively addressed by written comments.

[17] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for walk-ins. (Docket No. EERE-2017-BT-STD-0009, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

III. General Discussion

DOE developed this final rule after a review of the market for the subject walk-ins. DOE also considered comments, data, and information from interested parties that represent a variety of interests. This final rule addresses issues raised by these commenters.

A. General Comments

This section summarizes general comments received from interested parties regarding the proposed standards, rulemaking timing, and process.

1. Comments Regarding the Proposed Standard Levels

Ballesteros expressed general support for the standards proposed in the September 2023 NOPR, stating that the benefits would outweigh the burdens. (Ballesteros, No. 56 at p. 1)

DuPont supported panel efficiency standards remaining the same and the non-display door efficiencies remaining at 4-inch insulation thickness. DuPont stated that added efficiency could create a WICF supply shortage above current constraints. (DuPont, No. 74 at p. 2)

The CA IOUs supported DOE’s proposal to adopt TSL 2 for WICFs. The CA IOUs also supported DOE's proposal to establish energy conservation standards for high-temperature systems. (CA IOUs, No. 76 at p. 1)

In response to the March 2024 NODA, ASAP *et. al.* and the CA IOUs recommended that DOE adopt TSL 2 analyzed in the March 2024 NODA. (ASAP *et al*., No. 90 at pp. 1–2; CA IOUs, No. 91 at p. 1) However, ASAP *et al*. additionally urged DOE to consider higher standards for non-display doors associated with the use of thicker insulation. (ASAP *et al*., No. 90 at pp. 1–2)

DOE evaluated more-stringent standards for non-display doors associated with the use of thicker insulation; these are considered in TSL 3 of this final rule. The rationale for not adopting higher standards for non-display doors that would likely necessitate thicker insulation is discussed further in section V.C of this document.

AHRI recommended that DOE issue a no-new-standard approach for the equipment covered in the September 2023 NOPR, which would provide an additional 3 years of lead time to manufacturers and allow them to complete the transition to low global warming potential ("GWP") refrigerants. (AHRI, No. 72 at p. 3 and No. 86 at p. 3)

NRAC also recommended that DOE issue a "no-new-standard" standard for the equipment covered in the September 2023 NOPR to allow the necessary time needed to complete the transition to A2Ls[18] and low-GWP refrigerants required by the EPA's American Innovation and Manufacturing ("AIM") Act of 2020 and also the new UL 60335-2-89 standard[19]. NRAC commented that these regulations are placing significant

[18] Refrigerants in the A2L subgroup, as categorized by ASHRAE Standard 34, have lower toxicity and lower flammability than other subgroups.
[19] UL 60335-2-89, *Household and Similar Electrical Appliances – Safety – Part 2-89: Particular Requirements for Commercial Refrigerating Appliances and Ice-Makers with an Incorporated or Remote Refrigerant Unit or Motor-Compressor*.

burdens on manufacturers and end users, posing a high risk that none of the requirements will be met in the proposed timeframes. (NRAC, No. 73 at pp. 1–2)

DOE acknowledges that EPA's final rule published in the *Federal Register* on October 24, 2023, to address hydrofluorocarbons through the AIM Act ("October 2023 EPA Technology Transitions Final Rule") will require the heating, ventilation, air-conditioning, and refrigeration ("HVACR") industry to undertake a broad transition to lower-GWP refrigerants. 88 FR 73098. DOE has considered this refrigerant transition and the burdens that come with it in the analyses that support this final rule. In summary, DOE analyzed all medium- and low-temperature dedicated condensing system (*i.e.*, dedicated condensing unit and single-packaged dedicated system) representative units with R-448A as the baseline refrigerant, which DOE has concluded is representative of sub-300 GWP refrigerants that would likely be used in medium- and low-temperature dedicated condensing systems. DOE also analyzed R-290 as a design option for medium- and low-temperature single-packaged dedicated systems. DOE used R-404A to analyze medium- and low-temperature unit coolers, which provides a conservative analysis because sub-300 GWP refrigerants would likely increase unit cooler performance. DOE analyzed high-temperature single-packaged dedicated systems and high-temperature unit coolers using R-134a because DOE has not been able to identify a sub-300 GWP refrigerant that could serve as a replacement for R-134a in high-temperature applications that has enough performance data (*e.g.*, compressor coefficients) available to conduct a full engineering analysis for high-temperature units. These analyses are further discussed in sections IV.C.1.e, IV.C.1.f, and IV.F.2.a of this document. DOE also considers the potential manufacturer investments associated with the transition to low-GWP refrigerants in response to refrigerant regulations in section V.B.2.e of this document. Through these analyses, DOE has determined that the standards promulgated in this final rule are technologically feasible and economically justified given the refrigerant transition required of the HVACR industry.

NAFEM requested that DOE find that no-new-standards are justified at this time. NAFEM stated that DOE previously promulgated standards for WICFs in 2014, but six of the classes were remanded by the United States Court of Appeals for the Fifth Circuit; NAFEM further stated that DOE promulgated revised standards for these six classes in 2017, with compliance deadlines of 2020. NAFEM stated that based on this timeline, the latest technologies are still being implemented into the latest equipment. NAFEM commented that there has not been sufficient time to develop, test, and make available the types of new technologies that would impact the most recent energy efficiency standards and otherwise justify revising those standards in the next several years. (NAFEM, No. 67 at p. 2)

As indicated by NAFEM, compliance with the existing standards has been required for multiple years. Compliance with the current energy conservation standards for walk-in doors and medium-temperature dedicated condensing systems was required on June 5, 2017, over 7 years ago. Compliance with the current energy conservation standards for unit coolers and low-temperature dedicated condensing systems was required on July 10, 2020, over 4 years ago. EPCA requires that any new or amended standard for covered equipment 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(a); 42 U.S.C. 6295(o)(2)(A)) As part of DOE's assessment of whether adopting amended standards is economically justified, DOE considers the potential impact on manufacturers, including the potential investments required to develop, test, produce, and market compliant equipment. *See* sections IV.J and V.B.2 of this document for details on the manufacturer impact analysis. As discussed further in section V.C of this document, DOE is adopting amended standards for walk-ins that are technologically feasible and economically justified.

DOE also received comments that the standards proposed in the September 2023 NOPR and/or that updated analysis presented in the March 2024 NODA are too stringent.

AHRI and Hussmann commented that in the September 2023 NOPR, DOE determined that TSL 3 is not economically justified; however, DOE determined that TSL 2 is economically justified. AHRI and Hussmann further stated that for unit coolers, both TSL 3 and TSL 2 incorporate the max-tech design options for all unit cooler equipment classes. (AHRI, No. 72 at p. 4; Hussmann, No. 75 at pp. 2–3) Therefore, Hussmann recommended that efficiency levels for TSL 2 for unit coolers be set at the intermediate (EL 1) levels. (Hussmann, No. 75 at pp. 2–3) Hussmann also recommended that DOE propose an AWEF2 of 9.15 for medium-temperature unit coolers and an AWEF2 of 4.30 for low-temperature unit coolers. (Hussmann, No. 75 at pp. 5–7)

DOE notes that it determined in the September 2023 NOPR that, for refrigeration systems, TSL 3 was not economically justified. 88 FR 60746, 60852. This determination was made despite certain efficiency levels for certain equipment classes that made up

TSL 3 being economically justified. In the September 2023 NOPR, DOE tentatively determined that TSL 2 was economically justified. 88 FR 60746, 60853. Given that some efficiency levels for some representative units that made up TSL 3 in the September 2023 NOPR were cost effective, there was overlap in the efficiency levels that made up TSL 3 and the efficiency levels that made up TSL 2 for certain representative units. 88 FR 60746, 60786-60787. Medium-temperature unit coolers and low-temperature unit coolers were two of the equipment classes where the efficiency levels between TSL 3 and TSL 2 were the same. DOE is required to set standards that achieve the maximum improvement in energy that the Secretary determines is technologically feasible and economically justified (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(A)); therefore, in the September 2023 NOPR DOE proposed the economically justified maximum technology levels for medium- and low-temperature unit cooler equipment classes. DOE is adopting amended standards based on the updated analyses from the March 2024 NODA in this final rule that achieve the maximum improvement in energy that the Secretary determines is technologically feasible and economically justified. DOE notes that in this final rule it is adopting the max-tech efficiency level for low-temperature and high-temperature ducted unit coolers but is not adopting the max-tech efficiency level for all analyzed capacities of medium-temperature unit coolers in this final rule. *See* section V.C of this document for further discussion.

Lennox commented that the baseline design assumptions and AWEF2 levels may result in proposed AWEF2 standard levels that would drive financials considerably more unfavorably to manufacturers and consumers. Lennox requested that DOE correct discrepancies in baseline assumptions and costs associated with higher efficiency levels in the September 2023 NOPR and September 2023 NOPR TSD. (Lennox, No. 70 at p. 8) Lennox stated that once DOE has addressed the technical issues Lennox identified in the September 2023 NOPR, DOE must re-run the NOPR analysis to determine if the proposed standards are technologically feasible and economically justified. Lennox recommended that the final standards be no more stringent than those proposed in the September 2023 NOPR. (Lennox, No. 70 at p. 6) In response to the March 2024 NODA analysis, Lennox stated that DOE must address various technical issues – baseline design assumptions and costs of attaining higher efficiency levels, reduced incremental margins assumptions to attain higher efficiency levels, and product lifetime assumptions – to ensure that any new WICF energy conservation standard is "technologically feasible and economically justified", as required by statute. (Lennox, No. 87 at p. 3) Lennox further stated that section 7 of the NODA support document presents updated AWEF2 calculations for refrigeration system equipment classes at TSLs presented in the NODA that lack justification. (*Id.* at pp. 7–8) Lennox commented it has significant concerns regarding this rulemaking's technical and cost analysis, and DOE has not demonstrated that amended energy conservation standards are appropriate. (*Id.* at p. 8)

In the March 2024 NODA, DOE reviewed and updated parts of its analyses based on stakeholder feedback from the September 2023 NOPR and DOE's own findings. As such, in the March 2024 NODA, DOE presented updated LCC and PBP results, as well as national impacts. 89 FR 18555. Additionally, in this final rule, DOE further reviewed and updated its analyses based on stakeholder feedback from both the September 2023 NOPR and March 2024 NODA, in particular for refrigeration systems and through comments raised by Lennox. DOE addresses and discusses Lennox's indicated technical issues in section IV of this document. The updated analytical results that reflect the comments that have been addressed can be found in section V of this document. DOE has concluded that the analyses in this final rule are representative of the performance capabilities and costs of WICF components to justify the adopted standards. When proposing a standard level, DOE considers the benefits and burdens of each TSL as discussed in section V.C.1 of this document. As a result, DOE is adopting a standard level that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified for both consumers and manufacturers.

Senneca and Frank Door commented that the standards proposed in the September 2023 NOPR for WICFs contain procedural and substantive flaws, which affect the technical feasibility and economic justification of the proposed standards and have the potential to violate EPCA and the Administrative Procedure Act. (Senneca and Frank Door, No. 78 at p. 1) Senneca and Frank Door asserted that DOE used inaccurate inputs to calculate several values that are integral to DOE's evaluation of whether the proposed standards are economically justified, and that, therefore, DOE should withdraw the September 2023 NOPR and redo the evaluation with accurate inputs in every calculated value. (Senneca and Frank Door, No. 78 at p. 6) Senneca and Frank Door commented that the proposed standards would result in the elimination of certain types and/or sizes of doors and the elimination of anti-sweat heat, which the commenters stated would violate 42 U.S.C. 6295(o)(4). (Senneca and Frank Door, No. 78 at pp. 5–6) Following publication of the March 2024 NODA, Senneca commented that the NODA does not address flaws in the September 2023 NOPR. Senneca stated that DOE cannot identify technology options that, when applied in a real-world context as opposed to modeling, are capable of achieving the level of reductions that would be required under either set of standards; in effect, DOE has failed to meet its burden for both the standards in the September 2023 NOPR and the March 2024 NODA.

Imperial Brown stated that the 0.06 coefficient to calculate the March 2024 NODA MDEC for low-temperature doors is too stringent. Imperial Brown stated that this reduction leads to MDEC requirements that Imperial Brown believes the industry cannot achieve. Imperial Brown stated that it supports energy conservation but is concerned that the MDEC proposed is unattainable. (Imperial Brown, No. 84 at pp. 1–3)

RSG commented that the proposed changes in maximum daily energy consumption for non-display doors would pose a significant challenge because RSG and other manufacturers have already implemented reduced anti-sweat heat as a design option to the meet the current standards. RSG stated that the reduction in maximum daily energy consumption outpaces the technology changes for reduced, real-world power consumption; therefore, RSG suggested that DOE refrain from adopting such significant reduction in the maximum daily energy consumption at this time. (RSG, No. 69 at p. 1)

DOE notes that in the March 2024 NODA, DOE reviewed and updated parts of its analyses based on stakeholder feedback from the September 2023 NOPR and DOE's own findings. In the March 2024 NODA, DOE presented an updated engineering analysis for non-display doors based on stakeholder feedback in response to the September 2023 NOPR and presented updated LCC and PBP results, as well as national impacts. 89 FR

18555. Specifically, in the March 2024 NODA, DOE presented energy consumption allowances for electricity-consuming devices that may be present on non-display doors and updated the energy consumption due to thermal load for low-temperature non-display doors. DOE addresses and discusses the feedback received from Senneca and Frank Door, Imperial Brown, and RSG in section IV and V of this document. In this final rule, DOE is adopting standards for non-display doors that are less stringent (*i.e.*, allow a higher MDEC) than those proposed in the September 2023 NOPR. In consideration of stakeholder feedback and uncertainty as to whether all non-display doors could implement certain design options (*i.e.*, improved frame systems and reduced anti-sweat heat) DOE is adopting a standard level that does not necessitate the use of those design options, which is discussed in section V.C.1.a of this document. Based on the considerations discussed in section V.C.1.a of this document, DOE has concluded that the adopted standards for non-display doors would not result in the elimination of certain types and/or sizes of doors; nor would the adopted standards result in the elimination of anti-sweat heat. Further, DOE has concluded that the reduction in MDEC is achievable by the walk-in door industry. DOE has concluded that the analyses in this final rule are sufficiently representative of the performance capabilities and costs of WICF components to justify the adopted standards.

Rep. Bice expressed strong opposition to multiple rules recently proposed by DOE that would add new regulations. Rep. Bice expressed concern that the consistent proposals coming out of DOE are adding burdensome energy conservation standards to products Americans use on a regular basis. Rep. Bice stated that increased standards will increase production costs for manufacturers and retail prices for consumers and asserted that this would cost millions of dollars with little long-term benefit. (Rep. Bice, No. 82 at p. 1)

As previously discussed, EPCA requires that DOE must periodically evaluate the appropriateness of amended energy conservation standards and publish either a NOPD stating 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(a); 42 U.S.C. 6295(m)(1)) DOE has concluded that the standards adopted in this final rule are economically justified and will save consumers $442.7 million annually (2023$) over the lifetime of equipment shipped (see section I.C.1.c of this document for details).

2. Comments Regarding the Proposed Compliance Date

In the September 2023 NOPR, DOE estimated publication of a final rule regarding amended energy conservation standards for walk-ins in 2024; therefore, for purposes of the September 2023 NOPR analysis, DOE used 2027 as the first year of compliance with any amended standards for walk-ins, consistent with the requirements of EPCA (*see* 42 U.S.C. 6313(f)(5)(B)(i)). 88 FR 60746, 60791.

In response, AHRI commented that the proposal requires as much as a 15-percent increase in efficiency. AHRI stated that a maximum 5-percent increase in efficiency would be acceptable, depending on other related requirements, however, AHRI also stated the 2027 timing for compliance is not desirable even if DOE were to amend unit cooler energy efficiency minimums by 5 percent given the EPA Significant New Alternatives Policy Program ("SNAP") 23 activities and test method changes that would require efficiency improvements. (AHRI, No. 72 at p. 5) AHRI commented that should DOE adopt the standards proposed in the September 2023 NOPR without any changes, AHRI suggests that DOE target to publish this final rule by June 2025 with a 3-year compliance period (*i.e.*, compliance required by June 2028). AHRI recommended that if there are changes to the September 2023 NOPR based on stakeholder comments, the compliance date should be pushed back further. (*Id.* at p. 14)

Lennox commented that a 3-year lead time to comply with potential amended WICF energy conservation standards is inadequate. Lennox commented that manufacturer engineering, lab, and product development resources are already overburdened through 2026 due to required compliance with EPA's "technology transition" final rule. Lennox added that manufacturer resources are additionally strained by competing out-of-sequence rulemakings, which impose a cumulative regulatory burden on WICF manufacturers. Lennox requested that DOE allow an additional 2 years' lead time (for a total of 5 years) to comply with any amended WICF energy conservation standards; Lennox added that the 5-year lead time would allow for WICF manufacturers to implement required changes after the required EPA refrigerant transition. Lennox commented that due to these factors, manufacturing capacity and/or engineering resource constraints are significant and may indeed limit consumer access to, as well as increase costs for, WICF under a 3-year, versus a 5-year, compliance period. Lennox further commented that even a 5-year compliance period is feasible only if DOE issues final standards that are no more stringent than those proposed in the NOPR. (Lennox, No. 70 at pp. 1–3, 9)

Additionally, in response to the March 2024 NODA, Lennox stated that as an alternative to allowing a longer compliance period, DOE should postpone the rulemaking process until the low-GWP products are available to ensure DOE meets the statutory criteria in promulgating energy conservation standards that are "economically justified." Lennox stated that increasing the energy efficiency of WICF products using low-GWP refrigerants presents significant uncertainty regarding costs and stated that DOE has not adequately addressed this issue, as the design and manufacture of WICF equipment that uses low-GWP refrigerants is complex and involves A2L refrigerants that present significant engineering challenges different from existing refrigerants used. Lennox stated it is premature for DOE to consider tightening standards for WICF equipment that is not yet on the market. (Lennox, No. 87 at p. 2) Lennox stated that DOE should not move to a final rule regarding WICF equipment, but rather DOE should continue to improve its analysis to ensure that the proposed standards are economically justified. Lennox also stated that given the substantial redesign of WICF equipment that is already underway regarding EPA requirements to transition to equipment that uses low-GWP refrigerant, Lennox believes DOE’s best course would defer further rulemaking until that redesigned equipment is better understood and engineering and lab capacity becomes available to better assess amended WICF energy conservation standards. (Lennox, No. 87 at pp. 4–5) NRAC commented that engineering resources will be fully consumed by the transition to low-GWP refrigerants and transitioning all product lines to the new safety standards. NRAC commented that it will have insufficient time to meet the 2027 amended standard compliance date and requested a pause on the amended standards until after the transition to low-GWP refrigerants is complete. NRAC commented that the proposed rulemaking would require a transition to new low-GWP A2L refrigerants as well as a change in all the safety standards, which would in turn require changes to testing and design of current equipment. NRAC recommended a pause, delay, or no-new-standards rulemaking to benefit the environment and all parties. (NRAC, No. 73 at pp. 2–3)

DOE understands that Federal and State refrigerant regulations, such as EPA's October 2023 EPA Technology Transitions Final Rule, require manufacturers of WICF refrigeration systems to cease manufacturing equipment that uses high-GWP HFC refrigerants and to begin manufacturing redesigned equipment that uses low-GWP refrigerants before that rule's compliance date, which would occur prior to the expected compliance date of new and amended DOE standards. As discussed in section V.B.2.e of this document, DOE expects that the research and development and capital investment required to comply with the October 2023 EPA Technology Transitions Final Rule may exceed the typical industry R&D and capital expenses. DOE has quantitatively estimated those expenditures in its Government Regulatory Impact Model ("GRIM")[20] in the no-new-standards case and standards case to reflect the increased operating expenses and reduced cash flow experienced by industry due to Federal refrigerant regulations. DOE

[20] The GRIMs developed for this final rule are available for download at: *www.regulations.gov/docket/EERE-2017-BT-STD-0009/document.*

qualitatively discusses potential engineering and laboratory resource constraints in section V.B.2.cof this document.

Regarding the timeline to comply with EPA refrigerant regulations, in the notice of proposed rulemaking published in the *Federal Register* on December 15, 2022 ("December 2022 EPA Technology Transitions NOPR"), EPA proposed a January 1, 2025 compliance date for the refrigeration categories that apply to walk-in refrigeration systems (*i.e.*, remote condensing units and cold storage warehouse systems). 87 FR 76738, 76810. In the October 2023 EPA Technology Transitions Final Rule, EPA determined that due to the need for certain SNAP approvals[21], updates to building codes, equipment design, testing, and certifications, technician trainings, and manufacturing facility upgrades, providing additional time to comply was reasonable for certain subsectors in retail food refrigeration, including the categories applicable to walk-in refrigeration systems. 88 FR 73098, 73149–73152. As such, EPA finalized a compliance date of January 1, 2026, for both remote condensing units and cold storage warehouses, delaying compliance one year from what was proposed in the December 2022 EPA Technology Transitions NOPR.

In the September 2023 NOPR and March 2024 NODA, DOE analyzed a 3-year compliance lead-in period for walk-in doors, panels, and refrigeration systems, which DOE modeled as requiring compliance in 2027. DOE notes that it has some flexibility under EPCA to delay the effective date of amended standards: if the Secretary determines

[21] The EPA SNAP program evaluates and approves alternative refrigerants to those that are no longer compliant.

that a 3-year period is inadequate, the Secretary may establish an effective date for WICFs manufactured beginning on the date that is not more than 5 years after the date of publication of a final rule for WICFs. (42 U.S.C. 6313(f)(5)(B)(ii)) DOE received comments regarding industry's ability to meet the standards proposed in the September 2023 NOPR specific to walk-in refrigeration systems. Although most manufacturers emphasized that a 3-year lead-in and 2027 compliance date would not be feasible due to engineering and laboratory resource constraints related to the refrigerant transition, RSG commented that a 2027 compliance date would be viable to meet the standards proposed in the September 2023 NOPR for walk-in refrigeration systems. (RSG, No. 69 at p. 3) AHRI commented that if DOE adopted the standards proposed in the September 2023 NOPR, a June 2028 compliance date would be feasible for industry.

Generally, DOE understands that aligning compliance dates to avoid multiple successive redesigns can help to reduce cumulative regulatory burden. However, most stakeholder comments indicate that the rulemaking timelines and compliance periods for DOE and EPA regulations make it challenging to redesign and retest walk-in refrigeration systems simultaneously to meet both the October 2023 EPA Technology Transitions Final Rule and new and amended DOE standards. Specifically, manufacturers are in the midst of redesigning walk-in refrigeration systems to comply with the October 2023 EPA Technology Transitions Final Rule by January 1, 2026 and may not be able to incorporate the necessary updates to comply with new and amended DOE standards within the same design cycle. Furthermore, DOE is not aware of significant walk-in refrigeration system shipments currently rated above the baseline efficiency level (*i.e.*, EL 0). Thus, DOE expects that most manufacturers will need to update their equipment portfolios to meet the standards adopted in this final rule. Therefore, based on stakeholder comments and DOE's assessment of the investments and redesign required to meet the adopted levels, combined with the overlapping Federal refrigerant regulations, DOE is extending the compliance period so that compliance is required by December 31, 2028 (modeled as 2029), approximately 1 year later than the expected compliance year (2027) analyzed in the September 2023 NOPR (which was based on a 3-year compliance period).

DOE has determined that spreading out the DOE compliance date for amended energy conservation standards from the October 2023 EPA Technology Transitions Final Rule compliance date 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 approximately 4 years instead of 3 years. Manufacturers will also have more time to recoup any investments made to redesign walk-in equipment for the October 2023 EPA Technology Transitions Final Rule as compared to a 3-year compliance period.

DOE did not receive comments regarding the 3-year compliance period analyzed in the September 2023 NOPR for walk-in doors or panels. Therefore, DOE maintains the 3-year compliance period for the amended walk-in non-display doors standard in this final rule, which DOE models as 2028. As previously discussed, DOE is not amending the standard for walk-in panels and display doors.

3. Comments Regarding Rulemaking Process

In response to the September 2023 NOPR and March 2024 NODA, DOE received several comments regarding the process of the rulemaking.

In response to both the September 2023 NOPR and the March 2024 NODA, AHRI requested that DOE consider a pause in its current rulemakings relating to energy conservation standards for walk-ins, given the efforts now underway across the HVACR industry to transition to new classes of refrigerants with low GWP for the AIM Act. AHRI commented that since most substitute refrigerants capable of complying with the AIM Act are A2Ls, SNAP approvals contain highly prescriptive use conditions and limitations, including conformance to safety standards that are now in the process of being updated and revised, such as ASHRAE 15[22] and UL 60335-2-89. AHRI commented that State and local building codes further complicate the picture, with many prohibiting A2Ls and requiring updating, which can take 2 to 5 years to complete—eight States have updated their codes and more than 20 have yet to authorize A2L refrigerants for commercial refrigeration. (AHRI, No. 72 at pp. 1–2 and No. 86 at pp. 1–3)

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(a); 42 U.S.C. 6295(m)(1)) The

[22] ASHRAE Standard 15, *Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-2022, Designation and Safety Classification of Refrigerants*.

final rules that established the current standards for walk-in doors and refrigeration systems were issued in 2014 and 2017, respectively. Further, EPCA specifically prescribed that no later than January 1, 2020, DOE shall publish a final rule to determine if standards for walk-ins should be amended. (42 U.S.C. 6313(f)(5)) DOE is conducting this rulemaking pursuant to these statutory requirements.

Regarding AHRI's comments surrounding the transition to low-GWP refrigerants in response to Federal refrigerant regulations, DOE considered the refrigerant transition and the burdens that come with it in the analyses that support this final rule. With respect to AHRI's concern that some State and local building codes currently prohibit A2Ls, DOE notes that although it considers the potential impacts of refrigerant regulations on walk-in refrigeration systems in its analysis, the energy conservation standards adopted in this final rule generally do not require the use of specific refrigerants (*e.g.*, A2Ls).[23] Furthermore, DOE is aware of ongoing efforts by industry groups and other stakeholders to work with State and local officials to update building codes to allow for alternative refrigerants, such as A2Ls. Additionally, DOE notes that EPA, to the extent practicable, took building codes into account in its consideration of availability of substitutes in the October 2023 EPA Technology Transitions Final Rule. 88 FR 73098, 73136. As such, DOE understands that EPA established compliance dates for the transition to low-GWP refrigerants with the expectation that jurisdictions will prioritize completing building code updates with the October 2023 EPA Technology Transitions Final Rule deadlines in

[23] DOE notes that it expects that manufacturers of lower-capacity medium temperature single-packaged dedicated condensing systems would generally incorporate propane compressors at the standard level adopted in this final rule. However, the charge of propane required for these systems is within the acceptable charge limits specified in an EPA SNAP rule for propane in a refrigeration circuit (300 grams) for refrigeration systems with end-uses in the retail food industry. 89 FR 50410, 50467.

mind. *Id*. DOE notes that the change in the EPA compliance date for walk-in refrigeration systems (*i.e.*, from January 1, 2025 proposed in the December 2022 EPA Technology Transitions NOPR to January 1, 2026 finalized in the October 2023 EPA Technology Transitions Final Rule) provides additional time for jurisdictions to update their building codes or legislation accordingly. As previously discussed, DOE is finalizing a compliance date of December 31, 2028, for walk-in refrigeration systems (approximately 3 years after the October 2023 EPA Technology Transitions Final Rule compliance date for walk-in refrigeration systems), which DOE believes is sufficient time for manufacturers to comply with the adopted standards, accounting for other regulatory obligations. DOE expects that all states will have updated their building codes to reference the updated mechanical codes and safety standards by the December 31, 2028, compliance date.

Ravnitsky supported DOE's efforts to improve the energy efficiency of walk-ins, stating that the benefits estimated by DOE are substantial for the consumers, economy, and environment. Ravnitsky recommended that DOE adopt a negotiated rulemaking process to revise the standards for walk-ins. (Michael Ravnitzky, No. 55 at pp. 1–3)

The Appliance Standards and Rulemaking Federal Advisory Committee ("ASRAC") allows DOE to use negotiated rulemaking as a method to engage all interested parties, gather data, and attempt to reach consensus on establishing energy conservation standards. ASRAC has not voted to proceed with a negotiated rulemaking regarding energy conservation standards for WICFs. Further, there was no additional information provided to suggest that a negotiated rulemaking would result in standards significantly different than those proposed in the September 2023 NOPR or adopted in this final rule. Therefore, DOE is adopting this final rule after using the typical rulemaking process.

Senneca commented that the information contained in the March 2024 NODA undermines DOE's standards proposed in the September 2023 NOPR. Senneca stated that the failure to consider the energy consumption of the additionally analyzed electricity-consuming devices (*i.e.*, heating vents, heated viewing windows, lights, and thermometer/temperature alarms) despite having documented that they are all included on models of doors covered by the proposed standards invalidates DOE's conclusions that the proposed standards are technologically feasible and economically justified as they were based on a model door that is not representative of doors in the market. Senneca commented that DOE should withdraw the proposed standards and restart the process so that additional electrical components can be included in the required analysis. (Senneca, No. 92 at pp. 1–2) Senneca stated that DOE cannot propose new standards in a NODA. Senneca stated that the new standards cannot be considered a logical outgrowth of the September 2023 NOPR. Senneca also stated that the standards are not amendments to existing standards and that they are entirely new standards for entirely new classes of equipment. (Senneca, No. 92 at pp. 2–3) Senneca further stated that if DOE considered product literature and non-public information, DOE must first make data and information available to the public as part of the rulemaking docket before using that data and information. (Senneca, No. 92 at p. 3) Hormann and Jamison supported the comments made by Senneca and Frank Door in response to the September 2023 NOPR and March 2024 NODA. (Hormann, No. 85 at p. 1; Jamison, No. 83 at p. 1)

As noted previously, under EPCA DOE has authority to amend the energy conservation standards applicable to certain industrial equipment, including equipment meeting the definition of walk-in coolers and walk-in freezers. (42 U.S.C. 6295(m); 6316(a); 6311(20)). In doing so, DOE may make certain standards more stringent and can impose additional standards on equipment that fall within the definition of a covered equipment category that previously were not subject to existing regulation. Consistent with EPCA's purposes, this authority allows DOE to amend standards to adjust to technological innovations and changes in the marketplace. DOE further has authority to establish separate equipment classes if DOE determines that equipment capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)). In short, DOE has authority to amend the energy conservation standards applicable to walk-ins and to add certain equipment classes, as adopted in this final rule.

DOE further responds that it did not propose new standards in the March 2024 NODA. As discussed in the March 2024 NODA, upon consideration of the views shared in the September 2023 Public Webinar and public comments DOE received in response to the September 2023 NOPR, the March 2024 NODA presented an analysis with updated portions of DOE's NOPR analysis for walk-in non-display doors and refrigeration systems on which DOE had sought comments, data, and information. 89 FR 18555, 18556. In the March 2024 NODA, DOE demonstrated how the updated analysis applied to the existing equipment classes through the inclusion of the MDEC allowances (see section IV.A.1.a of this document) for non-display doors and the impact on the standards equations proposed in the September 2023 NOPR, which functionally would make them sub-classes within the existing class structure. (*Id*. at 89 FR 18576). DOE did not propose any new TSLs and sought further public input. *Id.* In this final rule, DOE has incorporated additional feedback regarding the March 2024 NODA analysis (*see* section IV of this final rule) and adopted standards that reflect the totality of feedback received during this rulemaking process, including the comments regarding energy use of electricity-consuming components, in response to both the September 2023 NOPR and the March 2024 NODA. The standards adopted in this final rule are within the range of alternatives proposed in the September 2023 NOPR.

In the September 2023 NOPR, DOE summarized the NOPR stage deviations from 10 CFR part 430, subpart C, appendix A (which DOE referred to as the "Process Rule" in that document). 88 FR 60746, 60756. In response to the September 2023 NOPR, Senneca and Frank Door disagreed with DOE's decision to deviate from the process outlined for the development of new efficiency standards, specifically regarding DOE's decision not to publish a Framework Document due to alleged redundancy and to reduce the comment period for interested parties to respond to the proposed rule by 20 percent. Senneca and Frank Door commented that if redundancy and multiplicity of comment opportunities were valid reasons to deviate from the Process Rule, no standards development rulemaking would need to follow the process adopted by DOE in that rule. Senneca and Frank Door commented that DOE's rulemaking process intentionally includes requirements to explain aspects of the rulemaking in multiple documents and provide interested parties with multiple opportunities to comment. Senneca and Frank Door additionally commented that the previous opportunities for interested parties to provide comments were not, in fact, opportunities to comment on the proposed standards themselves, but instead were opportunities for interested parties to inform DOE's decisions on whether to propose amended standards and what the proposed standards should be. Senneca and Frank Door commented that DOE's rationale for limiting the opportunity for the public to participate in the development of the proposed standards was further weakened when two leading trade associations jointly requested additional time to comment due to the complexity of the issues presented in the proposal, a request that DOE refused to accommodate. Senneca and Frank Door commented that DOE's decision to deviate from the Process Rule sets a precedent to continue deviating from the Process Rule. (Senneca and Frank Door, No. 78 at pp. 2–3)

Senneca and Frank Door commented that prior opportunities to comment on the technological feasibility and economic costs of the potential new standards did not sufficiently capture important information from WICF door manufacturers. Senneca and Frank Door commented that the single manufacturer of WICF doors to comment on DOE's Preliminary Analysis does not manufacture any doors that would be covered by the proposed standards, and that DOE's reliance on information from this manufacturer to justify reducing the amount of information made available to the public, shorten the length of the comment period, and support the conclusion that the proposed standards are technically feasible and economically justified is inconsistent with DOE's commitment to robust participation. (*Id.*)

In a final rule published on December 13, 2021, DOE adopted a provision allowing it to depart from the general guidance in 10 CFR part 430, subpart C, appendix A so long as DOE provides notice and an explanation(86 FR 70892, 70896). This rule restored DOE's authority to deviate on a case-by-case basis, which was included in previous versions of appendix A. (61 FR 36974) The provisions at 10 CFR part 430, subpart C, appendix A contain procedures, interpretations and policies that are generally applicable to the development of energy conservation standards, but DOE may, as provided in the rule itself, deviate from this appendix to account for the specific circumstances of a particular rulemaking. *See* section (3)(a) of appendix A to subpart C of 10 CFR part 431. If DOE concludes that changes to the procedures, interpretations, or policies in 10 CFR part 430, subpart C, appendix A are necessary or appropriate, DOE will provide notice in the *Federal Register* of modifications to this appendix with an accompanying explanation. *See* section (3)(b) of appendix A to subpart C of 10 CFR part 431.

As provided in the September 2023 NOPR, chapter 2 of the preliminary TSD that accompanied the preliminary analysis—entitled *Analytical Framework, Comments from Interested Parties, and DOE Responses*—describes the general analytical framework that DOE uses in evaluating and developing potential amended energy conservation standards. As such, in the September 2023 NOPR, DOE determined that publication of a separate framework document would be largely redundant given previously published documents. DOE maintains its determination that publication of a separate framework document would be largely redundant for this rulemaking. Further, 10 CFR part 430, subpart C, appendix A as amended does not require that a framework document and preliminary analysis be published in the pre-NOPR stage and states that such pre-NOPR documents could take several forms depending upon the specific proceeding. *See* section 6(a) of appendix A to subpart C of 10 CFR part 430.

As also noted previously, DOE requested comment in the July 2021 RFI on the analysis conducted in support of the last energy conservation standard rulemaking for walk-ins and provided a 30-day comment period. In its June 2022 Preliminary Analysis and TSD, DOE's analysis remained largely the same as the analysis conducted in support of the previous energy conservation standards rulemaking for walk-ins. DOE requested comment in the June 2022 Preliminary Analysis TSD on the analysis conducted in support of this current rulemaking. Given that the September 2023 NOPR analysis remained largely the same as the June 2022 Preliminary Analysis, and in light of the 60-day comment period DOE provided with its June 2022 Preliminary Analysis, DOE determined that a 60-day comment period was appropriate for the September 2023 NOPR and provided interested parties with a meaningful opportunity to comment on the proposed rule. 88 FR 60746, 60756. Additionally, DOE made subsequent updates to the September 2023 NOPR analysis in the March 2024 NODA and provided interested parties an opportunity to comment on those updates. 89 FR 18555.

Regarding Senneca and Frank Door's assertion that previous opportunities for interested parties to provide comments were not opportunities to comment on the proposed standards themselves, DOE notes that stakeholders were given the opportunity to comment on the assumptions used in analyses that fed into the standards proposed in the September 2023 NOPR. As discussed previously in this section, the analysis presented in the September 2023 NOPR remained largely the same as the analysis presented in the June 2022 preliminary analysis. Additionally, the March 2024 NODA afforded stakeholders an additional opportunity to comment on the updated analysis. As such, stakeholders were given multiple opportunities to provide input on the analyses and assumptions that support this final rule.

Regarding Senneca and Frank Door's assertion that prior opportunities to comment on the technological feasibility and economic costs of the potential new standards did not sufficiently capture important information from WICF door manufacturers, DOE notes that in addition to public comments, DOE sought feedback from WICF door manufacturers during confidential manufacturer interviews. Feedback from these interviews has been incorporated throughout the September 2023 NOPR analysis and this final rule analysis.

4. Comments Regarding Prescriptive Standards

Kolpak requested that DOE clarify its requirements for minimizing infiltration when doors are open and suggested that DOE require spring-loaded hinges causing the door to self-close and either fan-driven air curtains, strip curtains, or strip doors. (Kolpak, No. 66, Attachment 1 at pp. 2–3)

The prescriptive standards for walk-ins were set in EPCA by Congress and were subsequently codified by DOE at 10 CFR 431.306(a)(2). It is required that each walk-in cooler or walk-in freezer manufacturer on or after January 1, 2009, have strip doors, spring-hinged doors, or other methods of minimizing infiltration when doors are open. DOE is not updating the prescriptive standards for walk-ins in this rulemaking.

5. Comments Regarding the Standards Equations

DOE presented several potential energy conservation standards curves for refrigeration systems as supporting data for the March 2024 NODA. *See* section 7 of the NODA support document.[24]

AHRI, Hussmann, and Lennox stated that for the medium-temperature and low-temperature unit cooler (UC.M and UC.L) equipment classes, the efficiency level selected is the same for TSL 1, 2 and 3 but that there are different standards equations for TSL 3 than TSL 1 and 2 in the NODA support document. (AHRI, No. 86 at pp. 5–6; Hussmann, No. 88 at pp. 3–4; Lennox, No. 87 at p. 6) AHRI requested that DOE clarify the difference between the equations for TSL 1 and 2 and those for TSL 3. (AHRI, No. 86 at pp. 5–6)

DOE notes that the standards equations shown for medium-temperature and low-temperature unit coolers in the March 2024 NODA support document at TSL 3 should have matched those for TSL 1 and TSL 2, as the same efficiency level was selected for each TSL. The equations for TSL 3 were erroneously different from those at TSL 1 and 2 for medium-temperature and low-temperature unit coolers. DOE also notes that in the NODA support document, the equation for the high-temperature, ducted unit coolers at TSL 2 was erroneously written and did not account for the updated NODA analysis. In this final rule, the equation at TSL 2, which is the adopted standard level, has been

[24] "Detailed Data for Engineering Analysis and National Impact Analysis for the Notice of Data Availability Pertaining to Walk-in Coolers And Walk-In Freezers." Available at *www.regulations.gov/document/EERE-2017-BT-STD-0009-0079*.

corrected to reflect the changes made in the March 2024 NODA analysis. DOE does not believe these typographical errors impacted commenters' ability to evaluate and provide input on DOE's updated analysis.

AHRI and Lennox asked how the equation ($-6.43 \times 10^{-6} \times q_{net} + 9.97$) that increases the minimum AWEF2 from 9.65 in the September 2023 NOPR to a higher minimum AWEF2 up to 9.9 in the March 2024 NODA for net capacities greater than or equal to 9 kBtu/h and less than 54 kBtu/h was determined. (AHRI, No. 86 at p. 5; Lennox No. 87 at pp. 7–8) AHRI asserted that the AWEF2 standard should reflect a decrease and not an increase and recommended that DOE review the rationale and reconcile it with the change in the AWEF2 standard. (AHRI, No. 86 at p. 5)

In the September 2023 NOPR, for medium-temperature and low-temperature unit coolers, DOE proposed standards at constant AWEF2 values (*i.e.*, the proposed AWEF2 standard did not vary with capacity). Specifically, DOE proposed a standard equal to the average AWEF2 corresponding to the selected efficiency levels of each representative capacity in the selected TSL. Stakeholders pointed out that the proposed AWEF2 levels were above the "max-tech" levels for some of the representative capacities. (AHRI, No. 72 at p. 4; Hussmann, No. 75 at p. 2) Additionally, the proposed AWEF2 levels were below the "max-tech" levels for other representative capacities. In the March 2024 NODA, DOE presented standards equations for medium-temperature unit coolers that vary with capacity, following the representative-capacity efficiency levels more closely, but not exceeding any of the "max-tech" levels for specific representative capacities. As such, the presented standards equation resulted in AWEF2 values that were greater than what was proposed in the September 2023 NOPR for capacities between 9 kBtu/h and 54 kBtu/h for medium-temperature unit coolers.

See section IV.E.1 for discussion regarding how DOE set the standards equations for the standards adopted in this final rule.

B. Scope of Coverage

This final rule covers "walk-in coolers and walk-in freezers" defined as an enclosed storage space, including but not limited to panels, doors, and refrigeration systems, refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit ("°F") that can be walked into, and has a total chilled storage area of less than 3,000 square feet; however, the terms do not include products designed and marketed exclusively for medical, scientific, or research purposes. 10 CFR 431.302. Rather than establishing standards for complete walk-in systems, DOE has previously established separate standards for the principal components that make up a walk-in (*i.e.*, doors, panels, and refrigeration systems). In this final rule, DOE has continued with this approach.

A "door" means an assembly installed in an opening on an interior or exterior wall that is used to allow access or to close off the opening and that is movable in a sliding, pivoting, hinged, or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the frame (including mullions), the door leaf or multiple leaves (including glass) within the frame, and any other elements that form the assembly or part of its connection to the wall. *Id.*

A “panel” means a construction component that is not a door and is used to construct the envelope of the walk-in (*i.e.,* elements that separate the interior refrigerated environment of the walk-in from the exterior). *Id.*

A “refrigeration system” means the mechanism (including all controls and other components integral to the system’s operation) used to create the refrigerated environment in the interior of a walk-in cooler or walk-in freezer, consisting of:

(1) A dedicated condensing refrigeration system (as defined in 10 CFR 431.302); or

(2) A unit cooler.

In response to the September 2023 NOPR, AHRI commented that DOE is expanding the scope of the rulemaking to include CO_2 unit coolers, multi-circuit single-packaged dedicated systems, and ducted fan coil units, but DOE has not been able to procure a CO_2-dedicated condensing unit and did not test or allow for CO_2-dedicated condensing units. AHRI commented that the walk-in market will probably adopt CO_2-dedicated condensing units. (AHRI, No. 72 at p. 7)

In response to AHRI’s assertion that DOE did not allow for CO_2-dedicated condensing units, DOE notes that the test procedure for walk-in refrigeration systems does not explicitly define scope based on refrigerant, as discussed in the May 2023 TP Final Rule. 88 FR 28780, 28786. Notwithstanding the fact that DOE did not adopt test procedures specifically for CO_2-dedicated condensing units addressing the unique characteristics of CO_2, DOE has concluded that all such condensing units currently available, whether in the United States or elsewhere, can be tested using the existing test procedures set forth at 10 CFR part 431, subpart R, appendices C and C1. Specifically, DOE's understanding is that no modifications are needed to test CO_2-dedicated condensing units under the walk-in dedicated condensing unit test procedure, provided the CO_2 exiting the condensing unit is liquid. DOE also notes that there are CO_2-dedicated condensing units certified in DOE's Compliance Certification Database ("CCD") currently. On this basis, and the fact that no petitions for waiver of the DOE test procedure for condensing units have been submitted, DOE concludes that the current test procedures and energy conservation standards are applicable to such equipment. If a manufacturer believes that a CO_2-dedicated condensing unit contains one or more design characteristics that prevent testing of the basic model(s) according to the prescribed DOE test procedures or cause the prescribed test procedures to evaluate the CO_2-dedicated condensing unit in a manner so unrepresentative of its true energy consumption characteristics as to provide materially inaccurate comparative data, then manufacturers can petition for a waiver in accordance with 10 CFR 431.401. DOE notes that in the May 2023 TP Final Rule, DOE adopted test provisions specific for CO_2 unit coolers and added new provisions to appendix C1 because the industry test procedure referenced in the DOE test procedure at the time (AHRI 1250-2009, referenced in appendix C) did not accommodate CO_2 unit coolers. The procedure and provisions that DOE adopted were consistent with waivers and interim waivers granted to manufacturers of CO_2 unit coolers. 88 FR 28780, 28786.

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 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(a); 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 walk-in display and non-display doors is codified at 10 CFR part 431, subpart R, appendix A ("appendix A"), which includes provisions for determining maximum daily energy consumption, the metric on which current standards for walk-in display and non-display doors are based. 10 CFR 431.306 The current test procedure for walk-in panels is codified at 10 CFR part 431, subpart R, appendix B ("appendix B"), which includes provisions for determining R-value, the metric on which current standards for walk-in panels are based. The current test procedure for walk-in refrigeration systems is codified at 10 CFR part 431, subpart R, appendix C ("appendix C"). Appendix C includes provisions for determining AWEF, the metric on which current standards for walk-in refrigeration systems are based.

In the September 2023 NOPR analysis, DOE used the test procedures adopted in the May 2023 TP Final Rule to evaluate the efficiency of walk-in components. From this point forward the May 2023 TP Final Rule will be referred to as the "current test procedure."

In the May 2023 TP Final Rule, DOE established a new appendix, appendix C1 to subpart R ("appendix C1"), and a new efficiency metric, AWEF2, for refrigeration systems. (*See* 10 CFR part 431, subpart R, appendix C1.) The engineering analysis results and the adopted energy conservation standards for refrigeration systems are presented as AWEF2 values. Manufacturers would be required to begin using appendix C1 as of the compliance date of energy conservation standards promulgated as a result of this rulemaking.

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(a); 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 part 430, subpart C, appendix A, sections 6(b)(3)(i) and 7(b)(1). Section IV.A.2 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 and design options that are not screened out are considered as the basis for higher efficiency levels that DOE could consider for potential amended standards. Section IV.B of this document discusses the results of the 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 product, 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 products. 42 U.S.C. 6316(a); 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.[25] 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 of this document and in chapter 5 of the final rule TSD.

E. Energy Savings

1. Determination of Savings

For each trial standard level, DOE projected energy savings from application of the TSL to walk-in doors, panels, and refrigeration systems purchased in the 30-year period that begins in the year of compliance with the amended standards (2028–2057 for doors and panels, 2029-2058 for refrigeration systems).[26] The savings are measured over the entire lifetime of walk-ins purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption

[25] 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.
[26] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

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 the equipment would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis ("NIA") spreadsheet models to estimate national energy savings ("NES") from potential amended standards for walk-ins. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which are 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 full-fuel-cycle ("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.[27] 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.

[27] 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).

2. Significance of Savings

To adopt any new or amended standards for covered equipment, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 6316(a); 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. [28] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than the impacts of products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors.

As stated, the standard levels adopted in this final rule are projected to result in national energy savings of 1.60 quad, the equivalent of the primary annual energy use of 10.6 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

[28]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).

energy savings from the standard levels adopted in this final rule are "significant" within the meaning of 42 U.S.C. 6316(a); 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(a); 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. DOE first 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 payback period ("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 net present value 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(a); 42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of 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 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 analysis, 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 analysis is 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(a); 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 national energy savings.

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(a); 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(a); 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(a); 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 NOPR TSD to the Attorney General for review, with a request that the DOJ provide its determination on this issue. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for walk-ins 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(a); 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(a); 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 payback period for consumers. These analyses include, but are not limited to, the 3-year payback period 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(a) 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 IV.F of this document.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to walk-ins. 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 national impacts analysis uses a second spreadsheet set that provides shipments projections and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the GRIM, to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *https://www.energy.gov/eere/buildings/walk-coolers-and-walk-freezers*. Additionally, DOE used outputs 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 products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. 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 walk-ins. 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

When evaluating and establishing or amending energy conservation standards, DOE may establish separate standards for a group of covered equipment (*i.e.*, establish a separate equipment class) if DOE determines that separate standards are justified based on the type of energy used, or if DOE determines that equipment capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6316(a); 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.*)

As noted previously, rather than establishing standards for complete walk-in systems, DOE has established separate standards for each of the principal components that make up a walk-in (*i.e.*, doors, panels, and refrigeration systems). DOE's analysis for each component is discussed in the following sections.

a. Doors

DOE's existing standards for walk-in doors are based on six equipment classes differentiated by temperature and whether they are display doors or non-display doors.

Display Doors

DOE defines a display door as a door that is designed for product display or has 75 percent or more of its surface area composed of glass or another transparent material. 10 CFR 431.302. Display doors are further divided based on walk-in temperature (*i.e.,* cooler/medium-temperature or freezer/low-temperature). DOE currently defines separate energy conservation standards for these two classes of display doors: medium-temperature and low-temperature. 10 CFR 431.306(c).

In the September 2023 NOPR, DOE considered distinguishing display door classes by the presence or absence of a motorized door opener for the purposes of its analysis. DOE analyzed medium- and low-temperature display doors without motorized door openers and medium-temperature display doors with motorized door openers. *Id.* DOE did not identify any motorized display doors for low-temperature applications and therefore did not analyze such equipment in the September 2023 NOPR. 88 FR 60746, 60761. Ultimately, in the September 2023 NOPR, DOE did not find that amended standards for display doors were economically justified and therefore, DOE did not propose any amendments to the class structure for display doors. 88 FR 60746, 60841-60843.

DOE did not receive any comments regarding the equipment classes analyzed for display doors in the September 2023 NOPR. DOE maintains its conclusion from the September 2023 NOPR for this final rule, and for the purposes of this analysis, evaluated amended standards for display doors by presence or absence of a motorized door opener. Therefore, DOE evaluated the display door equipment classes in Table IV.1 for this final rule. However, as discussed further in section V.C.1.a of this document, DOE has determined that amended standards for display doors are not economically justified; therefore, DOE is not adopting equipment classes that differ from the existing classes for display doors.

Table IV.1 Equipment Classes Analyzed for Walk-In Display Doors

Opening Mechanism	Temperature	Class Code
Manual	Medium	DW.M
	Low	DW.L
Motorized	Medium	DS.M

DOE discusses representative units, baseline assumptions for representative unit efficiency, and design options analyzed at higher efficiency levels for walk-in display doors in section IV.C.1 of this document. Consistent with the September 2023 NOPR, DOE did not consider more-efficient levels for the motorized display door class beyond the current maximum energy consumption (*i.e.*, baseline efficiency level) in this final rule. In its review of the motorized display door market, DOE found that manufacturers are already implementing maximum technology design options, such as vacuum-insulated glass, to achieve the current maximum energy consumption standard since the motor consumes additional energy. DOE did not receive any comments regarding this in response to the September 2023 NOPR and DOE has not identified any energy-saving technology options for motorized display doors that were retained during the screening analysis, as discussed in sections IV.A.2.a and IV.A.2.b of this document.

Non-Display Doors

Non-display doors are all doors not considered display doors. (10 CFR 431.302) Non-display doors are mainly used to allow people and products to be moved into and out of the walk-in. Non-display doors are further divided into equipment classes by whether they are passage or freight doors. DOE defines a freight door as a door that is not a display door and is equal to or larger than 4 feet wide and 8 feet tall. *Id*. DOE defines passage doors as any doors that are not display doors or freights doors. *Id*. Passage and freight doors are further divided based on walk-in temperature (*i.e.,* cooler/medium-temperature or freezer/low-temperature). DOE currently defines separate energy conservation standards for the following walk-in non-display door classes (10 CFR 431.306(d)):

- Passage Door, Medium-temperature
- Passage Door, Low-temperature
- Freight Door, Medium-temperature
- Freight Door, Low-temperature

In the September 2023 NOPR, DOE proposed to combine passage and freight non-display door classes and instead differentiate non-display doors by whether or not they have motorized door openers. 88 FR 60746, 60761. Unlike door size, DOE tentatively determined that the presence or absence of a motorized door opener was a performance-related feature that justified adopting a different standard. As with its prior analysis, DOE also evaluated the motorized and non-motorized non-display door classes by temperature conditions: medium-temperature (*i.e.*, cooler) and low-temperature (*i.e.*, freezer). *Id*.

As discussed in the March 2024 NODA, DOE received comments in response to the September 2023 NOPR indicating that other electricity-consuming devices such as heated vents, heated viewing windows, lights, and thermometer/temperature alarms provide functionality. These physical and functional attributes, which can be installed on non-display doors, were not considered in the representative units analyzed in the September 2023 NOPR but would be included in the calculation of daily energy consumption ("DEC") per the test procedure. The current MDEC standards allow for additional electrical components such as heated vents, heated viewing windows, lights, and thermometer/temperature alarms to be included and considered in the DEC calculation. However, the basis of the energy conservation standards proposed in the September 2023 NOPR only accounted for the electrical energy consumption from anti-sweat heat around the perimeter of the door (and motors for doors classified as "motorized non-display doors"). As a result, in the March 2024 NODA, DOE tentatively concluded that the proposed standards as outlined in the September 2023 NOPR may be difficult to meet for basic models of doors that have additional electrical components beyond what DOE considered in its representative units. 89 FR 18555, 18556-18559.

Therefore, in the March 2024 NODA, DOE presented an updated analysis that included MDEC allowances for non-display doors with certain electricity-consuming devices based on the feedback received in response to the September 2023 NOPR. These MDEC allowances represent additional energy consumption added to the adopted standard calculation based on the presence of these certain electricity-consuming devices. The MDEC allowances implement the four features as adders which effectively result in a less-stringent standard when applied to the base equipment class. In the March 2024 NODA, DOE considered MDEC allowances, which represent additional equipment classes of non-display doors, if manufacturers offer basic models with any combination of the following four electricity-consuming devices:

- Lighting
- Anti-sweat heat for viewing window
- Digital temperature display with or without alarms
- Heated pressure relief vent

The four features are implemented as adders, which effectively result in a less-stringent standard when applied to the base equipment class. For example, if a basic model is sold with lighting, then the basic model would be subject to the adopted standard for that equipment class (*i.e.*, manual or motorized, low-temperature or medium-temperature non-display door) plus the lighting MDEC allowance. The allowances are additive, *i.e.*, maximum allowed MDEC is increased for each of the devices that is present on the door.

Each of these electrical components is a performance-related feature that provides functionality to the consumer when installed on a non-display door. Pursuant to EPCA, DOE may establish separate standards for a group of covered equipment (*i.e.*, establish a separate equipment class) if DOE determines that separate standards are justified based on the type of energy used or if DOE determines that the equipment's capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)(1)(B)) In the March 2024 NODA, DOE noted that these devices constitute a performance-related feature that justifies a higher standard. DOE sought comment in the March 2024 NODA on the MDEC allowances for the specified electricity-consuming devices. 89 FR 18555, 18559. DOE discusses comments received regarding the MDEC allowances in section IV.C.1.c of this document.

In this final rule, DOE is adopting the approach outlined in the updated analysis from the March 2024 NODA, that lighting, anti-sweat heat for viewing windows, digital temperature displays with or without alarms, and heated pressure-relief vents constitute performance-related features that justify a higher MDEC standard. Each equipment class of non-display doors is being further subdivided based on whether each electricity-consuming device is present or not present. DOE analyzed the equipment classes listed in Table IV.2 for walk-in non-display doors. DOE further evaluated the MDEC allowances for classes of non-display doors with lighting, anti-sweat heat for viewing windows, digital temperature displays with or without alarms, and/or heated pressure relief vents.

Table IV.2 Analyzed Equipment Classes for Walk-In Non-Display Doors

Opening Mechanism	Temperature	Class Code
Manual	Medium	NM.M
	Low	NM.L
Motorized	Medium	NO.M
	Low	NO.L

DOE discusses representative units, baseline assumptions for representative unit efficiency, and design options analyzed at higher efficiency levels for walk-in non-display doors in section IV.C.1.c of this document. DOE discusses MDEC allowances and the comments received in response to the March 2024 NODA regarding the MDEC allowances in section IV.C.1.c of this document.

b. Panels

DOE's existing standards for walk-in panels apply to three equipment classes that are differentiated by whether they are structural (also referred to as "wall or ceiling panels") or floor panels. Structural panels are further separated by temperature condition (*i.e.,* cooler or freezer). DOE's analysis for the June 2014 Final Rule determined that, unlike walk-in freezers, the majority of walk-in coolers have concrete floors and no insulated floor panels. DOE expected that setting an R-value requirement for walk-in cooler floor panels would cause manufacturers to stop selling cooler floor panels to avoid the certification burden. Thus, DOE did not adopt insulation R-value standards for walk-in cooler floors. 79 FR 32050, 32067. DOE's re-evaluation of the market for this rulemaking suggests that the walk-in cooler floor panel market has not changed substantially since the June 2014 Final Rule. Therefore, DOE has excluded walk-in cooler floor panels from this rulemaking.

DOE currently defines separate energy conservation standards for the following walk-in panel classes (10 CFR 431.306(a)):

- Structural Panel, Medium-Temperature
- Structural Panel, Low-Temperature
- Floor Panel, Low-Temperature

DOE has not established energy conservation standards for display panels because they make up a small percentage of the panel market; therefore, standards would not result in significant energy savings without incurring disproportionate costs. 79 FR 32050, 32067. In the September 2023 NOPR, DOE proposed maintaining the current panel equipment classes. 88 FR 60746, 60761-60762. DOE received no comment regarding panel equipment classes in response to the September 2023 NOPR. As such, DOE is maintaining its current equipment classes for walk-in panels. Table IV.3 summarizes the equipment classes for walk-in panels.

Table IV.3 Equipment Classes for Walk-In Panels

Component	Temperature	Class Code
Structural Panel	Medium	PS.M
	Low	PS.L
Floor Panel	Low	PF.L

c. Refrigeration Systems

DOE's existing standards for walk-in refrigeration systems apply to nine equipment classes, differentiated by whether they are unit coolers or dedicated condensing systems and by temperature (*i.e.,* whether they are a cooler or freezer). A "dedicated condensing system" means a dedicated condensing unit, a single-packaged dedicated system, or a matched refrigeration system. (*See* 10 CFR 431.302.) Dedicated condensing systems are further differentiated by their installation location (*i.e.,* indoor or outdoor). Low-temperature dedicated condensing systems and unit cooler equipment classes are further differentiated by net capacity. DOE currently defines separate energy conservation standards for the following walk-in refrigeration system classes (10 CFR 431.306(e)):

- Dedicated Condensing System, Medium-Temperature, Indoor
- Dedicated Condensing System, Medium-Temperature, Outdoor
- Dedicated Condensing System, Low-Temperature, Indoor, Net Capacity of less than 6,500 Btu/h
- Dedicated Condensing System, Low-Temperature, Indoor, Net Capacity of greater than or equal to 6,500 Btu/h
- Dedicated Condensing System, Low-Temperature, Outdoor, Net Capacity of less than 6,500 Btu/h

- Dedicated Condensing System, Low-Temperature, Outdoor, Net Capacity of greater than or equal to 6,500 Btu/h
- Unit Cooler, Medium-Temperature
- Unit Cooler, Low-Temperature, Net Capacity of less than 15,500 Btu/h, and
- Unit Cooler, Low-Temperature, Net Capacity of greater than or equal to 15,500 Btu/h.

Single-packaged dedicated systems, which are dedicated condensing systems with a combined condensing unit and unit cooler, were not evaluated separately from dedicated condensing units and matched refrigeration systems in the previous rulemaking. New test procedure provisions in appendix C1 require specific test methods for single-packaged dedicated systems that measure the inherent thermal losses of such systems. These thermal losses reduce the capacity and therefore the efficiency of single-packaged dedicated systems.

As discussed in the September 2023 NOPR, in general, DOE has separated packaged equipment from split dedicated condensing systems,[29] as packaged equipment provides consumers with more options for space-constrained applications. Single-packaged dedicated systems have both the cold and hot sides connected within the

[29] Split dedicated condensing systems or split systems refer to any dedicated condensing system that is made up of a unit cooler and a remote dedicated condensing unit. The systems are split because the unit cooler and dedicated condensing unit are not in the same package.

packaged framework and the cold side is exposed to the outside, which increases the losses associated with the thermal loads. Single-packaged dedicated systems are constrained by the overall dimensions and weight limitations of the equipment; therefore, manufacturers cannot employ the same technologies, such as increased heat exchanger sizes. In the September 2023 NOPR, DOE tentatively concluded that single-packaged system and split system walk-in refrigeration systems cannot be combined into the same equipment class because single-packaged systems provide consumers with more options for space-constrained applications and inherent differences in system design between packaged systems and split systems limit the efficiency of the former. For these reasons, in the September 2023 NOPR, DOE evaluated single-packaged dedicated systems separately from split systems. 88 FR 60746, 60762-60763.

DOE did not receive any comments in response to the September 2023 NOPR or March 2024 NODA regarding its separation of equipment classes for single-packaged dedicated systems and split systems. Further, DOE maintains its conclusion that separate equipment classes are warranted for single-packaged dedicated systems and split systems. Therefore, in this final rule, DOE maintained a separate analysis for single-packaged dedicated systems and split systems equipment classes.

In the May 2023 TP Final Rule, DOE defined a high-temperature refrigeration system as a walk-in refrigeration system that is not designed to operate below 45 °F. 88 FR 28780, 28789. DOE established a test procedure for high-temperature unit coolers, matched refrigeration systems, and single-packaged dedicated condensing systems, but did not establish a test procedure in the May 2023 TP Final Rule for high-temperature dedicated condensing units tested alone. 88 FR 28780, 28816–28817. As such, DOE did not analyze high-temperature dedicated condensing units as an equipment class, but did analyze high-temperature unit coolers, matched refrigeration systems, and single-packaged dedicated condensing systems in the September 2023 NOPR analysis. 88 FR 60746, 60762–60763.

High-temperature units are generally smaller capacity than medium-temperature units and therefore contain small-capacity compressors, which DOE has found to be less efficient. Additionally, some high-temperature units are either sold in ducted or non-ducted configurations, dependent on the configuration of the walk-in box and surrounding space. Ducting adds flexibility to the installation location and removes refrigeration equipment from the refrigerated storage space. However, ducting imposes a higher external static pressure on the system's fans and therefore, a ducted system has greater energy consumption to maintain the same or sufficient airflow (and sufficient cooling capacity) as a system without ducting. DOE tentatively concluded ducting of high-temperature units constitutes a performance-related feature. Therefore, in the September 2023 NOPR, DOE evaluated high-temperature ducted and non-ducted units as separate equipment classes. *Id*.

For the September 2023 NOPR, different from the treatment of medium-temperature and low-temperature matched refrigeration systems and single-packaged dedicated systems, DOE evaluated high-temperature matched refrigeration systems and high-temperature single-packaged dedicated systems as a single equipment class because the temperature difference between the refrigerated and ambient spaces for high-temperature refrigeration systems is less than the temperature difference for medium- and low-temperature systems. Therefore, thermal losses have less impact for high-temperature systems. This means that the difference in performance between high-temperature matched refrigeration systems and high-temperature single-packaged dedicated systems is much less than the performance difference expected between medium- or low-temperature matched refrigeration systems and medium- or low-temperature single-packaged dedicated systems. Because of the expected similarity in performance, DOE tentatively determined that a single class of equipment encompassing high-temperature matched refrigeration systems and single-packaged dedicated systems is appropriate. In its September 2023 NOPR analysis of high-temperature refrigeration units, DOE focused on single-packaged dedicated systems since this is where most of the shipments are concentrated for the high-temperature market. *Id*.

DOE did not receive any comments in response to the September 2023 NOPR or March 2024 NODA regarding its selection of high-temperature refrigeration system equipment classes. Further, DOE maintains its conclusions that the high-temperature refrigeration system classes proposed in the September 2023 NOPR are appropriate. Therefore, in this final rule, DOE maintained the high-temperature equipment classes analyzed in the September 2023 NOPR.

DOE analyzed and is establishing the equipment classes for refrigeration systems for this final rule presented in Table IV.4.

Table IV.4 Equipment Classes for Walk-In Refrigeration Systems

System	Temperature	Location	Class Code
Dedicated Condensing Units and Matched Refrigeration Systems	Medium-Temperature	Outdoor	DC.M.O
		Indoor	DC.M.I
	Low-Temperature	Outdoor	DC.L.O
		Indoor	DC.L.I
Unit Cooler	High-Temperature (Non-Ducted)	N/A	UC.H
	High-Temperature (Ducted)		UC.H.D
	Medium-Temperature		UC.M
	Low-Temperature		UC.L
Matched Refrigeration Systems and Single-Packaged Dedicated Systems	High-Temperature (Non-ducted)	Outdoor	SP.H.O
		Indoor	SP.H.I
	High-Temperature (Ducted)	Outdoor	SP.H.O.D
		Indoor	SP.H.I.D
Single-Packaged Dedicated Systems	Medium-Temperature	Outdoor	SP.M.O
		Indoor	SP.M.I
	Low-Temperature	Outdoor	SP.L.O
		Indoor	SP.L.I

In the September 2023 NOPR, DOE evaluated multiple capacities in each equipment class to better ascertain the relationship between efficiency and net capacity. In this final rule, DOE maintained the same approach and evaluated multiple capacities in each equipment class. This is discussed in more detail in the Representative Units subsection of section IV.C.1.e of this document.

2. Technology Options

DOE considered separate technology options for whole walk-ins, doors and panels, and refrigeration systems.

a. Fully Assembled Walk-Ins

Although DOE has set standards for walk-in components (*i.e.*, panels, doors, and refrigeration systems) rather than fully assembled walk-ins, EPCA gives DOE authority to establish standards that address fully assembled walk-ins. (42 U.S.C. 6313(f)(4)). Hence, DOE has considered technologies that could be relevant for fully assembled walk-ins in its technology assessment. In the market analysis and technology assessment presented in chapter 3 of the June 2022 Preliminary Analysis TSD and in the September 2023 NOPR, DOE identified seven technology options that would be expected to improve the efficiency of a fully assembled walk-in (*i.e.,* wall, ceiling and floor panels, door(s), and refrigeration system(s)) but would not apply specifically to any of the components analyzed in this rulemaking:

1) Energy storage systems,

2) Refrigeration system override,

3) Automatic evaporator fan shut-off,

4) Non-penetrative internal racks and shelving,

5) Humidity sensors,

6) Fiber optic natural lighting, and

7) Heat reclaim valve.

DOE received no comments on the technology options that might improve the efficiency of whole walk-ins in response to the September 2023 NOPR. DOE maintained the same technology options for whole walk-ins for this final rule analysis. DOE further discusses these technology options in chapter 3 of the final rule TSD.

b. Doors and Panels

In the NOPR market analysis and technology assessment, DOE identified 15 technology options that would be expected to improve the efficiency of doors and/or panels, as measured by the DOE test procedure. The technology options analyzed for doors in the September 2023 NOPR are listed in Table IV.5.

Table IV.5 Summary of Door- and Panel-Related Technology Options Analyzed in the September 2023 NOPR

Technology Options	Applicable Component
Door gaskets	Doors
Anti-sweat heater/freezer wire controls	
Display and window glass system insulation performance	
Non-electric, reduced, or no anti-sweat systems	
Improved frame systems	
Automatic door opening and closing systems	
Occupancy sensors	
High-efficiency lighting	
Utilization of box design to minimize anti-sweat heater systems	
Automatic insulation deployment systems	Display doors
Infiltration-reducing devices or systems (*e.g.*, air curtains, strip curtains, vestibule entryways, revolving doors)	Non-display doors

<table>
<tr><td>Insulation thickness and material</td><td rowspan="2">Non-display doors and panels</td></tr>
<tr><td>Damage-sensing systems (e.g., air and water infiltration sensors, heat flux sensors)</td></tr>
<tr><td>Panel interface systems</td><td rowspan="2">Panels</td></tr>
<tr><td>Structural materials</td></tr>
</table>

DOE received comments regarding several of the technology options pertaining to the screening or use of these technology options in the engineering analysis in response to the September 2023 NOPR and March 2024 NODA. DOE summarizes those comments and addresses them further in sections IV.B and IV.C of this document.

DOE did not receive any comments suggesting that specific new technology options for doors and panels be considered; therefore, DOE is considering the same technology options for doors and panels in this final rule that it considered in the September 2023 NOPR.

c. Refrigeration Systems

In the September 2023 NOPR, DOE identified 17 technology options that would be expected to improve the efficiency of refrigeration systems,

1. Improved evaporator and condenser fan blades,
2. Improved evaporator and condenser coils,
3. Evaporator fan control,
4. Oil management systems,

5. Hydrocarbon refrigerants,[30]

6. Ambient subcooling,

7. Higher efficiency fan motors,

8. Higher efficiency compressors,

9. Variable-speed compressors,

10. Liquid suction heat exchanger,

11. Adaptive defrost,

12. Hot gas defrost,

13. Floating head pressure,

14. Variable-speed condenser fan control,

15. Economizer cooling,

16. Crankcase heater controls, and

17. Improved thermal insulation for single-packaged dedicated systems.

88 FR 60746, 60764–60765.

Regarding the technology options analyzed in the September 2023 NOPR, the CA IOUs recommended that DOE consider additional design options in its analysis that could justify even more cost-effective savings for TSL 2, specifically evaporator fin density, two-speed condenser fan modulation, more-efficient single-speed compressors, electronic expansion valves, and efficiency improvements to condensate pan heating. (CA IOUs, No. 76 at p. 1) Similarly, ASAP *et al*. recommended that DOE consider electronic

[30] Hydrocarbon refrigerants were not listed as a technology option in the September 2023 NOPR notice. 88 FR 60746, 60764-60765. However, they were listed as a technology option on p. 3–41 of chapter 3 of the NOPR TSD and considered in the September 2023 NOPR analysis as a design option to improve AWEF2 of certain refrigeration system representative units.

expansion valves (“EEVs”) as a design option for outdoor refrigeration systems. (ASAP *et al*., No. 77 at pp. 2–3)

DOE notes that evaporator fin density and more-efficient single-speed compressors were considered as technology options in the September 2023 NOPR as a part of improved evaporator coils and higher efficiency compressors, respectively. *See* sections 3.3.7.2 and 3.3.8.3 of chapter 3 of the September 2023 NOPR TSD. In response to these recommendations, DOE considered two-speed condenser fan controls, EEVs, and condensate pan heating controls as technology options for this final rule analysis. In response to comments submitted on the September 2023 NOPR, DOE also evaluated more efficient single-speed compressors in the March 2024 NODA. 89 FR 18555, 18560-18561. A more detailed discussion of additional comments submitted in response to the technology and design options analyzed in the September 2023 NOPR and March 2024 NODA is included in section IV.B.1.c and the Design Options subsection of sections IV.C.1.e and IV.C.1.f of this document.

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 results 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, sections 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 criteria, and whether DOE determined that a technology option should be excluded ("screened out") based on the screening criteria.

1. Screened-Out Technologies

a. Fully Assembled Walk-Ins

In the June 2022 Preliminary Analysis and September 2023 NOPR, DOE screened out the following technology options under the tentative assumption that they would not affect rated energy consumption of the walk-in components as measured by the DOE test procedure. While these technologies may improve the energy efficiency of a fully assembled walk-in installed in the field, DOE's current walk-in test procedures are component specific. DOE initially established the current approach in its April 15, 2011, final rule in which DOE found that a component-based approach would address the unique challenges posed in regulating the energy efficiency performance of walk-in envelopes. 76 FR 21580, 21582. As noted in that rule, these challenges include the fact that walk-in units are frequently assembled using components made by multiple manufacturers, and walk-in installers may not be equipped to test all the components that comprise a walk-in. The screened-out options included the following:

- Energy storage systems,
- Refrigeration system override,
- Automatic evaporator fan shut-off,

- Non-penetrative internal racks and shelving,
- Humidity sensors, and
- Heat reclaim valves.

88 FR 60746, 60765.

Furthermore, in this final rule, DOE is screening out fiber optic natural lighting because it would not affect rated energy consumption of the walk-in components as measured by the DOE test procedure.

DOE did not receive any comments in response to the September 2023 NOPR screening analysis regarding technologies applicable to fully assembled walk-ins. As such, in this final rule, DOE has screened out all technology options for fully assembled walk-ins for the same rationale as provided in the September 2023 NOPR. For details of this screening analysis, *see* section 4.2.1 of chapter 4 of the final rule TSD.

b. Doors and Panels

In the September 2023 NOPR, DOE screened out the following technology options because any reduction in energy use would not be captured by the test procedure in appendix A to subpart R of 10 CFR part 431 (“appendix A”) for doors, and any increase in overall thermal improvement of a panel would not be captured by the test procedure that measures R-value of insulation only in appendix B to subpart R of 10 CFR part 431 (“appendix B”):

- Infiltration-reducing devices,

- Air and water infiltration sensors,
- Heat flux sensors, and
- Structural materials for panels.

88 FR 60746, 60765–60766.

Infiltration-reducing technologies could include door gaskets, automatic door opening and closing systems, air curtains, strip curtains, vestibule entryways, revolving doors, and panel interface systems. DOE had tentatively determined that any potential energy savings from infiltration-reducing devices would not be captured because air infiltration is a characteristic of a fully assembled walk-in. The walk-in test procedures do not evaluate the energy use of the assembled walk-in box and instead evaluate the energy use of a single component (*i.e.*, door or panel); therefore, technologies that may improve energy efficiency of the full walk-in box were screened out. *Id.*

Additionally, DOE tentatively concluded that any potential energy savings from air and water infiltration sensors, heat flux sensors, and structural materials for panels would not be captured by either the appendix A or appendix B test procedures. Air and water infiltration sensors and heat flux sensors are technology options that would most benefit the end user for monitoring the continuing performance of walk-in components; however, the potential degradation captured by these sensors over the lifetime of a walk-in are not reflected in the current test procedure. Additionally, changes to panel structural materials are not captured in the test procedure since the current walk-in panels test procedure provides a method for determining the R-value of the panel insulation only. In other words, the overall thermal performance of the panel, including structural materials, is not captured by the current test procedure. Therefore, such technologies were screened out. *Id.*

Additionally, in the September 2023 NOPR, DOE screened out the technology option to utilize insulation from the box/cooler wall to minimize door anti-sweat heat power. 88 FR 60746, 60766. As discussed in the September 2023 NOPR, DOE recognizes that an ideally designed walk-in box ensures that panel design could reduce door sweating; however, since its walk-in test procedures evaluate the performance of walk-in components separately, these design pairings are not captured by the test procedure and therefore cannot be used to analyze higher efficiency levels. *Id.*

Furthermore, in the September 2023 NOPR, DOE screened out the following technologies due to technological infeasibility since DOE was not able to find these technologies incorporated into either prototypes or commercially available walk-in doors or panels:

- Non-electric anti-sweat systems,
- Higher efficiency LEDs, and
- Automatic insulation deployment systems.

Id.

DOE screened out panel and door insulation thicker than 6 inches because DOE received feedback during manufacturer interviews that it is not practicable to manufacture and install. DOE tentatively concluded that insulation thicker than 6 inches would be heavy, unwieldy, and take up space that the consumer would otherwise use. Additionally, panels and non-display doors greater than 6 inches that use foam-in-place insulation would take an excessive amount of time to cure, impacting the practicability to manufacture, install, and service. *Id*.

In response to the September 2023 NOPR, Senneca and Frank Door commented that aerogels and vacuum-insulated panels are not usable as framing materials and cannot support the weight of the product; nor can they hold fasteners such as screws and bolts. Senneca and Frank Door commented that DOE's conclusion that the proposed standards are technologically feasible based on a manufacturer's ability to use aerogels and vacuum-insulated panels should be withdrawn. Senneca and Frank Door stated that two-part polyurethane foam is essential to the ability of a walk-in door to function properly because it is an insulator and the method manufacturers use to keep the framing materials and metal skins adhered to one another. Senneca and Frank Door commented that incorporating aerogels or vacuum insulation would lessen the utility and performance of WICF doors. Senneca and Frank Door also stated that aerogels cannot be exposed to moisture, which is present in all WICFs. Senneca and Frank Door stated that neither aerogels nor vacuum insulation are commercially available for use by WICF door manufacturers. (Senneca and Frank Door, No. 78 at pp. 3–5) Furthermore, Senneca and Frank Door commented that DOE’s estimated costs of incorporating aerogels and vacuum insulation into WICF doors are severely underestimated. (Senneca and Frank Door, No. 78 at p. 10)

DOE did not consider aerogels and vacuum-insulated panels as design options in the September 2023 NOPR to improve thermal insulation of framing materials of doors and/or panels. In section 3.3.5.1 of the September 2023 NOPR TSD, DOE discusses potential thermal improvements through the use of insulation thickness and materials relevant to non-display doors and panels. In that section, DOE describes the primary method through which to improve insulating capacity—*i.e.*, by increasing insulation thickness using existing foam materials. DOE also stated that other options to improve the insulating capacity of the envelope could include the use of insulating materials that have higher thermal resistance per inch of thickness than materials currently used, such as aerogels and vacuum-insulated panels. While these were mentioned as potential technology options, DOE did not evaluate the use of aerogels or vacuum-insulated panels in the September 2023 NOPR analysis as alternative insulating materials in non-display doors and panels. Similarly, in this final rule analysis, DOE did not consider the use of aerogels or vacuum-insulated panels.

As discussed in the September 2023 NOPR, walk-in doors typically use anti-sweat heater wires to prevent (1) condensation from collecting on the glass, frame, or any other portion of the door, which can puddle and be hazardous to walk-in users; (2) glass from fogging; and (3) condensation that may lead to low-temperature doors freezing shut. The amount and rate of condensation on walk-in doors is dependent on the relative humidity surrounding the walk-in and the surface temperature of the door. It can also be affected by the thermal resistance of the door frame and edge materials. To ensure the temperature of the door surface stays above the dewpoint of its surroundings, electric resistive heater wire is installed around the frame of the door. DOE recognizes that anti-sweat systems on doors may be necessary in high-humidity environments and DOE does not have sufficient evidence to demonstrate that anti-sweat heat can be removed from doors installed in all climate zones of the United States without having a potential negative impact on the safety and functionality of the walk-in. Therefore, DOE screened out the elimination of anti-sweat heater systems in the September 2023 NOPR on the basis of safety of technology. 88 FR 60746, 60766. However, DOE screened in reduced anti-sweat heat. *Id.* at 88 FR 60767. DOE evaluated the energy savings and cost associated with reducing rated anti-sweat heater power for medium-temperature and low-temperature doors based on a combination of certified values in DOE's Compliance Certification ("CCMS") database, rated anti-sweat heater power per linear foot of wire based on product literature, and information received during confidential interviews with manufacturers. *Id*. at 88 FR 60770.

In response to the September 2023 NOPR, Senneca and Frank Door commented that reducing the amount of anti-sweat heat would lessen the utility, performance, and safety of walk-in doors such that doors could freeze shut and puddles or ice patches could form on the floor. Senneca and Frank Door commented that reducing or eliminating anti-sweat heat is not sufficient to meet the proposed standard. (Senneca and Frank Door, No. 78 at pp. 4–5) NAFEM commented that the prior WICF rulemaking resulted in safety concerns because by reducing the door perimeter heater's wattage, passage doors are more likely to freeze closed and temporarily trap workers. NAFEM commented that WICF manufacturers have reported an increase in consultants requesting corrective action concepts and strategies to allow trapped workers to open frozen doors through secondary, fail-safe methods other than the emergency release handles or push buttons used on most walk-in doors. (NAFEM, No. 67 at p. 3)

DOE also received comments in response to the September 2023 NOPR from RSG and Kolpak supporting the levels of reduced anti-sweat heat that DOE analyzed. (Kolpak, No. 66, Attachment 1 at p. 1; RSG, No. 69 at p. 1) Kolpak agreed with DOE's proposal to reduce anti-sweat heater wire power and commented that the anti-sweat heater wires on its non-display doors have already been reduced to 1 W/ft for medium-temperature and 5 W/ft for low-temperature. Additionally, Kolpak commented that the anti-sweat heater wire power on its non-display doors use bimetallic thermostat controls that turn the heater wire off once it has reached a temperature required to remove condensation. (Kolpak, No. 66, Attachment 1 at p. 1) RSG commented that it has already reduced heater wire power to the level proposed in the September 2023 NOPR; therefore, the reduced heater wire power values proposed in the September 2023 NOPR should be acceptable for most applications. (RSG, No. 69 at p. 1)

In response to the March 2024 NODA, DOE received additional comments regarding the screening of reduced anti-sweat heat.[31]

Although RSG previously commented in support of the levels of anti-sweat heat analyzed in the September 2023 NOPR, in response to the March 2024 NODA, RSG commented that to meet the standards in the March 2024 NODA, RSG's door frame anti-

[31] DOE did not update its analysis regarding anti-sweat heat around the perimeter of the door leaf in the March 2024 NODA. DOE nevertheless considered these comments as part of developing the final rule.

sweat heaters would need to be reduced to half the current wattage and this reduction could result in formation of condensate water, which is a safety slip issue. RSG stated that the heater wire wattages were reduced about 50 percent to meet the 2017 door MDEC standards. RSG commented that a balance should exist between energy consumption and safety when considering new energy requirements. RSG commented that technology options for walk-in door construction have not significantly changed since 2017 and are limited largely to existing components and insulation science. RSG commented that manual non-display doors may be a category best suited for no new changes, similar to panels. (RSG, No. 89 at p. 1) Despite the fact that RSG previously commented in support of the reduced anti-sweat heat levels that DOE analyzed, DOE is viewing RSG's latest comment in response to the March 2024 NODA as its current position on the screening of this technology option.

Imperial Brown commented that door perimeter heater cables are critical components of walk-in freezer doors that eliminate condensation or frost formation at the door perimeter. Imperial Brown commented that in a worst-case scenario, a door could become frozen shut, leading to entrapment and risk of death. Imperial Brown stated that it reduced the power consumption of its perimeter heater cables in response to the first WICF standards rulemaking and even though Imperial Brown has not witnessed freezing issues since, condensation issues are not uncommon, especially in high-humidity geographical areas. Imperial Brown commented it does not believe that it can further reduce the power rating of its perimeter heater cables without risking doors freezing shut and endangering lives. Imperial Brown commented it targets heater cables rated at 4.5 to 5.5 W/ft of door perimeter for PVC frame doors and non-PVC frame doors, respectively.

Imperial Brown stated that because heater cables are only available in limited ohms/ft ratings, the real heat cable W/ft will differ from the target number and that deviation can be as much as ± 25 percent. Imperial Brown provided a description of how it wires its doors. (Imperial Brown, No. 84 Attachment 1 at p. 2) Imperial Brown commented it does not know of ways to reduce energy consumption of its—or competitors'—freezer door perimeter heater cables without producing unacceptable products. Imperial Brown commented that condensation on door gaskets may lead to mold growth (health hazard) and frost formation around the door (life hazard). (Imperial Brown, No. 84 at p. 3) Imperial Brown also provided DEC numbers for several of its models. (Imperial Brown, No. 84, Attachment 2)

Regarding NAFEM's comments that the prior rulemaking (*i.e.*, June 2014 Final Rule) resulted in safety concerns, DOE notes the performance standards finalized in the prior rulemaking and in this rulemaking are not prescriptive, *i.e.*, they don't prescribe use of specific design options or technologies to reduce energy consumption. Therefore, manufacturers may comply with MDEC standards using any technologies they see fit, and the standard levels themselves set no explicit requirements on anti-sweat heater wattage levels. In the June 2014 Final Rule, DOE included anti-sweat heat for both cooler and freezer non-display doors in its analysis but did not analyze reduced anti-sweat heat as a design option; therefore, the standard levels adopted for non-display doors in the June 2014 Final Rule were representative of baseline anti-sweat heat wattage used in non-display doors at the time. 79 FR 32050. Furthermore, there are several factors besides anti-sweat heat wattage that could affect the chances that a low-temperature non-display door would freeze shut, including but not limited to the humidity of the environment, the thermal characteristics of the door, how well the walk-in door is sealed during construction and installation, and how often the door is opened. RSG and Imperial Brown commented that in response to the MDEC standards that went into effect in 2017 they both reduced the anti-sweat heat on their non-display doors to a level that they indicate is the minimum level required to restrict the formation and freezing of condensation to prevent safety issues under typical conditions in the field. Imperial Brown commented that it has not witnessed doors freezing shut with the current anti-sweat heat levels that it uses. Stakeholder feedback primarily indicates that further reducing anti-sweat heat beyond what is used to meet the existing standards increases the risk of condensation forming on non-display doors. Based on public comments and data included in those public comments and a review of certified data, DOE has concluded that manufacturers offer models for sale that use anti-sweat heat wattage around the perimeter of the door leaf at levels equal to or lower than those analyzed for the reduced anti-sweat heat design option in the September 2023 NOPR. For example, DOE identified 20 manufacturers of medium-temperature non-display doors that use anti-sweat heater wire wattage around the perimeter of the door leaf that is less than or equal to what DOE analyzed for the reduced anti-sweat heat design option. Similarly, DOE has identified low-temperature non-display doors with anti-sweat heat levels that are at or below the reduced ASH level that DOE analyzed in this rulemaking. The presence of these doors on the market with lower ASH wattage than what DOE analyzed indicates that manufacturers are safely applying these designs in the field today without leading to an increase in safety incidents or increasing risks. As such, DOE is not screening out reduced anti-sweat heat as a technology option for non-display doors in this final rule.

However, as discussed in section V.C.1.b of this document, DOE does not expect that the standard level adopted in this final rule for non-display doors would necessitate the use of reduced anti-sweat heat. Rather, DOE expects that manufacturers would incorporate anti-sweat heat controls, which only limit or turn off anti-sweat heat when anti-sweat heat is not necessary based on the ambient conditions, to meet the standard level adopted in this final rule for non-display doors. DOE does not expect to see an increase in condensation when the anti-sweat heat is turned off when ambient conditions do not result in a need to reduce the humidity.

The September 2023 NOPR and March 2024 NODA also evaluated reduced thermal conduction load through improved framing systems and materials. In response, Kolpak commented that it supports requiring more-efficient frames. (Kolpak, No. 66, Attachment 1 at p. 3)

Senneca and Frank Door commented that DOE's determination that the proposed standards are technologically feasible for all non-display doors does not consider doors that are manufactured separately from the walk-in box in which they are installed. Senneca and Frank Door stated that these types of doors must be bolted onto the walk-in box in the field using various fasteners and the commenters are unaware of any framing materials for these types of doors with a low enough U-factor that could meet the proposed standard levels. (Senneca and Frank Door, No. 78 at p. 5) Additionally, Senneca and Frank Door commented that common framing materials include aluminum, plastics, and wood and that the commenters are unaware of any framing materials with a low enough U-factor to comply with the proposed standards. (Senneca and Frank Door, No. 78 at pp. 3–4) Imperial Brown stated that non-PVC frame doors are a necessity for applications that have higher structural requirements (*e.g.,* bigger doors with heavier pass-thru traffic or doors installed in areas with seismic or high wind exposures). (Imperial Brown, No. 84 at p. 2)

Despite mixed support and opposition of thermal improvements to framing systems in doors, DOE is aware through public comments and review of the market that better thermally insulating (and therefore less energy consumptive) frame systems exist on the market. Some stakeholder comments suggest that such thermally-improved frame designs may have reduced structural rigidity compared to traditional (*e.g.*, wood) framing systems. Nonetheless, DOE expects that non-display doors with thermally-improved frames can maintain a certain level of resiliency to typical structural loads (*e.g.*, accommodating typical walk-in traffic) because they are available for sale in the walk-in market. As such, DOE is not screening out the improved frame design option for non-display doors in this final rule. Nevertheless, due to the variability in structural loads that walk-in doors may be subject to, DOE recognizes that there is not full certainty that the best thermally-insulating frame systems available on the market would be sufficiently robust in certain circumstances. If there are cases where thermally-improved frame designs are not sufficiently robust in structure, then this could result in the need for earlier replacement of certain non-display doors. DOE considers and discusses the impact to consumer economics as a result of a potentially reduced lifetime for non-display doors in section IV.F.7 of this document.

In this final rule, DOE is screening out the same technologies for doors and panels that it screened out in the September 2023 NOPR. DOE further discusses considerations for adopting a standard level that could require reduced anti-sweat heat and improved frame design options in section V.C.1.a of this document.

c. Refrigeration Systems

In the September 2023 NOPR, DOE tentatively determined that adaptive defrost, hot gas defrost, oil management systems, and economizer cooling would not affect the measured AWEF2 value of walk-in refrigeration systems based on the DOE test procedures outlined in the newly adopted appendix C1. 88 FR 60746, 60766. DOE did not receive any comments in response to the September 2023 NOPR regarding its tentative conclusion. DOE maintains this conclusion for the final rule.

In the September 2023 NOPR, DOE responded to CA IOU comments requesting that DOE include EEVs as a standalone technology option. 88 FR 66710, 66713. The CA IOUs commented that an EEV would reduce cycling losses and therefore save energy when compared to a thermostatic expansion valve ("TXV"). *Id.* Because the tests conducted as part of the test procedure in appendix C1 are steady-state tests, DOE tentatively concluded that a test performed with a TXV would result in the same measured efficiency as a test of the same unit performed with an EEV. *Id.* In response, the CA IOUs commented they disagree with DOE's statement that DOE cannot include EEVs as a technology option because the test procedure measures refrigeration performance at steady-state conditions and would therefore not capture the energy savings of EEVs because, according to a study conducted by Hill Phoenix, an 8.7-percent reduction in kWh was found when using an EEV rather than a mechanical TXV at steady-state temperature. (CA IOUs, No. 76 at pp. 5–6)

DOE was not able to determine if the Hill Phoenix study was conducted at steady-state conditions from a chart shown by the CA IOUs with their comment. DOE notes that a refrigeration system with steady ambient air temperature and steady refrigerated storage space temperature may not qualify as a steady-state test. A steady-state test must include no compressor cycling, as the DOE test procedure specifies. *See* 10 CFR part 431, subpart R, appendix C1 and section C3.6.1 of AHRI 1250-2020. DOE was unable to find the complete study conducted by Hill Phoenix that the CA IOUs reference, so DOE is unable to confirm that the test was conducted at test conditions representative of the DOE test procedure for walk-in refrigeration equipment. DOE likewise cannot confirm that the savings seen in Hill Phoenix's study would be measurable by the DOE test procedure in appendix C1. Therefore, DOE determined it was appropriate to still screen out EEVs as a standalone design option given that no evidence has been presented to indicate that adding EEVs to walk-in refrigeration equipment would result in a measurable increase in efficiency when tested according to the DOE test procedure. EEVs within the context of the floating head pressure design option are discussed in more detail in section IV.C.1.e of this document.

In this final rule analysis, DOE has determined that the following technologies will not have an effect on walk-in refrigeration system efficiency as measured by appendix C1, and therefore is screening them out on that basis:

- Adaptive defrost,
- Hot gas defrost,
- Oil management systems,
- Economizer cooling, and
- Electronic expansion valves.

In the September 2023 NOPR, DOE also screened out three-phase motors as a technology option. 88 FR 60746, 60766. The use of three-phase motors requires three-phase power. Not all businesses that use walk-ins are equipped with three-phase power, and therefore must use single-phase equipment. DOE therefore screened out this technology option because it could result in the unavailability of this equipment with certain performance features for certain consumers. *Id*.

Furthermore, in the September 2023 NOPR, DOE screened out improved evaporator and condenser coils for high-temperature refrigeration systems on the grounds of having adverse impacts on the functionality of the equipment in response to stakeholder feedback regarding the space constraints imposed when installing high-temperature refrigeration systems. 88 FR 60746, 60766.

DOE did not receive comments in response to its tentative conclusions regarding the screening of improved evaporator and condenser coils for high-temperature refrigeration systems and three-phase motors. DOE maintains its conclusions from the September 2023 NOPR and is screening out three-phase motors and improved evaporator and condenser coils for high-temperature refrigeration systems in this final rule.

2. Remaining Technologies

a. Doors and Panels

Through a review of each technology, DOE concludes that all of the other identified technologies for doors and panels listed in section IV.A.2.b of this document met all five screening criteria to be examined further as design options in this analysis. In summary, DOE did not screen out the following technology options:

- Glass system insulation performance for display doors,
- Occupancy sensors (lighting controls) for doors,
- Anti-sweat heater controls for doors,
- Improved frame systems and materials for non-display doors,
- Reduced anti-sweat heater systems for non-display doors, and
- Increased insulation thicknesses up to 6 inches for non-display doors and panels.

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.

b. Refrigeration Systems

Through a review of each technology, DOE concludes that all the other identified technologies listed in section IV.A.2.c of this document met all five screening criteria to be examined further as design options in this analysis. In summary, DOE did not screen out the following technology options for walk-in refrigeration systems:

- Improved condenser and evaporator fan blades,
- Improved evaporator and condenser coils for medium- and low-temperature refrigeration systems,
- Off-cycle and on-cycle evaporator fan control,
- Hydrocarbon refrigerants,
- Ambient subcooling,
- Higher-efficiency condenser and evaporator fan motors (excluding three-phase motors),
- Higher-efficiency compressors,
- Variable-speed compressors,
- Liquid suction heat exchanger,
- Head pressure control,
- Condenser fan speed control (two-speed and variable-speed),

- Crankcase heater controls,
- Improved thermal insulation for single-packaged dedicated systems, and
- Condensate pan heating controls.

DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially available products 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.

In response to the September 2023 NOPR, NAFEM commented that the remaining design options for refrigeration systems are not new technologies and most were considered in the last WICF rulemaking. NAFEM stated that, therefore, these technologies do not serve as actionable opportunities for manufacturers to increase energy efficiency. (NAFEM, No. 67 at p. 3) In response, DOE notes that the technology options that DOE considers in the screening analysis and then the engineering analysis do not need to be technologies that were not considered in previous rulemakings. DOE has determined that the technology options identified as remaining technologies would increase the efficiency of walk-ins as measured by the test procedure and pass all screening criteria. The technologies could be in use already or have been used. This is considered when determining which design options are representative of the baseline units in the engineering analysis.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of each component of walk-ins (*i.e.*, doors, panels, refrigeration systems). 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).

For this final rule analysis, DOE used a design-option approach for doors, panels, dedicated condensing units, single-packaged dedicated systems, and high-temperature unit coolers. DOE used an efficiency-level approach for medium- and low-temperature unit coolers. These approaches are discussed in the following sections.

a. General Feedback

In response to the March 2024 NODA analysis, DOE received several comments of general feedback pertaining to the efficiency analysis.

AHRI requested a release of all documents and data, while maintaining individual manufacturer confidentiality, used to support the proposed amendments in the September 2023 NOPR and March 2024 NODA specifically related to unit coolers and refrigeration systems. AHRI stated its concern that DOE is not using physical units running in different conditions to complete off-cycle tests to determine the wattage, alternate refrigerants, and single-speed compressor changes. AHRI recommended DOE test physical products using a data evaluation process such as an alternative efficiency determination method ("AEDM") with validation that reflects the changes DOE proposed in the September 2023 NOPR and updated in the March 2024 NODA for all dedicated condensing units and unit coolers. AHRI stated that its members do not see the same results in real life that DOE has detailed in the September 2023 NOPR and March 2024 NODA. (AHRI, No. 86 at p. 4)

DOE collects data to inform the rulemaking process in many different ways. Some of this data is pulled from public sources such as product catalogs or public stakeholder comments. Other data sources are not public, such as information received through the public request for comments identified by stakeholders as confidential business information or information shared with DOE during confidential interviews. In an effort to be as open as possible and solicit the best feedback possible, DOE publishes summary data and analyses in the TSDs that accompany rulemaking documents and, in the case of walk-ins, the engineering spreadsheets used in the rulemaking. Many of the assumptions or values that feed into these analyses are a result of aggregated and anonymized confidential feedback. DOE is unable to share additional data that informs the walk-ins rulemaking given its legal obligations to maintain confidentiality of such data, even if sources were anonymized. DOE received comments that requested the release of specific data, which are discussed in the following sections.

To understand the efficiencies of units currently available on the market, DOE conducted a round of refrigeration system testing. Additional analysis and teardowns of these units also informed the off-cycle power and design option performance considered in this rulemaking. It would be overly burdensome for DOE to conduct a physical test for every representative unit with every combination of design options analyzed in this final rule analysis. Therefore, this round of testing was used to validate the refrigeration systems engineering analysis at certain efficiency levels and representative capacities, as manufacturer tests are used to validate AEDMs. Based on these validations, DOE has determined that the refrigeration system analyses conducted to support this final rule are representative of the performance of walk-in refrigeration systems. Specific instances of validating analysis through physical testing are described in the following sections. DOE also notes that the refrigeration engineering spreadsheet used for this final rule, which details the analysis for medium- and low-temperature dedicated condensing systems, includes all assumptions and values that feed into the analysis and is available on the docket. Additionally, the engineering analysis approach is further described in more detail in chapter 5 of the final rule TSD.

Lennox stated that DOE must continue to review the baseline design assumptions and the methods and associated costs of attaining increased efficiency levels. Lennox stated that DOE should clearly demonstrate that it has correlated the baseline designs and methods to improve efficiency to actual products and test results. (Lennox, No. 87 at p. 3)

As stated previously in this section, DOE has validated various efficiency levels for different representative capacities using physical test results. Additionally, DOE has validated the costs analyses in this final rulemaking using physical teardowns. As such, DOE has determined that the engineering analyses for walk-in refrigeration systems in this final rule are representative of walk-in refrigeration systems and that the cost-efficiency correlations developed are also representative.

b. Display Doors

Representative Units

As previously mentioned in section IV.A.1.a of this document, DOE evaluated equipment classes for display doors in the September 2023 NOPR based on the presence or absence of a motor. DOE did not evaluate higher efficiency levels for motorized display doors in the September 2023 NOPR analysis, and therefore it did not further consider the representative units for those motorized display doors. DOE analyzed three representative door sizes for manually opening display doors. The representative units were based on the number of door openings within a common frame; DOE has identified that as many as five door openings can be contained within a single frame. Additionally, DOE based its representative door sizes on typical height and width of doors found in equipment product literature. 88 FR 60746, 60768.

In response to the September 2023 NOPR, Anthony commented that although DOE is not amending the energy conservation standards for walk-in display doors, the definition of "door" changed in the test procedure rulemaking, which has the effect of decreasing the energy use allowed for lighting and anti-sweat heaters for display doors, except for the case when a door has a single opening. Anthony stated that the effect violates the prohibition in EPCA of adopting energy standards that impair the functionality of a pre-existing product. (Anthony, No. 71 at p. 1) Anthony stated that manufacturers will switch to single-opening doors per frame, which complicates wiring and installation, increases the cost, and does not serve customer preferences. (Anthony, No. 71 at p. 2)

Anthony commented that with DOE's recently adopted single-door interpretation, doors with multiple openings are penalized compared to multiple individual doors installed in the same-size opening. Anthony stated that this penalty is not justified because the two installations would effectively be the same, and Anthony suggested that treating doors with multiple openings as multiple individual doors would be more consistent with field installation practices. Anthony provided a comparison of how the energy conservation standard for display doors changes based on whether the single-opening interpretation or multi-opening interpretation is used. The comparison shows that the maximum daily energy consumption standard increases for the multi-door interpretation, which is based on the surface of area of a single door and multiplying it by the number of doors in the system. (Anthony, No. 71 at pp. 3–4)

Anthony stated that the standard for display doors has an offset (0.41 kWh/day for medium-temperature display doors and 0.29 kWh/day for low-temperature display doors) that's intended to account for effects that do not scale for surface area, such as heat transfer through framing materials, anti-sweat heater power, and lighting power. Anthony commented that with the single-door interpretation, there is a lower allowable maximum daily energy consumption, because that offset term is applied once, and therefore the maximum daily energy consumption would be much greater for multiple single-door systems compared to one multiple-opening door. Anthony stated that this incentivizes the usage of multiple single doors. (Anthony, No. 71 at pp. 4–8)

Anthony commented that the multi-door interpretation results in the same maximum daily energy consumption as multiple single doors and a single multiple-opening door and is, therefore, the logical interpretation. (Anthony, No. 71 at p. 8)

The amended definition of "door" adopted in the May 2023 TP Final Rule was not a change in the test procedure, but rather an intent to better clarify DOE's existing scope, test procedure provisions, and application of the standards to walk-in doors. 88 FR 28780, 28788. "Door" was previously defined at 10 CFR 431.302 as "an assembly installed in an opening on an interior or exterior wall that is used to allow access or close off the opening and that is movable in a sliding, pivoting, hinged, or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the door panel, glass, framing materials, door plug, mullion, and any other elements that form the door or part of its connection to the wall." As amended, door is now defined at 10 CFR 431.302 as "an assembly installed in an opening on an interior or exterior wall that is used to allow access or close off the opening and that is movable in a sliding, pivoting, hinged, or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the frame (including mullions), the door leaf or multiple leaves (including glass) within the frame, and any other elements that form the assembly or part of its connection to the wall." The frame and all elements that form the door or part of its connection to the wall has always been a part of the definition.

Given that DOE clarified in the May 2023 TP Final Rule that doors with multiple leaves within a single frame would be considered a door under the existing test procedure and standards, DOE chose to analyze representative units that reflect the display doors available on the market, which consist of doors with one through five leaves within a single frame. DOE did not receive any other comments regarding the representative units of display doors analyzed in the September 2023 NOPR. Therefore, in this final rule, DOE analyzed the same representative units for manually opening display doors as were analyzed in the September 2023 NOPR. Table IV.6 lists the display door classes and sizes that DOE analyzed in its engineering analysis for this final rule, where the dimensions listed are consistent with the surface area that is used to determine the maximum daily energy consumption.

Table IV.6 Representative Units Analyzed for Display Doors

Opening Mechanism	Temperature	Class Code	No. of Door Openings	Dimensions (height x length, ft)
Manual	Medium-temperature	DW.M	1	6.25 × 2.5
			3	6.25 × 7.5
			5	6.25 × 12.5
	Low-temperature	DW.L	1	6.25 × 2.5
			3	6.25 × 7.5
			5	6.25 × 12.5

Baseline Efficiency, Design Options, and Higher Efficiency Levels

To determine the baseline efficiency of manually opening display doors in the September 2023 NOPR, DOE relied on the current energy conservation standards and minimum prescriptive requirements for the glass pack of transparent reach-in doors at 10

CFR 431.306(b)(1)–(2). DOE's analysis suggested that manufacturers already implement high-efficiency frame designs to minimize thermal transmission; therefore, DOE included high-efficiency frame designs as a baseline design option for manually opening display doors in the September 2023 NOPR. 88 FR 60746, 60768.

In the September 2023 NOPR, DOE evaluated the design options listed in Table IV.7 for manually opening display doors. As noted, design option DR1 includes baseline design options; additional design options are evaluated in DR2 (EL 1) and DR3 (EL 2). *Id*. DOE did not evaluate any changes to the amount of lighting or anti-sweat heat across efficiency levels and included lighting controls and anti-sweat heat controls in all efficiency levels (from baseline to max-tech).

Table IV.7 Design Options Evaluated for Display Doors

Efficiency Level	Design Option Code	Description	
		Medium-Temperature, Manual Display Doors	Low-Temperature, Manual Display Doors
0 (Baseline)	DR1	2-pane glass with argon gas fill	3-pane glass with argon gas fill
1	DR2	3-pane glass with argon gas fill	3-pane glass with krypton gas fill
2	DR3	2-pane vacuum-insulated glass	2-pane vacuum-insulated glass

In response to the September 2023 NOPR, Anthony commented that based on its own market research of manufacturer websites, the average wattage for lighting of display doors is nearly double what DOE asserts is reflective of the industry. Anthony further stated that the display doors that employ the low-wattage LED lighting fixtures are low-end models, which make up approximately 17 percent of the display door market, and therefore are not representative of the typical display door. Anthony commented that, based on its experience and research, approximately 20 percent of customers that purchase these low-end models replace the lighting with higher-performing lighting that is typical for most higher-end display doors. Anthony suggested that aftermarket replacement of lighting may become more common practice given the inadequacy of the level of lighting DOE proposes to require. (Anthony, No. 71 at pp. 2–3)

Anthony stated that if DOE does not correct the errors in its analysis, it is likely that purchasers of display doors will buy aftermarket higher-wattage lighting and higher-voltage anti-sweat heaters designed to preserve and enhance the fundamental display functionality of the doors. (Anthony, No. 71 at p. 2)

DOE notes that its efficiency analysis is intended to be reflective and representative of the display door market. In order to evaluate the potential increase in cost and any downstream quantitative impact to consumers, DOE must assign a baseline design in order to evaluate the potential for higher-efficiency designs. DOE developed its baseline representative units from the existing market. DOE analyzes a pathway to higher efficiency in its engineering analysis, but DOE does not require that this exact pathway be taken. For display doors, DOE only requires that the MDEC performance standard in terms of kWh/day be met. While manufacturers are required to meet the prescriptive requirements applicable to display doors (*see* 10 CFR 431.302(a) and (b)), manufacturers are free to meet the MDEC standard using any design options they deem necessary. The design options evaluated by DOE should not be interpreted as prescriptive requirements, but rather possible steps along a potential efficiency improvement path. In this final rule, DOE is not adopting amended standards for display doors and is therefore not requiring any level of lighting that is different from what may already be required to meet the existing standards. Additionally, DOE recognizes that if manufacturers require higher lighting wattage for certain basic models of display doors, they may need to implement more efficient designs (*e.g.*, more thermally efficient glass packs) in order to meet the existing standard, which could limit the pathways to higher efficiency. *See* section V.C.1 for further discussion of the viability of higher efficiency levels for display doors and DOE's conclusions regarding not amending standards for display doors.

Lastly, DOE defines a "manufacturer of a walk-in cooler or walk-in freezer" as any person who (1) manufactures a component of a walk-in cooler or walk-in freezer that affects energy consumption, including but not limited to refrigeration, doors, lights, windows, or walls; or (2) manufactures or assembles the complete walk-in cooler or walk-in freezer. 10 CFR 431.302. In a final rule pertaining to compliance, certification, and enforcement of walk-ins ("March 2011 Final Rule"), DOE adopted this definition of manufacturer of a walk-in cooler or walk-in freezer and discussed the responsibility of certification and compliance. 76 FR 12422, 12442–12444 (March 7, 2011). DOE stated in the March 2011 Final Rule that component manufacturers are responsible for certifying compliance of the components they manufacture for walk-in applications and ensure compliance with the applicable standards for those components. 76 FR 12422, 12444. DOE noted in that final rule that the adopted definition of "manufacturer" extends the compliance responsibility to both the component manufacturer and the assembler, even though the component manufacturer is responsible for certification.

Assemblers of the complete walk-in system are required to use only components that are certified to meet the Federal energy conservation standards in the assembled walk-in. *Id*. If an assembler was to purchase a compliant component and then alter the component in a manner that affects the energy efficiency or consumption of the component, the assembler would be considered the manufacturer of the component and would be responsible for testing, compliance, and certification of the altered component. Failure to comply with these requirements would subject the assembler to civil penalties pursuant to 10 CFR 429.102(a)(1). If the alteration renders the component noncompliant with the applicable energy conservation standard, use of the component in a complete walk-in cooler or walk-in freezer would render the assembled unit noncompliant and subject the assembler to civil penalties pursuant to 10 CFR 429.102(a)(6), both for the noncompliant component and the noncompliant complete walk-in.

For example, if an assembler purchases a compliant display door and replaces the display door's lighting with aftermarket lighting, the assembler would be considered the manufacturer of the altered display door and be responsible for testing and certifying the door as compliant with applicable DOE energy conservation standards. Failure to do so would subject the assembler to civil penalties. If the after-market lighting rendered the display door noncompliant with the applicable DOE energy conservation standard, use of the altered door in a complete walk-in would subject the assembler to civil penalties, both for the manufacture of the noncompliant display door and the manufacture of the noncompliant complete walk-in cooler or walk-in freezer. *See generally* 10 CFR 429.102 and 429.120.

Anthony commented that DOE's use of a single static value for anti-sweat heater wattage does not take into account the need for heat scaling with walk-in space or with the number of openings in a door assembly. Anthony stated that as a result, manufacturers will be required to use anti-sweat heaters that are inadequate to eliminate condensation, which could lead to aftermarket installation of higher-voltage anti-sweat heaters or more costly products. (Anthony, No. 71 at p. 3)

As mentioned previously, DOE only requires that the MDEC performance standard in terms of kWh/day be met. While manufacturers are required to meet the prescriptive requirements applicable to display doors (*see* 10 CFR 431.302(a) and (b)), manufacturers are free to meet the MDEC standard using any design options they choose. In this final rule, DOE is not adopting amended standards for display doors, and it is therefore not requiring any level of anti-sweat that is different from what is already required by the existing standards.

Regarding aftermarket installation of higher-voltage anti-sweat heaters, if assemblers were to install a display door with aftermarket anti-sweat heat replacing the anti-sweat heater of the originally purchased display door, they would be at risk of installing a non-compliant display door.

For this final rule, DOE maintained the analysis conducted for the September 2023 NOPR for display doors.

c. Non-Display Doors

Representative Units and Baseline Efficiency

As previously mentioned in section IV.A.1.a of this document, DOE evaluated equipment classes for non-display doors based on the presence or absence of a motorized door opener in the September 2023 NOPR. In the June 2022 Preliminary Analysis, DOE analyzed three representative sizes for each class of non-display doors. 88 FR 60746, 60769. DOE did not receive any comments regarding the representative units analyzed for the September 2023 NOPR. In this final rule, DOE analyzed the same non-display door representative sizes that it evaluated in the September 2023 NOPR. Table IV.8 lists the non-display door classes and sizes that DOE analyzed in the engineering analysis for this final rule.

To determine non-display door baseline efficiency for each representative unit, DOE relied on the current energy conservation standards. In the September 2023 NOPR, DOE determined for its analysis that baseline non-display doors had 3.5-inch-thick insulation for coolers and 4-inch-thick insulation for freezers, wood framing materials, a viewing window, and anti-sweat heat around the perimeter of the door leaf without controls. DOE did not consider lighting or other electrical components in its baseline representative units for non-display doors. *Id.* As such, DOE only considered design options relevant to the design of the baseline representative units, including anti-sweat controls, reduced anti-sweat heat, improvements to the framing systems to make the frame more thermally insulative, and increased insulation thickness. *Id.* at 88 FR 60770.

As previously mentioned, DOE received comments in response to the September 2023 NOPR that resulted in reconsideration of the equipment classes that were proposed for non-display doors to account for other electricity-consuming devices that DOE did not consider in its representative units and baseline for analysis. In response to comments received regarding the September 2023 NOPR analysis, DOE recognized that it cannot include all other possible electrical components in its baseline representative units and cannot analyze reduced energy consumption for other electrical components because not all doors contain these components. Therefore, in the March 2024 NODA, DOE updated its analysis to present equipment classes with MDEC allowances for non-display doors if manufacturers offer basic models with certain electricity-consuming devices. 89 FR 18555, 18556–18559.

DOE considered the additional electrical component energy consumption through the use of MDEC allowances. Therefore, DOE maintained the same representative units with components and features that are generally applicable for most doors and could be analyzed for reduced energy consumption at the baseline. DOE did not receive any comments regarding this update approach presented in the March 2024 NODA. For this final rule, DOE evaluated the same representative units and considers the additional electrical components through the use of the MDEC allowances. Table IV.8 lists the non-display door classes and sizes that DOE analyzed baseline and higher efficiency levels for in the engineering analysis for this final rule.

Table IV.8 Non-Display Door Representative Units Analyzed in This Final Rule

Opening Mechanism	Temperature	Class Code	Size	Dimensions, (height x length (in))
Manual	Medium-Temperature	NM.M	Small	84 x 38
			Medium	90 x 40
			Large	96 x 56
	Low-Temperature	NM.L	Small	84 x 38
			Medium	90 x 40
			Large	96 x 56
Motorized	Medium-Temperature	NO.M	Small	100 x 66
			Medium	118 x 90
			Large	154 x 90
	Low-Temperature	NO.L	Small	100 x 66
			Medium	118 x 90
			Large	154 x 66

Design Options and Higher Efficiency Levels

For the September 2023 NOPR analysis, DOE evaluated the design options listed in Table IV.9 for non-display doors. The following subsections discuss the comments received regarding these design options and the implementation of these design options to achieve higher efficiency levels.

Table IV.9 Design Options Evaluated in the September 2023 NOPR Analysis for Non-Display Doors

Design Option Code	Description
-	**Anti-sweat heater wire controls**
ASHNC	No anti-sweat heater controls
ASCTRL	Anti-sweat heater controls
-	**Improved frame systems and lower-conductivity framing materials**
FR1	Baseline non-display door frame made of wood
FR2	Improved non-display door frame made of insulation
-	**Decreased anti-sweat heater power**
ASH1	Baseline anti-sweat heater power
ASH2	Reduced anti-sweat heater power
-	**Increased insulation thickness**
TCK1	Baseline insulation thickness
TCK2	Increased insulation thickness 1
TCK3	Increased insulation thickness 2
TCK4	Increased insulation thickness 3

In response to the September 2023 NOPR analysis, Senneca and Frank Door commented that DOE's recommended methods for compliance with the new standards do not account for how several of these methods are currently used by manufacturers and how that limits a manufacturer's ability to use those methods to generate the additional energy savings required to meet the proposed standards. (Senneca and Frank Door, No. 78 at pp. 3–4)

DOE analyzes units and design options based on an evaluation of the current market. DOE understands that some models on the market may utilize the higher-efficiency design options analyzed in the engineering analysis; however, many of the models using higher-efficiency design options are also outperforming the current MDEC standards (*i.e.,* have rated DEC below the baseline). As discussed in section V.C.1 of this document, DOE estimated that 35 percent of the non-display door market can already meet the standards DOE is adopting for non-display doors through the use of higher efficiency design options such as those analyzed in this rulemaking. Further, DOE notes that the standards finalized in this rulemaking are not prescriptive; manufacturers may comply with them using any technologies they see fit.

As previously discussed in section IV.B.1.b of this document, DOE screened out the same technology options in this final rule as it did in the September 2023 NOPR. Therefore, for this final rule, DOE analyzed the same design options for non-display doors as it did in the September 2023 NOPR.

i. Reduced Anti-Sweat Heater Power

In the September 2023 NOPR, DOE considered reduced anti-sweat heater power as a design option for all non-display doors. For medium-temperature doors, DOE evaluated a reduction in anti-sweat heater power to 2 W/ft based on an evaluation of certified data in DOE's private CCMS database, which had approximately 93 percent of models reported a rated anti-sweat heater power of less than or equal to 2 W/ft. For low-temperature doors, DOE evaluated a reduction in anti-sweat heater power to 5 W/ft based on a combination of certified values in CCMS, rated anti-sweat heater power per linear foot of wire based on product literature, and information received during confidential interviews with manufacturers. Table IV.10 shows the baseline and reduced anti-sweat heater wire power evaluated in the September 2023 NOPR.

Table IV.10 Anti-sweat Heater Wire Power per Linear Foot Used in September 2023 NOPR Analysis

Equipment Class	Baseline Anti-sweat Heater Wire Power Rating (W/ft)	Reduced Anti-sweat Heater Wire Power Rating (W/ft)
Medium-Temperature, Manually-Opening Non-Display Doors	4	2
Low-Temperature, Manually-Opening Non-Display Doors	10	5
Medium-Temperature, Motorized Non-Display Doors	4	2
Low-Temperature, Motorized Non-Display Doors	9.5	5

As discussed in section IV.B.1.b of this document, DOE received multiple comments both in favor of screening out the reduced anti-sweat heat design option and supporting the levels of reduced anti-sweat heat that DOE analyzed. As discussed in that section, DOE ultimately included reduced anti-sweat heat as a technology option for all non-display doors in this final rule because manufacturers offer models for sale with anti-sweat heat at or below the reduced anti-sweat heat wattage values that DOE analyzed. Regarding the power in W/ft that DOE analyzed for the reduced anti-sweat heat design option, Kolpak supported the reduced anti-sweat heater wire power values that were analyzed. (Kolpak, No. 66, Attachment 1 at p. 1) As such, DOE maintained the values evaluated for reduced anti-sweat heater wire power for the September 2023 NOPR in this final rule analysis.

ii. Improved Thermal Conduction Load Through Improved Frame Systems and Increased Insulation Thickness

As discussed in the September 2023 NOPR TSD, DOE determined U-factors for each representative door size by scaling the U-factors determined from tested non-display doors based on theoretical U-factors. DOE also assumed each non-display door had a window sized at 2 ft^2. Wood frames are the least efficient framing material currently found on the market and were selected as the baseline framing material. Polyurethane door frames are more thermally insulative and were selected as the improved framing material. *See* section 5.7.1.3 of the September 2023 NOPR TSD.

Based on stakeholder feedback and detailed calculations provided by Kolpak in response to the September 2023 NOPR, in the March 2024 NODA, DOE reevaluated the analyzed U-factors for both medium-temperature and low-temperature non-display doors. 89 FR 18555, 18559–18560. For medium-temperature doors, DOE found that the thermal conduction load at the proposed energy conservation standard level (EL 3) from the September 2023 NOPR is representative of the achievable thermal conduction load of non-display doors on the market. Therefore, in the March 2024 NODA, DOE did not make any adjustment to the U-factors evaluated for the medium-temperature non-display doors at EL 3. *Id*. For low-temperature doors, DOE further analyzed available data for the March 2024 NODA and tentatively determined that the thermal conduction load by area in the proposed standard level from the September 2023 NOPR was lower than that calculated using the data DOE evaluated. Therefore, DOE increased the U-factors at EL 3 (which corresponded to the proposed standard level in the September 2023 NOPR) for each representative unit of low-temperature non-display doors by 9 percent for the March

2024 NODA. DOE tentatively determined that this increase in U-factor would be more representative of the low-temperature non-display doors currently on the market. 89 FR 18555, 18559–18560.

In response to the September 2023 NOPR, Senneca and Frank Door commented that the design options analyzed that are technologically feasible and not already utilized by manufacturers would not be sufficient to meet the proposed energy consumption. For example, Senneca and Frank Door stated that increasing thickness to 6 inches would not result in a U-factor necessary to meet the proposed standard. (Senneca and Frank Door, No. 78 at pp. 3–4) DOE's test data and information provided by Kolpak demonstrate that there are doors currently on the market that meet or exceed the thermal conduction load that DOE analyzed at EL 3 (*i.e.*, the proposed standard level from the September 2023 NOPR) without increasing insulation thickness. *See* chapter 5 of the final rule TSD for plots of DOE's test data compared to the efficiency levels DOE analyzed in this final rule. Further, as discussed in section V.C.1.b of this document, DOE does not expect that the standard level adopted in this final rule for non-display doors would necessitate the implementation of design options that would decrease U-factor (*e.g.,* improved frame or increased insulation thickness), as the standard level adopted in this final rule includes the baseline U-factor analyzed.

In the March 2024 NODA, DOE requested comment on the representativeness of the adjustments made to the U-factors for the low-temperature non-display doors. *Id.* Senneca stated that because Kolpak manufactures and distributes complete walk-in coolers and freezers, its data is not representative of the energy efficiency that can be achieved by companies that manufacture and distribute walk-in cooler and freezer doors that are sold and installed separately. (Senneca, No. 92 at p. 3) Senneca's comment suggests that non-display doors that are sold separately from the walk-in in which they are installed may have different energy consumption than doors sold with a complete walk-in. However, DOE received additional data in response to the March 2024 NODA from another manufacturer, Imperial Brown, that manufactures walk-in doors for "new construction, retrofit and remodel applications" and states its "models are compatible with all manufacturers of cold storage systems."[32] (Imperial Brown, No. 84, Attachment 2) DOE reviewed the data provided by Imperial Brown and found that the thermal load characteristics of these models are well within the thermal load that DOE determined to be required to meet the adopted standard for this final rule. Therefore, DOE has concluded that the data provided by Kolpak, and subsequently by Imperial Brown, are representative of the energy efficiency that can be achieved for all non-display doors, including those that are sold separately from the walk-in in which they are installed.

Also in response to the March 2024 NODA, RSG stated that it already uses low-density, high-insulation foam core material without a wood frame, so the thermal load technology exceeds the DOE baseline. (RSG, No. 89 at p. 1)

[32] See *imperialbrown.com/products/doors*.

DOE did not receive any other comments in response to its adjustment of thermal conduction load/U-factors made in the March 2024 NODA. For this final rule, DOE maintained the same thermal conduction load and U-factors as the March 2024 NODA.

Maximum Daily Energy Consumption Allowances

As previously discussed, in the March 2024 NODA, DOE updated its analysis to present maximum daily energy consumption allowances for non-display doors where manufacturers offer basic models with certain electricity-consuming devices. 89 FR 18555, 18556–18559. To develop the MDEC allowances specific for walk-in non-display doors with certain electrical components, DOE reviewed the data and calculations submitted by Kolpak, as well as product literature from hardware and instrument manufacturers. In its comment, Kolpak provided information regarding the following components that are included on its basic models of non-display doors: anti-sweat heat on viewing windows; lighting and mechanisms to turn the lighting on or off (*e.g.*, manual toggle switches, door-open timers, occupancy sensors); heated ventilators (also called heated pressure relief vents); and temperature alarms. (Kolpak, No. 66, Attachment 1 at pp. 1–2) Kolpak provided information on model numbers of electrical components, rated wattage of those components, number of electrical components on its doors, and the calculation of the direct and indirect electrical energy consumption for all electrical components. (Kolpak, No. 66, Attachment 2) Using the detail provided by Kolpak, DOE also looked into the hardware and instrument manufacturers' product offerings for electrical components to better understand the range of potential options for these additional electrical components. Based on this, DOE grouped the electrical components into four categories for the March 2024 NODA: lighting, anti-sweat heat for viewing windows, digital temperature displays/alarms, and heated pressure relief vents. 89 FR 18555, 18557. Table IV.11 presents the MDEC allowances for lighting, anti-sweat heat for viewing windows, digital temperature displays/alarms, and heated pressure relief vents from the March 2024 NODA and the underlying assumptions used to determine the MDEC allowances.

Table IV.11 Maximum Daily Energy Consumption Allowances and Assumptions for Each Component from March 2024 NODA

Device	Wattage of Component(s) (W)	Controls (Y/N)	Location	MDEC Allowance – Medium-Temperature (kWh/day)	MDEC Allowance – Low-Temperature (kWh/day)
Door light, night light, and/or switch	14.3	No	Interior	0.33	0.40
Heated viewing window: medium-temperature	34	Yes	Interior	0.25	-
Heated viewing window: low-temperature	84	Yes	Interior	-	1.42
Digital temperature without alarm	2.4	No	Interior	0.07	0.09
Digital temperature display with alarm	8	No	Interior	0.24	0.30
Heated vent: low-temperature only	23	No	Interior	-	0.85

In the March 2024 NODA, DOE sought comment on the MDEC allowances developed for the specified electricity-consuming devices. DOE also sought comment on the assumed wattages, presence or absence of controls, and location that were considered in the calculation of MDEC allowances for the specified electricity-consuming devices. 89 FR 18555, 18559. In response, DOE received several comments that were supportive of the approach and the MDEC allowances developed.

ASAP *et al*. supported DOE's approach regarding non-display doors with additional electrical components but encouraged DOE to gather additional information to ensure that the energy use allowances for non-display doors with additional electrical components reflect the use of efficient components. (ASAP *et al*., No. 90 at p. 2)

The CA IOUs supported DOE's evaluation of the identified additional non-display door electricity-consuming components and agreed that DOE cannot analyze reduced energy consumption for these electrical components as they are not included with all non-display doors. The CA IOUs supported the grouping of these components into four categories, the conservative assumption that certain additional electrical components contribute to indirect walk-in refrigeration load, and the proposed MDEC allowances in the March 2024 NODA. The CA IOUs also supported the relevant revisions to the walk-in non-display door standards equations set forth in the March 2024 NODA. (CA IOUs, No. 91 at p. 2)

Imperial Brown supported providing separate MDEC allowances for lighting, anti-sweat heat for viewing windows, digital temperature displays/alarms, and heated pressure relief vents. Imperial Brown further stated that the MDEC allowance for lighting, digital temperature displays/alarms, and heated pressure relief vents are reasonable for medium- and low-temperature doors. (Imperial Brown, No. 84 at p. 1) Imperial Brown provided data to support its comments. (Imperial Brown, No. 84, Attachment 2)

RSG stated that DOE's suggestion to account for lights, heated viewing windows, heated vents, and digital temperature displays in the MDEC equations are a step in the right direction. RSG stated that the equations for MDEC from Table II.24 of the March 2024 NODA remain overly restrictive. (RSG, No. 89 at p. 1)

As discussed in the previous subsection (Improved Thermal Conduction Load Through Improved Frame Systems and Increased Insulation Thickness), Senneca stated that because Kolpak manufactures and distributes complete walk-in coolers and freezers, its data is not representative of the energy efficiency that can be achieved by companies that manufacture and distribute walk-in cooler and freezer doors that are sold and installed separately. (Senneca, No. 92 at p. 3) As summarized in this section, two manufacturers that offer doors that are sold and installed separately from the walk-in box commented in support of some of the maximum daily energy consumption allowances and provided specific feedback to support their comments and recommendations for the MDEC allowances.[33] DOE discusses the feedback received from these manufacturers in the following subsections.

DOE also received several specific comments regarding each component. The subsections that follow describe the underlying assumptions for each category of electrical components and the relevant comments received in response to the September 2023 NOPR and the March 2024 NODA.

---

[33] See *imperialbrown.com/products/doors, master-bilt.com/product_category/walk-in-repair/*, and *norlake.com/nor-lake-products/foodservice/products/walk-in-repair/*.

i. Lighting

In response to the September 2023 NOPR, Kolpak encouraged DOE to adopt an efficiency requirement for light bulbs used in doors that is more stringent than 40 lumens/W. Kolpak commented that it uses LED light bulbs that have an efficacy of at least 88 lumens/W and controls, and therefore it does not have a means of further reducing energy consumption from lighting. (Kolpak, No. 66, Attachment 1 at p. 1) Kolpak also stated that it supports DOE requiring non-display doors to have light controls such as occupancy sensors or door-open timers instead of manual toggle light switches. (Kolpak, No. 66, Attachment 1 at p. 3)

As discussed in the March 2024 NODA, for the lighting category, DOE considered lighting, a night light, and a pilot light located on a switch to develop an appropriate DEC allowance for doors that have lighting. 89 FR 18555, 18557. Lighting provides visibility within the walk-in, particularly near the entrance and exit of the walk-in, and is commonly controlled by a switch. Switches used for turning the lights on and off often have a pilot light so that the switch can be located in the dark. As included in Kolpak's comment and calculations, a night light could also be attached to the walk-in door.

Based on Kolpak's provided data and a review of product literature,[34] in the March 2024 NODA, DOE assumed lighting would have rated power of 13 W, a switch with a pilot light would have a rated power of 0.3 W, and a night light would have a rated

[34] *See https://www.kasonind.com/files/pdf/Kason_Catalog_lightingElectrical_Digital.pdf*

power of 1 W. The lighting wattage used to develop the MDEC allowance was based on the information and calculations provided by Kolpak, which specify an LED light fixture with an efficacy of 88 lumens/W.

Based on a review of models certified to DOE, DOE also assumed that these components would not be controlled by demand-based controls, and therefore it used the percent time off (“PTO”) values specified for lighting and other electricity-consuming devices without controls, timers, or auto-shut-off systems, per Table A.2 of appendix A, along with the rated power to determine the direct electrical energy consumption. Based on a review of product literature and doors it has tested, DOE assumed that the light and night light would be located on the interior of the walk-in, and the switch may be located on either the interior or exterior of the walk-in; therefore, all the three components associated with lighting were conservatively assumed to be sited on the internal face of the door for the purposes of determining the indirect electrical energy consumption. *See* 10 CFR part 431, subpart R, appendix A, sections 6.3.2.2 and 6.3.3.

In response to the March 2024 NODA, ASAP *et al*. stated that controls could be implemented to reduce lighting energy usage. (ASAP *et al*., No. 90 at p. 2) RSG stated that the door light allowance appears low. RSG stated that walk-in lighting is a safety issue and there needs to be enough lumens to sufficiently light the walk-in entrance and interior to allow the operators the ability to safely perform their duties. RSG recommended that a 17 to 20 W light with around 1,500-lumens output would be a better assumption than 13 W. (RSG, No. 89 at pp. 1–2)

Based on the feedback received from RSG and ASAP *et al.*, for this final rule DOE evaluated the MDEC allowance for lighting based on updated assumptions using (1) a 20 W light bulb in the MDEC calculation instead of a 13 W light bulb, and (2) demand-based controls. DOE compared the MDEC allowance calculated using these two assumptions with the MDEC allowance calculated in the March 2024 NODA. The two scenarios are shown in Table IV.12. These two changes in assumptions mostly offset each other in terms of the daily energy consumption from the lighting because the higher wattage lightbulb increases the daily energy consumption, however, the demand-based controls reduce the daily energy consumption.

Table IV.12 Maximum Daily Energy Consumption Allowances and Assumptions for Lighting

Device	Wattage of Component(s) (W)	Controls (Y/N)	Location	MDEC Allowance – Medium-Temperature (kWh/day)	MDEC Allowance – Low-Temperature (kWh/day)
Door light, night light, and/or switch	14.3	No	Interior	0.33	0.40
Door light, night light, and/or switch	21.3	Yes	Interior	0.33	0.39

DOE has concluded that the MDEC allowances presented in the March 2024 NODA sufficiently capture the additional energy consumption of lighting, which provides visibility within the walk-in, specifically near the entrance and exit of the walk-in near the door. Therefore, DOE is adopting the MDEC allowances calculated for the March 2024 NODA.

ii. Anti-Sweat Heater for Viewing Window

DOE included windows in its representative units of non-display doors. However, as discussed in the March 2024 NODA, DOE did not consider additional anti-sweat heat specific to the window. 89 FR 18555, 18557–18558. Antisweat heaters are a performance-related feature used on viewing windows to prevent (1) condensation from collecting on the glass, and (2) fogging of the glass.

In response to the September 2023 NOPR, Kolpak commented that it is standard for medium-temperature non-display doors with viewing windows to have an anti-sweat heater wire around the frame of the window and for low-temperature non-display doors with viewing windows to have an anti-sweat heater wire and heated glass coating on the outer pane of glass. Kolpak commented that its widely used supplier used to provide a 10 W/ft anti-sweat heater wire without controls. Kolpak stated that it uses a 5 W/ft heater wire with controls in the frame of the viewport window. Kolpak stated that it cannot find additional means to reduce the energy consumption of the anti-sweat heater wire in the viewing window frame further. (Kolpak, No. 66 Attachment 1 at p. 1) Kolpak also stated that it supports DOE requiring non-display doors to have anti-sweat heater wire maximums for viewing windows similar to the maximums for the non-display doors and controls for non-display door anti-sweat heater wires and controls for window anti-sweat heater wires. (Kolpak, No. 66, Attachment 1 at p. 3)

Based on Kolpak's provided data and a review of product literature, for the March 2024 NODA, DOE assumed that if anti-sweat heat is included around and/or on viewing windows, that anti-sweat heat would have a rated power of 34 W for medium-temperature (*i.e.*, cooler) applications and 84 W for low-temperature (*i.e.*, freezer) applications. DOE also assumed that these components would be controlled by some demand-based controls based on the information provided by Kolpak, and therefore DOE used the PTO values specified for anti-sweat heat with controls, timers, or auto-shut-off systems per Table A.2 of appendix A, along with the rated power to determine the direct electrical energy consumption. DOE assumed that for the purposes of determining the indirect electrical energy consumption of the anti-sweat heater, 75 percent of the total power is attributed to the interior and 25 percent of the total power is attributed to the exterior of the walk-in, consistent with the assumptions outlined in the DOE test procedure. *See* 10 CFR part 431, subpart R, appendix A, sections 6.3.2.2 and 6.3.3.

In response to the March 2024 NODA, Imperial Brown stated that the MDEC allowance for anti-sweat heat of viewing windows for low-temperature doors is too stringent. Imperial Brown stated that it offers a 12” x 12” nominal viewing window from its vendor that consumes 50 W for low-temperature installations and does not include demand-based controls, which yields a total DEC of 1.74 kWh/day above the MDEC allowance in the NODA. Imperial Brown stated it is not aware of a vendor that provides view windows with controls for its application. Imperial Brown stated it also offers a 12” x 24” nominal viewing window, which accommodates a wider range of human height, that consumes 84 W for low-temperature installations and does not include demand-based controls. Imperial Brown stated that the DEC for this window heat is 3.11 kWh/day. Imperial Brown recommended that the MDEC for heated windows be defined per square foot of window and that the maximum acceptable area of a viewing window be defined. (Imperial Brown, No. 84 at p. 1)

While Imperial Brown stated it is not aware of a vendor that provides view windows with controls for its application, DOE notes that Kolpak stated in its comment that it requested that its viewing window vendor make windows with bimetallic thermostats to control the heater wire around the viewport. There is no indication that the applications for these two manufacturers of non-display doors are any different; therefore, DOE has no evidence that other manufacturers could not implement anti-sweat controls on the viewing windows used in non-display doors. Therefore, DOE has concluded that calculating the MDEC allowance for anti-sweat heat for viewing windows based on the presence of controls is appropriate.

DOE further evaluated Imperial Brown's suggestion that the MDEC allowance for heated viewing windows be defined per square foot of window. To do this, DOE collected the information provided by Kolpak and Imperial Brown and reviewed additional information found in product literature of a manufacturer of heated viewing windows.[35] DOE calculated the direct and indirect electrical energy consumption for each viewing window size and anti-sweat wattage used, based on the presence of controls, and plotted the MDEC allowance by window area to develop a linear relationship. These updated MDEC allowances calculated per area of window size and the linear relationship based on the area of the viewing window can be found in Table IV.13.

[35] *See norfabinc.com/wp-content/uploads/2022/04/VU-PORT-Spec-Sheet-5-Watt-1.pdf.*

Table IV.13 Maximum Daily Energy Consumption Allowances for Anti-Sweat Heat on Viewing Windows

Device	Window Size	MDEC Allowance – (kWh/day)
Heated viewing window – medium-temperature	14” x 24”	0.25
Heated viewing window – medium-temperature	14” x 14”	0.18
Heated viewing window – medium-temperature	14” x 14”	0.19
Heated viewing window – low-temperature	14” x 24”	1.50
Heated viewing window – low-temperature	14” x 24”	1.42
Heated viewing window – low-temperature	12” x 24”	1.42
Heated viewing window – low-temperature	14” x 14”	0.93
Heated viewing window – low-temperature	14” x 14”	0.84
Heated viewing window – low-temperature	12” x 12”	0.84
Heated viewing window – medium-temperature	-	$0.06 \times A_{window} + 0.10$*
Heated viewing window – low-temperature	-	$0.54 \times A_{window} + 0.23$*
*A_{window} represents area in square feet of the viewing window. The MDEC allowance for non-display doors with heated viewing windows cannot exceed 0.25 and 1.50 kWh/day for medium-temperature and low-temperature applications, respectively.		

DOE has concluded that the MDEC allowances presented in the March 2024 NODA would sufficiently capture the additional energy consumption required for doors that require heated viewing windows. As shown in Table IV.13, the MDEC allowance varies by window size and amount of anti-sweat heat presented per window size. Per Imperial Brown’s recommendation, DOE has concluded that setting the MDEC allowance for heated viewing windows per area of viewing window (in square feet) would sufficiently capture the difference in additional energy that would be consumed by anti-sweat heaters on viewing windows for smaller and larger windows. DOE does not intend to limit the maximum acceptable area of a viewing window; however, the wattage of the anti-sweat heater for the 14-inch by 24-inch windows for both medium- and low-temperature applications were the maximum wattages that DOE found based on public comment and manufacturer literature. As such, DOE is maintaining the MDEC allowances for heating viewing windows for medium- and low-temperature applications from the March 2024 NODA as the maximum allowance. DOE's calculations were based on the four window sizes that it has identified through comments and a review of product literature. Therefore, DOE has concluded that the MDEC allowances defined by window area as shown in Table IV.13 are appropriate, and DOE is adopting them in this final rule for non-display doors with heated viewing windows.

iii. Digital Temperature Displays with or without Alarms

A digital temperature display allows users to easily monitor the temperature of the walk-in. The digital temperature display is connected to a thermocouple that measures the temperature of the walk-in, and the interface on the exterior of the walk-in displays the temperature within the walk-in compartment. In the March 2024 NODA, based on review of product literature and Kolpak's data, DOE had determined that a digital temperature display could be paired with alarms or stand alone (*i.e.*, without alarms). 89 FR 18555, 18558. The alarms alert kitchen staff or others if the refrigerated goods within the walk-in compartment are in conditions that are too warm or too cold, which may spoil or ruin these goods. Additionally, alarms can sound if the walk-in door is left open for too long. Kolpak commented that walk-ins with multiple compartments that have only one exterior door but have doors on interior partitions that separate the compartments often have two temperature alarms on the exterior door so that the alarms can be heard by those outside of the walk-in. (Kolpak, No. 6, Attachment 1 at p. 2) Kolpak also stated that it supports DOE requiring non-display doors to have temperature alarms with a maximum energy usage such as 7 W each but allow multiple temperature alarms on one door. (Kolpak, No. 66, Attachment 1 at p. 3) Additionally, through its review of hardware and instrument manufacturers' product offerings, DOE identified that a panic or entrapment alarm could be installed for use in the event that a user is unable to exit the walk-in. Based on Kolpak's provided data and a review of hardware manufacturers' product literature,[36] in the March 2024 NODA, DOE assumed a digital temperature display without alarms would have a rated power of 2.4 W and a digital temperature display with alarms would have rated power of 4 W. In consideration of Kolpak's comment that a walk-in comprising two compartments may require two temperature displays with alarms to be located on the exterior non-display door, DOE assumed that digital temperature display with alarm(s) would have a total rated power of 8 W. DOE assumed based on a review of Kolpak's data and product literature that the digital temperature display with or without alarms would always be on, and as such used the PTO specified for other electricity-consuming devices without controls, timers, or auto-shut-off systems, per Table A.2 of appendix A, along with the rated power to determine the direct electrical energy consumption. The temperature display and alarms would likely be sited on the exterior of the walk-in door to be seen and heard; however, components of the display would be located interior to the walk-in, such as the thermocouple. Therefore, DOE conservatively assumed these components would be sited on both the internal and external face of the door for the purposes of determining the indirect electrical energy consumption. *See* 10 CFR part 431, subpart R, appendix A, sections 6.3.2.2 and 6.3.3. Additionally, DOE assumed that a door would either have one or the other but would not have both (1) a

[36] *See https://www.kasonind.com/files/pdf/Kason_Catalog_lightingElectrical_Digital.pdf*

digital temperature display without an alarm, and (2) a digital temperature display with alarms.

As previously mentioned, DOE received general support from ASAP *et al.* and the CA IOUs regarding the MDEC allowances and support from Imperial Brown regarding the MDEC allowance for digital temperature displays/alarms. DOE did not receive any other comments regarding its assumptions for determining the MDEC allowances or the MDEC allowances themselves for doors with a (1) digital temperature display without an alarm, or (2) digital temperature display with alarms. In this final rule, DOE is maintaining the MDEC allowances for doors with a (1) digital temperature display without an alarm, or (2) digital temperature display with alarms as calculated for the March 2024 NODA. These calculated allowances can be found in Table IV.14. Consistent with the March 2024 NODA, DOE assumed that a door would either have one or the other but would not have both (1) a digital temperature display without an alarm, and (2) a digital temperature display with alarms. As such, only one of these MDEC allowances would apply based on whether there is or is not an alarm connected to the digital temperature display. This is demonstrated in the standards equations presented in section I of this document.

iv. Heated Pressure Relief Vent

Heated ventilators, or heated pressure relief vents, are performance-related features that allow doors to open more easily when there is a pressure differential between the interior and the exterior of the walk-in.

In response to the September 2023 NOPR, Kolpak stated that heated ventilators can affect energy consumption of non-display doors and were not detailed in DOE's proposal. Kolpak stated that some manufacturers put heated ventilators on a non-door panel so that they are not considered in the energy consumption calculation of a door; however, Kolpak places these devices on the door, where its energy consumption is captured in the daily energy consumption calculation. Kolpak commented that it uses the lowest-wattage heated ventilator available and cannot find additional means to decrease the energy consumption of the heated ventilators. Kolpak stated that it asked its supplier of heated ventilators to explore adding a bimetallic thermostat control to the heating element, but there are concerns regarding quality due to the nature of its applications. (Kolpak, No. 66 at p. 2) Kolpak's data indicates that a 4 W heated ventilator is used on doors for both medium-temperature and low-temperature installations. (Kolpak, No. 66, Attachment 2) Kolpak also stated that it supports DOE requiring non-display doors to have heated ventilators to have a maximum energy usage such as 4 W unless the compartment is over 2,500 cubic feet and heated ventilators' energy usage to be included in the door calculation even if on a wall panel. (Kolpak, No. 66, Attachment 1 at p. 3)

In the March 2024 NODA, DOE evaluated an MDEC allowance for non-display doors with heated ventilators. 89 FR 18555, 18558. DOE had tentatively determined, however, that while medium-temperature applications may require a pressure relief vent, it may not be necessary for the pressure relief vent to be heated. Therefore, DOE did not develop a MDEC allowance for medium-temperature non-display doors. *Id.*

Additionally, based on review of hardware manufacturers' product literature and the recommendations for pressure relief vents based on the size of a walk-in,[37] DOE tentatively determined that a heated pressure relief vent for low-temperature walk-in applications could require up to 23 W of heat to prevent freezing and therefore provide sufficient airflow between the walk-in compartment and the exterior. DOE assumed based on a review of Kolpak's data and hardware manufacturers' product literature that the heater component of the pressure relief vent would always be on, and as such used the PTO specified for other electricity-consuming devices without controls, timers, or auto-shut-off systems, per Table A.2 of appendix A, along with the rated power to determine the direct electrical energy consumption. Because the heated vent is located between both the exterior and interior of the walk-in, it is considered to be located interior to the walk-in for the purposes of determining the indirect electrical energy consumption. *See* 10 CFR part 431, subpart R, appendix A, sections 6.3.2.2 and 6.3.3.

As previously mentioned, DOE received general support from ASAP *et al*. and the CA IOUs regarding the MDEC allowances and support from Imperial Brown regarding the MDEC allowance for heated pressure relief vents. ASAP *et al*. encouraged DOE to further investigate the discrepancy between Kolpak's suggested ventilator heater power and the power allowance included in the NODA for low-temperature non-display doors. (ASAP *et al*., No. 90 at p. 2)

[37] *See www.kasonind.com/files/pdf/Kason_Catalog_WalkIn_Digital.pdf.*

Based on product literature of heated pressure relief vents, DOE assumes that the required wattage would scale with walk-in volume. A 4 W heated pressure relief vent may be sufficient for a small walk-in up to 2,000 or 2,500 cubic feet, which is consistent with Kolpak's comment; however, larger walk-ins (*i.e.*, greater than 2,500 cubic feet) may require a heated pressure relief vent up to 23 W. Because the performance standards are separated out by component, doors are tested and rated based on the energy consumption of the door alone, independent of the volume of the walk-in that the door would be installed in. Therefore, DOE conservatively used 23 W for the heated pressure relief vent, recognizing that heated pressure relief vents installed on walk-in doors could have rated power as high as 23 W.

DOE calculated the MDEC allowances (*i.e.*, the sum of the direct and indirect electrical energy consumption) for low-temperature doors with heated pressure relief vents, which can be found in Table IV.14.

v. Door Leaf Perimeter Anti-Sweat Heat

In the March 2024 NODA, DOE did not analyze an MDEC allowance specific to anti-sweat heat around the perimeter of the door leaf because this electricity-consuming device was already included in the representative units analyzed. In response to the April 2024 NODA, Imperial Brown stated that the portion of the equation that accounts for the perimeter heater cable is out of line compared to the MDEC allowance for heated view windows. Imperial Brown stated that the DEC for heater cables should not be a function of A_{ND}, but a function of door-opening perimeter, because total heater cable power consumption is based upon length. Imperial Brown described the anti-sweat heat wiring pathways of its non-display doors. Imperial Brown asserted that the A factor in the MDEC equation must be increased or the equation needs to include a dedicated portion for the door perimeter heater cable component where P_{ND} is the perimeter of the non-display door opening. (Imperial Brown, No. 84 at pp. 2–3)

Anti-sweat heater wire is generally applied to the perimeter of the door leaf or the frame that comes into contact with the door leaf. However, DOE notes that the energy conservation standards for non-display doors are expressed as a function of A_{ND}, which includes the frame of the door in addition to the door leaf. The area of the door frame and door leaf can vary for doors of the same overall area A_{ND}. For the purposes of the analysis, DOE analyzed a representative door leaf area and frame area, but this may vary across door models with the same overall area. The energy conservation standards proposed in the September 2023 NOPR and the updated standards equations shown in the March 2024 NODA already included perimeter anti-sweat heat for non-display doors. Therefore, DOE is not adopting a separate allowance for the perimeter anti-sweat heat. As further discussed in section V.C of this document, DOE is adopting standards less stringent than proposed in the September 2023 NOPR. Therefore, the A factor in the MDEC equation has been increased.

vi. Components Summary

Table IV.14 presents the updated MDEC allowances for lighting, anti-sweat heat for viewing windows, digital temperature displays/alarms, and heated pressure relief vents for this final rule.

Table IV.14 Maximum Daily Energy Consumption Allowances for Each Component for This Final Rule

Device	MDEC Allowance – Medium-Temperature (kWh/day)	MDEC Allowance – Low-Temperature (kWh/day)
Door light, night light, and/or switch	0.33	0.40
Heated viewing window	$0.06 \times A_{window} + 0.10$*	$0.54 \times A_{window} + 0.23$*
Digital temperature display without alarm	0.07	0.09
Digital temperature display with alarm	0.24	0.30
Heated vent – low-temperature only	-	0.85
* A_{window} represents area in square feet of the viewing window. The MDEC allowance for non-display doors with heated viewing windows cannot exceed 0.25 or 1.50 kWh/day for medium-temperature and low-temperature applications, respectively.		

As discussed previously, each of these electrical components provides some functionality to the consumer when installed on a non-display door. Additionally, having these electrical components installed on the door limits the number of electrical connections that need to be wired when installing a walk-in. Pursuant to EPCA, DOE may establish separate standards for a group of covered equipment (*i.e.*, establish a separate equipment class) if DOE determines that separate standards are justified based on the type of energy used or if DOE determines that the equipment's capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6316(a); 42 U.S.C. 6295(q)(1)(B)) DOE has tentatively determined that that the devices it has listed previously constitute a performance-related feature that justifies a higher standard and therefore is adopting the MDEC allowances for non-display doors that include these components on or within the door.

DOE notes that the information described previously and in Table IV.14 was used to develop the MDEC allowances for basic models of non-display doors that have any number of these components sited on or within the non-display doors. However, DOE notes that for the purposes of determining DEC in accordance with the Federal test procedure at appendix A, manufacturers must follow the instructions for calculating both direct and indirect electrical energy consumption of components as described in appendix A.

In the March 2024 NODA, DOE reviewed non-public manufacturer data submitted to DOE's CCD to estimate the percentage of the market that includes these other electricity-consuming devices on non-display doors. DOE's estimates of shipments containing electricity-consuming devices from the March 2024 NODA are shown in Table IV.15.

Table IV.15 Percentage of Non-Display Door Shipments Containing Each Electricity-Consuming Device

Component	Percentage of Shipments with Component			
	Medium-Temperature, Manual	Low-Temperature, Manual	Medium-Temperature, Motorized	Low-Temperature, Motorized
Lighting	10%	6%	22%	33%
Viewing Window ASH	4%	1%	4%	3%
All Other Electrical Components	8%	8%	28%	73%

In response, RSG stated that lighting is included in 100 percent of its medium- and low-temperature manual doors. RSG stated that the viewing window shipment numbers DOE estimated appear to be close. RSG stated that 100 percent of RSG's medium- and low-temperature manual doors contain one or more of the digital temperature display and/or heated vent options. (RSG, No. 89 at p. 2) DOE has accounted for this in its updated equipment efficiency distributions shown in Table IV.51 of this document.

d. Panels

Representative Units

In the September 2023 NOPR, DOE evaluated the same representative units for each panel equipment class that it evaluated for the June 2014 Final Rule. 88 FR 60746, 60770. DOE did not receive any comments regarding the representative units of panels analyzed in the September 2023 NOPR. In this final rule, DOE maintained the same representative units for each panel equipment class. Table IV.16 summarizes the representative units evaluated for walk-in panel equipment classes.

Table IV.16 Representative Units Analyzed for Panels in This NOPR

<table>
<tr><th>Equipment</th><th>Temperature</th><th>Equipment Class Code</th><th>Dimensions (Height x Length, ft)</th></tr>
<tr><td rowspan="3">Structural</td><td rowspan="3">Medium</td><td rowspan="3">PS.M</td><td>8 × 1.5</td></tr>
<tr><td>8 × 4</td></tr>
<tr><td>9 × 5.5</td></tr>
<tr><td rowspan="3">Structural</td><td rowspan="6">Low</td><td rowspan="3">PS.L</td><td>8 × 1.5</td></tr>
<tr><td>8 × 4</td></tr>
<tr><td>9 × 5.5</td></tr>
<tr><td rowspan="3">Floor</td><td rowspan="3">PF.L</td><td>8 × 2</td></tr>
<tr><td>8 × 4</td></tr>
<tr><td>9 × 6</td></tr>
</table>

Baseline Efficiency, Design Options, and Efficiency Levels

In the September 2023 NOPR, DOE evaluated increasing insulation thickness to obtain higher insulation R-values for panels as calculated pursuant to appendix B of subpart R to 10 CFR part 431. The thermal resistance of insulating materials increases approximately linearly with material thickness. 88 FR 60746, 60771.

For determining the baseline efficiency level, DOE relied on the current R-value standards. Based on DOE's analysis of the market, 3.5 inches of foam insulation is generally used for baseline medium-temperature panels and low-temperature floor panels, while 4 inches of foam insulation is used in baseline low-temperature structural panels to meet the minimum R-value requirements specified in 10 CFR 431.306(a)(3)–(4). *Id*.

In addition, DOE found that many panel manufacturers offer insulation in thicknesses of 4, 5, and 6 inches. DOE also observed that the majority (approximately 75 percent) of the market uses polyurethane insulation, with the remainder using extruded polystyrene ("XPS"), expanded polystyrene, and polyisocyanurate insulation in its walk-in panels. Therefore, DOE assessed the incremental increase in R-value for polyurethane insulation at 4, 5, and 6 inches as design options, with 6 inches being the max-tech design option. *Id.*

DOE did not receive any comments regarding the specifics of the efficiency analysis (*i.e.*, baseline efficiency, design options, and efficiency levels) DOE conducted for panels in the September 2023 NOPR. For the panels' efficiency analysis, DOE maintained the same baseline efficiency, design options, and efficiency levels in this final rule.

e. Dedicated Condensing Units and Single-Packaged Dedicated Systems

Refrigerants Analyzed

i. Background and NOPR Analysis

As previously mentioned, EPA published a NOPR, "Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under Subsection (i) the American Innovation and Manufacturing Act of 2020," on December 15, 2022, under the AIM Act, which proposed refrigerant regulations regarding acceptable GWP limits for various air-conditioning and refrigeration systems. 87 FR 76738. The December 2022 EPA Technology Transitions NOPR proposed to establish a limit of 300 GWP for refrigeration systems with remote condensing units in retail food refrigeration systems and cold storage warehouses with less than 200 pounds ("lbs") of charge, which includes split-system walk-in refrigeration systems covered under the scope of the September 2023 NOPR. EPA proposed this take effect January 1, 2025. EPA finalized its proposals in the October 2023 EPA Technology Transitions Final Rule published on October 24, 2023, with an extended effective date of January 1, 2026. 88 FR 73098.

In the September 2023 NOPR, DOE estimated the potential performance penalties associated with transitioning medium- and low-temperature refrigeration systems from R-448A and R-449A to lower-GWP alternatives by modeling the performance of three potential replacement A2L refrigerants, which have GWPs less than 300: R-454A, R-454C, and R-455A. DOE tentatively determined that R-454A would be the most likely replacement refrigerant for medium- and low-temperature walk-in refrigeration systems once the regulations proposed in the December 2022 EPA Technology Transitions NOPR take effect. DOE also tentatively determined that R-454A would have comparable performance to the currently used refrigerant R-448A. 88 FR 60746, 60772. As there was limited compressor performance data available for R-454A at the time, DOE used R-448A as the basis for its engineering analysis for medium- and low-temperature dedicated condensing units and single-packaged dedicated systems.[38] *Id*. In the September 2023 NOPR, DOE requested performance data for walk-in refrigeration systems using R-454A, R-454C, and/or R-455A. DOE also sought comment on its tentative determinations that R-454A is the most likely replacement for the current refrigerants being used (*e.g.*, R-448A and R-449A) for medium- and low-temperature refrigeration systems and that walk-in dedicated condensing systems would not suffer a performance penalty when switching from R-448A or R-449A to R-454A. *Id.*

Also as discussed in the September 2023 NOPR, DOE tentatively determined that high-temperature refrigeration systems currently use R-134a exclusively. 88 FR 60746, 60773. Due to the October 2023 EPA Technology Transitions Final Rule, walk-in cooler refrigeration systems that use R-134a will be banned from being manufactured and instead will be required to be manufactured with a low-GWP substitute will be required by 2025 or 2026 depending on the sector.[39] In the September 2023 NOPR, DOE analyzed high-temperature refrigeration systems using R-134a given that at the time of publishing

[38] DOE notes that a more efficient single-speed compressor that used propane was analyzed as a design option for some single-packaged dedicated systems. A propane compressor was analyzed if the charge limit for propane was sufficient to provide the analyzed capacity and the propane compressor resulted in increased efficiency.

[39] The compliance date for manufacture of products using lower-GWP refrigerants for self-contained “retail food refrigeration standalone units” is January 1, 2025, while the compliance date for manufacture of “retail food remote condensing units” and “cold storage warehouses” is January 1, 2026. 40 CFR Part 84, Subpart B.

no clear low-GWP replacement had been identified by the high-temperature refrigeration system industry or refrigerant manufacturers. *Id*. In the September 2023 NOPR, DOE also requested comment on any potential low-GWP replacements for high-temperature systems. *Id*.

Additionally, for the September 2023 NOPR, DOE analyzed R-290 (propane) as a design option for medium- and low-temperature single-packaged dedicated systems. The current charge limit for R-290 for single-packaged systems is 300 grams.[40] 88 FR 60746, 60772. DOE did not analyze R-290 as a design option for dedicated condensing units, since it is not suitable for use in split systems under current regulations, and because DOE tentatively determined that split-system charge requirements would exceed the 300-gram limit. *Id.* Additionally, DOE was unable to identify compressors for high-temperature applications designed for use with R-290. As such, DOE did not analyze R-290 as a design option for high-temperature refrigeration systems.

ii. Candidate Replacements for Current Refrigerants

As previously mentioned, DOE sought comment on its tentative determinations that R-454A is the most likely replacement for the current refrigerants being used for low- and medium-temperature refrigeration systems (*i.e.*, R-448A and R-449A). 88 FR 60746, 60772.

[40] EPA published a final rule pertaining to hydrocarbon refrigerants on June 13, 2024.. 89 FR 50410. This rule limits the acceptable charge of propane in a refrigeration circuit to 300 grams for refrigeration systems with end-uses in the retail food industry. 89 FR 50410, 50467.

In response to the September 2023 NOPR, RSG stated that there is no firm way forward in the regulatory landscape or industry regarding A2L refrigerants and testing. (RSG, No. 69 at p. 2) Additionally, RSG stated that the inclusion of per- and polyfluoroalkyl substances 'PFAS' ("forever chemical") as components of most A2Ls (*e.g.*, R-454) has raised concerns domestically and globally, leading to bans of the chemicals in increasing numbers. RSG requested that DOE consider this as a factor in proposing technologies for energy savings. (RSG, No. 69 at p. 2) AHRI and Hussmann commented that PFAS and perfluorooctanoic acid ("PFOA") regulations by EPA and States could prohibit the use of R-454A and stated that Maine has PFA reporting requirements starting on January 1, 2025. (AHRI, No. 72 at p. 10; Hussmann, No. 75 at p. 10) AHRI and Hussmann commented that States that are Climate Alliance members, such as New York, may pursue regulations with GWP limits lower than 150. (*Id.*) AHRI commented that by the time the standards go into effect, EPA may have lowered the GWP allowance from 300 to 150. (AHRI, No. 72 at p. 10)

DOE is not currently aware of any current or proposed regulations (other than certain State regulations[41] that were considered in the March 2024 NODA and are further discussed in the "NODA Analysis" subsection of this section) that would limit walk-in refrigeration systems to refrigerants with less than 150 GWP or regulate PFAS present in refrigerants. As a result, DOE did not consider potential future bans of PFAS, or further

[41] California established (effective January 1, 2022) a limit of 150 GWP for retail food refrigeration equipment and cold storage warehouses with more than 50 lbs of charge. Washington also established (effective January 1, 2025 for new equipment and January 1, 2029 for retrofit equipment) a limit of 150 GWP for retail food refrigeration equipment and cold storage warehouses with more than 50 lbs of charge.

future restrictions to the GWP of refrigerants used in walk-in refrigeration systems in this analysis.

AHRI, Hussmann, and Lennox commented that customers that have refrigeration circuits both above and below 200 lb may not want to have two different refrigerants on the same site and would use a refrigerant below 150 GWP. (AHRI, No. 72 at p. 10; Hussmann, No. 75 at p. 10; Lennox, No. 70 at p. 7)

DOE recognizes that customers will, and do, have varying needs that may impact their choice of refrigerant used in a walk-in. However, DOE selected the most representative refrigerant to account for the behavior of the entire walk-in industry. As a result, DOE did not consider locations with installations above and below 200 lb in this analysis and only considered walk-in installations below 200 lb of refrigerant, focusing on sub-300 GWP refrigerants for split-system walk-in refrigeration systems, except as discussed further in the NODA Analysis subsection.

The CA IOUs recommended that DOE consider R-471A, a new refrigerant in the marketplace, as a refrigerant that would comply with potential future regulations that require sub-150 GWP refrigerants for walk-in refrigeration systems. The CA IOUs commented that because R-471A impacts WICF efficiency, offers 30-percent energy savings over CO_2, and has a GWP of less than 150, it is likely to replace R-454A in the long term. (CA IOUs, No. 76 at p. 11) ASAP *et al*. commented that both R-454A and R-471A may exceed the efficiency of R-404A over a broad range of operating conditions.

(ASAP *et al*., No. 77 at pp. 5–6) NRAC commented that R-471A is not suitable for low-temperature applications. (NRAC, No. 73 at p. 2)

DOE is aware that R-471A could be used as a refrigerant for medium-temperature walk-in refrigeration systems in the future; however, there is currently not enough publicly available data on R-471A to analyze in this rulemaking. Therefore, DOE did not consider R-471A as a refrigerant for medium-temperature systems in this final rule analysis. In this final rule analysis DOE maintained the refrigerants analyzed for medium- and low-temperature dedicated condensing systems from the NOPR analysis and conducted all analyses using R-448A as a performance proxy for R-454A.

As previously mentioned, in the September 2023 NOPR, DOE also requested comment on any potential low-GWP replacements for high-temperature systems. 88 FR 60746, 60773.

AHRI, Hussmann, and NRAC cited R-471A as a possible replacement for R-134a for high-temperature applications. (AHRI, No. 72 at pp. 10–11; Hussmann, No. 75 at p. 11; NRAC, No. 73 at p. 2) Hussmann stated that little information on R-471A is available, but the manufacturer could provide details. (Hussmann, No. 75 at p. 11) As discussed previously in this section, DOE does not have sufficient data to analyze the performance of R-471A.

AHRI commented that R-1234yf (GWP < 1) can replace R-134a for remote system applications and is commonly applied in commercial refrigeration today. (AHRI, No. 72 at p. 10) DOE acknowledges that R-1234yf is a potential replacement for R-134a in high-temperature walk-in applications. DOE has not been able to identify any performance data for R-1234yf compatible compressors for high-temperature applications and therefore did not analyze R-1234yf as a refrigerant in this analysis.

AHRI stated that it is aware of A1 refrigerants with performance similar to R-134a and a GWP below 300, but it noted these cannot be used in low-temperature applications above atmospheric pressure and these have considerably lower capacity compared to A2L alternatives. AHRI commented that like-for-like capacity units require larger condensing units and unit coolers for these A1 refrigerants compared to their A2L counterparts. (AHRI, No. 72 at pp. 10–11) Given the limited information provided by AHRI about potential sub-300 GWP A1 refrigerants, and their potential downsides, DOE did not analyze such refrigerants for high-temperature refrigeration systems in this final rule.

ASAP *et al*. commented that R-513A—which is currently used in ENERGY STAR®-rated service-over-counter commercial refrigeration equipment ("CRE")—is a low-GWP replacement for R-134a in high-temperature applications with similar reported efficiency. (ASAP *et al*., No. 77 at pp. 5–6) DOE notes that R-513A has a GWP of 573, which is lower than the GWP of R-134a but would not comply with the October 2023 EPA Technology Transitions Final Rule regulation. Thus, DOE did not consider R-513A as a refrigerant for high-temperature applications in its engineering analysis for this final rule.

Based on the feedback received and a review of publicly available resources, DOE has not been able to identify a sub-300 GWP refrigerant that could serve as a replacement for R-134a in high-temperature applications that has enough performance data (*e.g.*, compressor coefficients) available to conduct a full engineering analysis for high-temperature single-packaged dedicated condensing systems. As such, DOE is maintaining the analysis conducted in the September 2023 NOPR and analyzing high-temperature single-packaged dedicated systems using R-134a.

iii. Performance of Alternative Refrigerants

For the September 2023 NOPR, DOE estimated potential performance penalties associated with transitioning from R-448A and R-449A to a lower-GWP refrigerant by modeling the performance of three potential replacement A2L refrigerants for dedicated condensing units: R-454A, R-454C, and R-455A. DOE tentatively concluded R-454A would be the most likely replacement for split-system walk-in refrigeration systems because R-454A has the lowest glide and would be the highest-performance sub-300 GWP replacement for R-448A and R-449A of the three refrigerants analyzed. DOE also tentatively concluded that medium- and low-temperature walk-in refrigeration systems would not suffer a performance penalty when switching from R-448A or R-449A to R-454A. DOE requested performance data for walk-in refrigeration systems using R-454A, R-454C, and/or R-455A. 88 FR 60746, 60771–60772.

In response to the September 2023 NOPR, ASAP *et al*. supported DOE's refrigerant assumptions in the engineering analysis and noted that these assumptions may result in conservative standard levels, particularly for low- and medium-temperature systems, when considering the upcoming switch to low-GWP refrigerants. (ASAP *et al*., No. 77 at pp. 5–6)

RSG commented that it appears that some A2Ls perform similar to HFCs, such as R-449. (RSG, No. 69 at p. 2) NRAC commented that preliminary testing on R-454A, R-454C, and R-455A shows R-454A to be the best performer of the three and the one closest to R-448A/R-449A in terms of performance; however, more time is needed to thoroughly test for all scenarios, applications, and equipment types. (NRAC, No. 73 at p. 2) AHRI and Lennox commented that DOE's supposition that A2L refrigerants are of equal performance to HFCs has proven to not be true, as the new refrigerants are generally worse in overall performance. (AHRI, No. 72 at p. 15; Lennox, No. 70 at p. 10) DOE notes that in the September 2023 NOPR it did not make statements about the performance of A2Ls in general compared to HFC refrigerants. As discussed previously in this section, based on currently available data, DOE tentatively determined that specifically R-454A has similar performance to R-448A and R-449A for walk-in dedicated condensing units.

RSG commented that A2L refrigerants require significantly more components and design limitations than HFC refrigerants that may affect performance. (RSG, No. 69 at p. 2) AHRI, Hussmann, and Lennox commented that A2L refrigerants have higher ancillary power requirements from additional solenoid valves, sensors, and controls that are required to meet the safety standards, and motors could consume more power due to tighter spacing and additional grilles. (AHRI, No. 72 at p. 10; Hussmann, No. 75 at pp. 10–11; Lennox, No. 70 at p. 7) In response to the March 2024 NODA, AHRI recommended that DOE review UL 60335-2-89. AHRI stated that DOE's evaluation did not consider the safety shut-off valves that will run during the on- and off-cycle condition. AHRI also stated that due to the mitigation requirements, there are some cases where some condenser fans will run when the compressor is off. (AHRI, No. 86 at p. 8) In response to these comments, DOE reviewed UL 60335-2-89, the relevant safety standard for using A2L refrigerants with walk-in refrigeration systems. DOE found a requirement for additional leak detection sensors, which DOE already assumed would be included and determined would result in negligible additional wattage. Per section 1.7.5 of Annex 101.DVU of UL 60335-2-89, when a leak detection system is present, condenser fans only have to run when a leak is detected and therefore would not have increased power consumption as measured during a test conducted in accordance with the DOE test procedure at appendix C1. Furthermore, DOE found no requirement for valves that are not already present in WICF refrigeration systems and that would consume appreciable power. Additionally, DOE has determined that any grille spacing requirements would not increase fan power consumption by a measurable amount. As such, DOE did not include any allowance for additional power consumption as a result of a transition to A2L refrigerants.

Lennox commented that technologies that are currently in use may not be able to be directly applied to low-GWP refrigeration systems without thorough evaluation. (Lennox, No. 70 at p. 5) DOE is not aware of current technologies or design options analyzed in this analysis that cannot be used with low-GWP refrigerants, including A2Ls.

AHRI and Lennox stated that while R-454A performs better than R-454C and R-455A for dedicated condensing units, R-455A performs better than R-454A for unit coolers. Additionally, AHRI and Lennox commented that R-455A has an advantage in the marketplace due to mitigation cost and use allowance because of its lower flammability limit ("LFL"). (AHRI, No. 72 at p. 10; Lennox, No. 70 at p. 7)

DOE's understanding is that the use of A2L refrigerants is a greater concern for the performance of dedicated condensing units than for unit coolers due to the high glide of A2L refrigerants.[42] Therefore, DOE's performance impact assessment of A2Ls focused on dedicated condensing units rather than on unit coolers. As such, DOE has not conducted analysis on A2L refrigerant performance in unit coolers to determine which A2L refrigerant performs best in unit coolers. Feedback collected during manufacturer interviews indicated that the very high glide of R-455A[43] made it a poor refrigerant candidate for dedicated condensing units as compared to other alternatives. Because a unit cooler would be paired with a dedicated condensing in over 80 percent of applications, R-455A would likely not be used as a refrigerant in unit cooler applications. Additionally, based on DOE's understanding of safety standard UL 60335-2-89, walk-in refrigeration systems using safety shut-off valves such as the liquid line solenoids already included on most if not all walk-in refrigeration system installations would not face charge limits that are restrictive enough to interfere with the use of any A2Ls, including

[42] The DOE test procedure for walk-in unit coolers and dedicated condensing units tested alone is based on specification of the dewpoint temperature corresponding with unit cooler exit or dedicated condensing unit inlet pressure. *See* AHRI 1250-2020 tables 12–17. The average two-phase refrigerant temperature associated with this condition is lower for a higher-glide refrigerant, which is more favorable for unit coolers and less favorable for dedicated condensing units.

[43] As show in Table 5.6.4 of the NOPR TSD, R-455A has a glide of 17 °F at walk-in test conditions, while R-448A has a glide of 8.2 °F, R454A has a glide of 8.6°F, and R-454C has a glide of 11.8°F.

R-454A.[44] Based on this, DOE has concluded that R-454A and R-454C are still the most likely replacement refrigerants for walk-in applications.

iv. NODA Analysis

Additionally, in response to the September 2023 NOPR, DOE received comment that R-454C or R-455A would be more likely replacements for R-448A and R-449A than R-454A, because California and Washington State have regulations that prohibit the use of a refrigerant with a GWP greater than 150 for systems with more than 50 lb of charge. These comments are summarized in the March 2024 NODA. 89 FR 18555, 18562–18563.

In the March 2024 NODA, DOE acknowledged that certain localities already require WICF refrigeration systems to be designed for use with sub-150 GWP refrigerants.[45] 89 FR 18555, 18562. In the September 2023 NOPR, DOE tentatively concluded that the highest-performing sub-150 GWP refrigerant appropriate for use in split-system walk-in refrigeration systems is R-454C. *See* section 5.6.3.1 of the September 2023 NOPR TSD. To assess the potential impact of State-level sub-150 GWP requirements, DOE reviewed the energy efficiency ratio ("EER") of R-454C compressors with capacities representative of walk-in refrigeration systems and compared these EERs

[44] UL 60335-2-89 states that if safety shut-off valves are included in a system, the max releasable charge is equal to only the charge downstream of the valve. UL 60335-2-89 Annex 101.DVU Section 1.4.3.7. In this case, restrictions are only placed on the charge weight of the releasable charge, not the total system charge. DOE has determined that UL 60335-2-89's charge weight restrictions for various walk-in box volumes would far exceed the releasable charge between the liquid line solenoid and the compressor charge for representative systems paired with these boxes.

[45] California established (effective January 1, 2022) a limit of 150 GWP for retail food refrigeration equipment and cold storage warehouses with more than 50 lb of charge. Washington also established (effective January 1, 2025 for new equipment and January 1, 2029 for retrofit equipment) a limit of 150 GWP for retail food refrigeration equipment and cold storage warehouses with more than 50 lb of charge.

to those of the baseline compressors analyzed in the September 2023 NOPR. DOE determined the R-454C EERs at operating conditions representative for the A test conditions prescribed in the DOE test procedure for walk-in refrigeration systems, adjusting the condensing dewpoint up 2 ºF to account for the higher refrigerant temperature glide of R-454C as compared to R-448A or R-454A.

DOE found that trends in the R-454C compressor efficiencies generally aligned with the compressor EERs used in the September 2023 NOPR analysis, except for the DC.M.O.025 and DC.M.I.025 representative units. At this 25 kBtu/h capacity DOE found that the available R-454C compressor had an EER that is 4 percent less than that of the compressor analyzed in the September 2023 NOPR. Based on this, DOE determined that using the R-454C compressor analyzed could result in an AWEF2 that is 2 percent lower for 25 kBtu/h medium-temperature dedicated condensing units than a comparable unit using an R-454A-compatible compressor. As such, and in the absence of more efficient compressors of the same type compatible with R-454C, DOE tentatively determined that to achieve the standard proposed in the September 2023 NOPR (based on the performance of R-448A), a medium-temperature walk-in refrigeration system using a sub-150 GWP refrigerant may need to incorporate additional design options beyond what DOE presumed in the September 2023 NOPR. To determine the cost of these additional design options, DOE constructed the cost curves corresponding to use of the R-454C compressor (with a roughly 2-percent reduction of AWEF2 for each evaluated design) and calculated the additional cost to attain the proposed AWEF2 by interpolating along the cost-efficiency curves. Based on this analysis in the March 2024 NODA, DOE tentatively determined that the additional manufacturer sales price ("MSP") required to achieve the AWEF2 at TSL 1 from the March 2024 NODA for less-than-150 GWP refrigerant would be $381 for 25 kBtu/h medium-temperature indoor dedicated condensing units and $96 for 25 kBtu/h medium-temperature outdoor dedicated condensing units. 89 FR 18555, 18563.

In the March 2024 NODA, DOE requested comment on the estimated additional MSP associated with 25 kBtu/h medium-temperature indoor and outdoor dedicated condensing units achieving the proposed AWEF2 standard levels while operating with a refrigerant with less than 150 GWP. 89 FR 18555, 18563.

In response to the March 2024 NODA, Lennox stated that the cost increases appear low for the medium-temperature indoor and outdoor dedicated condensing units achieving the proposed AWEF2 standard levels while operating with a refrigerant with less than 150 GWP. Lennox stated that due to the high glide of the lower-GWP refrigerants, the reduction in cooling capacity will need to be offset in the product design through increased coil surface or other design improvements that will increase product cost. (Lennox, No. 87 at p. 5)

DOE notes that the 150-GWP MSP adders presented in the March 2024 NODA consider additional design improvements to achieve AWEF2 levels based on sub-300 GWP refrigerants and do not represent the total cost of converting a system designed for R-448A to use a sub-150 GWP A2L. Given the lack of specific data and feedback on the 150 GWP cost adders, DOE was unable to adjust the methodology used to determine these adders. Therefore, in this final rule analysis, DOE maintained the methodology used in the March 2024 NODA to determine 150-GWP cost adders for medium-temperature 25 kBtu/h indoor and outdoor dedicated condensing units. Using this methodology, DOE determined that the DC.M.O.025 representative unit would increase in MPC by $128 when using sub-150 GWP refrigerants for that standard level finalized in this final rule, and the DC.M.I.025 representative unit would increase by $390. Adders for each trial standard level analyzed are summarized in Table IV.17. The approach to apply the 150-GWP cost adders as a sensitivity to consumer impacts are discussed in section IV.F.2.a. of this document.

Table IV.17 Sub-150 GWP Cost Adders for Certain Dedicated Condensing Unit Equipment Classes

Equipment Class	Baseline (EL 0) 2023$	TSL 1 2023$	TSL 2 2023$
DC.M.O.025	1.56	86.22	128.25
DC.M.I.025	95.21	389.72	389.72

v. Final Rule Analysis Summary

In this final rule, DOE maintained the refrigerants analyzed in the September 2023 NOPR analysis for dedicated condensing units and single-packaged dedicated condensing systems. Specifically, DOE analyzed all medium- and low-temperature representative units with R-448A as the baseline refrigerant, which DOE has concluded is representative of sub-300 GWP refrigerants that would likely be used in medium- and low-temperature dedicated condensing systems. As discussed previously, for DC.M.O.025 and DC.M.I.025, DOE considered the cost adder associated with using a refrigerant that is sub-150 GWP. DOE analyzed R-290 as a design option for medium-and low-temperature single-packaged dedicated systems. Finally, DOE analyzed high-temperature single-packaged dedicated systems using R-134a in this final rule analysis.

Representative Units

Table IV.18 lists the representative units analyzed in the September 2023 NOPR for walk-in dedicated condensing units and single-packaged dedicated systems.

Table IV.18 Representative Units Analyzed for Dedicated Condensing Units and Single-Packaged Dedicated Systems

System	Temperature	Location	Class Code	Capacity (kBtu/h)
Dedicated Condensing Units	Medium	Outdoor	DC.M.O	9
				25
				54
				75
				124
		Indoor	DC.M.I	9
				25
				54
				75
	Low	Outdoor	DC.L.O	3
				9
				25
				54
				75
		Indoor	DC.L.I	9
				25
				54
Single-Packaged Dedicated Systems	High (Non-ducted)	Outdoor	SP.H.O	2
				7
		Indoor	SP.H.I	2
				7
	High (Ducted)	Outdoor	SP.H.O.D	2
				7
		Indoor	SP.H.I.D	2

				7
	Medium	Outdoor	SP.M.O	2 9
		Indoor	SP.M.I	2 9
	Low	Outdoor	SP.L.O	2 6
		Indoor	SP.L.I	2 6

In response to the representative units analyzed in the September 2023 NOPR, AHRI requested that DOE clarify how capacity factors into DOE's high-temperature analysis and observed that if the lowest capacity for high-temperature systems is 9 kBtu/h with a rotary compressor, then any unit with a capacity below 9 kBtu/h with a hermetic compressor may be at a disadvantage. (AHRI, No. 72 at p. 6)

DOE analyzed two representative units for high-temperature dedicated condensing systems in the September 2023 NOPR. The smallest capacity that DOE analyzed was a 2 kBtu/h high-temperature single-packaged dedicated system that used a hermetic reciprocating compressor, not a rotary compressor. Thus, DOE considered the efficiency impact of using reciprocating compressors for lower-capacity units by analyzing a representative 2 kBtu/h unit and a representative 7 kBtu/h unit. In this final rule analysis, DOE analyzed the same representative units for high-temperature single-packaged dedicated systems.

AHRI commented that it had previously recommended that DOE add high-temperature dedicated condensing units, since leaving these out of the scope would be a competitive disadvantage for manufacturers that sell single-packaged dedicated systems and matched split systems for high-temperature applications. AHRI highlighted that DOE did not analyze high-temperature dedicated condensing units in the NOPR analysis and therefore is not proposing to establish an equipment class for high-temperature dedicated condensing units. AHRI stated that DOE is continuing to disallow the use of high-temperature dedicated condensing units without a waiver. AHRI commented that due to the smaller size of this market and the continual evolution to lower-GWP refrigerants, as well as transitions to the new product safety standards (UL 60335-2-89), DOE's stance is a disservice to an already smaller, disenfranchised market segment. AHRI recommended that DOE analyze indoor and outdoor high-temperature dedicated condensing systems with capacities of 2, 9, and 25 kBtu/h. (AHRI, No. 72 at pp. 7–8)

As discussed in the May 2023 TP Final Rule, DOE's evaluation of the wine cellar market indicates that specific high-temperature dedicated condensing units are rarely, if ever, sold outside of matched-pair configurations. 88 FR 28780, 28810. As such, in the May 2023 TP Final Rule, DOE did not establish specific test provisions for high-temperature dedicated condensing units tested alone. *Id.* Instead, DOE assumed that high-temperature dedicated condensing units would be tested as a part of matched pairs. Thus, a matching unit cooler would be available for conducting a matched-pair test including any such condensing unit, and manufacturers would not be required to petition for waiver, as suggested by AHRI. Details of this decision not to include test provisions specific for high-temperature dedicated condensing units tested alone are outlined in the May 2023 TP Final Rule. 88 FR 28780, 28810. Because there is no test procedure for high-temperature dedicated condensing units tested alone and DOE has not received any comments indicating that the analysis for single-packaged high-temperature refrigeration systems would not be representative of high-temperature matched pairs, DOE did not separately analyze such products as representative units in this final rule. While high-temperature matched refrigeration systems were not separately analyzed as representative units, the energy conservation standards set forth in this final rule for high-temperature systems encompass high-temperature single-packaged dedicated systems and high-temperature matched refrigeration systems.

In response to the September 2023 NOPR, AHRI commented that multiple commenters had asked DOE to analyze additional representative units at a broader range of capacities, but it noted that below approximately 4 kBtu/h, DOE is simply maintaining the current AWEF but converting it to AWEF2. AHRI commented that DOE is overlooking the fact that lower-capacity compressors are less efficient than higher-capacity compressors. AHRI stated that for the medium-temperature dedicated condensing systems, the AWEF2 minimums do not take this into account, thus continuing to exacerbate the original issue both commented on and known to DOE. AHRI commented that the prior walk-in market had gone down to 1/2–3/4 HP medium-temperature indoors, but because DOE did not analyze hermetic reciprocating compressors originally, it has been impossible to meet the minimum AWEF in many cases. (AHRI, No. 72 at pp. 6–7)

As discussed in the September 2023 NOPR, DOE did not analyze medium-temperature dedicated condensing units with a capacity less than 4 kBtu/h, because DOE tentatively determined that those systems would have to be equipped with all available design options to meet the current standards. DOE notes that despite the technologies necessary for these units to achieve minimum AWEF2 standards, there are medium-temperature dedicated condensing systems certified in the CCD. As such, DOE did not evaluate higher efficiency levels for medium-temperature dedicated condensing units with capacity less than 4 kBtu/h in the September 2023 NOPR; instead, DOE proposed to maintain the current standard level for this equipment, but convert it from the current AWEF metric to the AWEF2 metric based on the appendix C1 test procedure. 88 FR 60746, 60774. This tentative determination was an acknowledgement that, among other factors, smaller-capacity compressors used in these units are less efficient than the larger-capacity compressors used in larger units. Based on testing and analysis conducted, DOE has determined that converting AWEF to AWEF2 at the baseline efficiency level does not result in more stringent standards. As such, in this final rule analysis DOE is not analyzing medium-temperature dedicated condensing units below 4 kBtu/h for the same reasons outlined in the September 2023 NOPR.

For the reasons outlined previously, in this final rule DOE analyzed the same representative units for dedicated condensing units and single-packaged dedicated systems that it analyzed in the September 2023 NOPR.

Design Options

i. Design Options Analyzed for NOPR

In the September 2023 NOPR, DOE used a design-option approach to evaluate potential efficiency improvements for walk-in dedicated condensing units and single-packaged dedicated systems. 88 FR 60746, 60768. DOE considered the technologies listed in Table IV.19 as design options for dedicated condensing units and single-packaged dedicated systems in the September 2023 NOPR.

Table IV.19 NOPR Analysis Refrigeration System Design Options

	Dedicated Condensing Units	**Single-Packaged Dedicated Systems**
All Units	• Higher-efficiency compressors • Improved condenser coil • Higher-efficiency condenser fan motors	• Higher-efficiency compressors • Higher-efficiency condenser fan motors • Off-cycle and on-cycle evaporator fan control • Improved thermal insulation
Outdoor Units Only	• Crankcase heater controls • Variable-speed condenser fan control • Ambient subcooling • Head pressure controls	• Crankcase heater controls • Variable-speed condenser fan control • Ambient subcooling • Head pressure controls
Medium- and Low-Temperature Units Only		• Improved evaporator and condenser coil • Hydrocarbon refrigerants

ii. More Efficient Single-Speed Compressors

In the September 2023 NOPR, DOE analyzed higher-efficiency compressors as a design option for dedicated condensing units and single-packaged dedicated systems. 88 FR 60746, 60777. The higher-efficiency compressor design options included both higher-efficiency single-speed compressors and variable-speed compressors. As discussed in section 5.7.2.1 of the September 2023 NOPR TSD, DOE did not analyze more efficient single-speed compressors for medium- and low-temperature dedicated condensing units due to concerns that an analysis based on more efficient semi-hermetic compressors would not be achievable by scroll compressor technology and therefore could limit or eliminate scroll compressor technology for which there is functionality to the consumer;

instead, DOE only analyzed variable-speed compressors as a compressor design option for these equipment classes and did not analyze any changes to type of compressor (*i.e.*, scroll or semi-hermetic) at higher efficiency levels for a given representative unit. For single-packaged dedicated systems, DOE considered both higher-efficiency single-speed compressors and variable-speed compressors in the September 2023 NOPR analysis.

In response to the September 2023 NOPR, ASAP *et al*. and the CA IOUs recommended that DOE analyze higher-efficiency single-speed compressors, without changing compressor type, as design options for dedicated condensing units (*i.e.*, swapping a less efficient scroll compressor for a more efficient scroll compressor). These comments are summarized in the March 2024 NODA. In response to these comments, in the March 2024 NODA, DOE analyzed more efficient single-speed compressors for medium- and low-temperature dedicated condensing units. 89 FR 18555, 18560–18561. DOE identified higher-efficiency single-speed compressors that could be incorporated into the following representative units: DC.M.O.054, DC.M.I.054, and DC.M.O.124. *Id*. Details of this analysis can be found in the March 2024 NODA. *Id*.

In response to the March 2024 NODA, DOE received the following comments. The CA IOUs supported DOE's updated walk-in refrigeration system analysis presented in the March 2024 NODA, specifically DOE's evaluation of a high-efficiency single-speed compressor design option for certain equipment classes. The CA IOUs encouraged DOE to further investigate higher-efficiency compressors as a design option for all walk-in refrigeration system equipment classes in the next rulemaking and after the commercial refrigeration market has completed the transition to low-GWP refrigerants.

(CA IOUs, No. 91 at p. 2) DOE may evaluate the compressor market when beginning any future rulemakings to understand which units may have more efficient single-speed compressors available as a design option.

AHRI and Lennox stated they do not agree that selecting a larger compressor is reasonable for increasing AWEF, as not every model will have a larger compressor available. (AHRI, No. 86 at pp. 7–8; Lennox, No. 87 at p. 5) AHRI requested to see real-world testing of compressors in units to evaluate this change. AHRI stated that looking at compressor data alone is not reflective and suggested that the interaction between compressors, coil designs, airflow levels, and refrigerant characteristics needs to be validated to determine performance. (AHRI, No. 86 at pp. 7–8)

DOE notes that it identified a range of single-speed compressors from 50 kBtu/h to 60 kBtu/h with EERs higher than the baseline compressor(s) analyzed for the DC.M.O.054, DC.M.I.054, and DC.M.O.124 representative units. To analyze this range of more efficient compressors, DOE selected a compressor that had larger capacity than the baseline compressor. DOE selected this compressor because its EER was in line with the capacity versus the EER trend of higher-efficiency scroll compressors. The capacity of the higher-efficiency compressor selected for the analysis of this representative unit did not play into its selection, nor would it cause the representative unit to be more efficient than if a lower-capacity compressor with the same EER were selected. While the selected compressor is larger than the baseline compressor, DOE has determined it is still representative of this capacity range that the representative unit analyzes. DOE has determined that manufacturers would be able to select a higher-efficiency compressor from this range with a capacity that best suits their needs.

DOE's refrigeration system analysis for the March 2024 NODA did evaluate a compressor's impact on the refrigeration system as a whole, including condenser coil and condenser fan characteristics. DOE is unable to conduct real-world testing for every representative unit with every configuration of design options analyzed in this final rule due to time and resource constraints that make such a task unrealistic. Instead, DOE has made use of the most representative data available to model the performance of representative units to the best of its ability. DOE notes that publicly available compressor performance coefficients retrieved from manufacturer literature have been a key component of all DOE's walk-in refrigeration systems analyses including the analysis endorsed by the ASRAC Working Group[46]. As such, DOE has determined that compressor performance coefficients are a representative method to estimate the energy consumption and mass flow of compressors available on the market today. DOE is maintaining this method of analyzing compressors in this final rule analysis.[47]

In this final rule, DOE is maintaining the higher-efficiency single-speed compressor analysis for the following representative units, as analyzed for the March

[46] ASRAC Working Group transcripts are docketed at *regulations.gov/docket/EERE-2015-BT-STD-0016/document.*

[47] Compressor coefficients used in this final rule analysis can be found on the "Comp DB" tab of the final rule refrigeration systems engineering analysis spreadsheet docketed at *regulations.gov/docket/EERE-2017-BT-STD-0009/document.*

2024 NODA: DC.M.O.054, DC.M.I.054, and DC.M.O.124. Details of this analysis can be found in section 5.7.2.1 of the final rule TSD.

iii. Condenser Fan Controls

In the September 2023 NOPR analysis, DOE analyzed variable-speed condenser fans for outdoor dedicated condensing units and outdoor single-packaged dedicated systems. 88 FR 60746, 60777. As discussed in the September 2023 NOPR, when analyzing variable-speed condenser fans, DOE only considered variable-speed motors and controls, not two-speed motors and controls. 88 FR 60746, 60776. As stated in the September 2023 NOPR, this decision was based on manufacturer interviews and DOE's analysis, which showed that fully variable-speed fans are more effective at increasing a unit's efficiency than two-speed fans and that the costs for variable- and two-speed electronically commutated motors ("ECMs") are similar. *Id.*

In response, the CA IOUs recommended that DOE include two-speed condenser fan modulation as a technology option, in addition to considering fan speed cycling and variable-speed modulation. The CA IOUs disagreed with DOE's conclusion that variable-speed and two-speed ECMs have similar costs, suggesting that the controllers for variable-speed ECMs cost more to manufacture than those for two-speed ECMs. The CA IOUs provided links to a walk-in condensing unit equipped with a two-speed condenser fan, and two fan controllers. (CA IOUs, No. 76 at p. 3)

Prompted by the CA IOUs' comments, DOE investigated the costs of two-speed and variable-speed motor costs and the costs of necessary controls for two-speed and variable-speed operation and was not able to find a considerable difference in cost based on the information available. In this final rule, DOE has determined that due to the almost identical construction of two-speed and variable-speed ECMs, and the similar complexity in two-speed and variable-speed controllers, there is generally not a discernible difference between the cost of a variable-speed condenser fan setup and that of a two-speed condenser fan setup. Therefore, in this final rule, DOE is not analyzing two-speed fans as a design option.

Additionally, AHRI commented that DOE should reconsider using variable-speed condenser fan motors as a technology option. AHRI commented that variable-speed condenser fan motors are typically used in applications with modulating or two-stage compressors, versus single stage; however, AHRI stated that modulating and two-stage compressors are not needed to meet AWEF2 and would add significant costs if used. (AHRI, No. 72 at p. 7)

In its analysis, DOE found that there are efficiency benefits of using variable-speed condenser fans with single-stage compressors. Specifically, variable-speed condenser fans allow for reduced fan speed at lower ambient temperatures to reduce condenser head pressure.

Furthermore, AHRI commented that most dedicated condensing units use condenser fan motors under 1 HP, and with supply of these fans limited on the market, manufacturers would face challenges sourcing variable-speed condenser fan motors across their portfolio of capacity offerings since the availability for walk-in applications is also limited. AHRI stated that suppliers of motors in the smallest size range for walk-in use are difficult to find because walk-in market motors are too large to use in the reach-in market and too small compared to those needed in the air-conditioning condensing unit market. The motors needed to achieve AWEF2 for dedicated condensing unit product lines are not readily available off the shelf for the sizes needed in these markets, with volumes inadequate to justify development by condenser fan motor original equipment manufacturers ("OEMs"). (AHRI, No. 72 at p. 7)

DOE notes that it has identified dedicated condensing systems with variable-speed condenser fan motors.[48] Thus, DOE has determined that variable-speed condenser fan motors are available on the market. Therefore, DOE is considering variable-speed condenser fan motors as a design option in this analysis.

iv. Condensate Pan Heater

As discussed in the September 2023 NODA, DOE did not include drain line heaters on any of the single-packaged dedicated condensing system representative equipment analyzed in the September 2023 NOPR analysis, as DOE tentatively determined that such devices would typically be provided as a feature that may be optionally installed by a contractor. 88 FR 66710, 66714.

[48] *See* a line of dedicated condensing units with variable-speed fan motors as an optional specification in the following catalog: *www.heatcraftrpd.com/dA/6dcf836788/NEW-BN-TB-CU-AIRCOOLED-HAD-.5-6.pdf*.

In response, the CA IOUs recommended that DOE consider condensate pan heating technology options, such as water level sensors or hot gas routing, for packaged systems. In response to an earlier exchange with DOE in which DOE believed the CA IOUs referred to the drain line heater, the CA IOUs stated that, in fact, they were referring to the condensate pan heater inside the packaged system. The CA IOUs stated that the condensate pan heater is usually installed by the manufacturer on top of the walk-in box for indoor units, and they provided an illustration of the difference between the drain line and condensate pan heaters. The CA IOUs commented that manufacturers include the condensate pan heater in the packaged system because the condensate cannot be piped to a drain and must be evaporated. The CA IOUs recommended that DOE consider technologies that reduce the energy use of the condensate pan heater, such as water level sensors or hot gas routing, as technology options for packaged systems. (CA IOUs, No. 76 at pp. 9–10)

Throughout investigative testing conducted to support this final rule single-packaged dedicated system analysis, DOE has not encountered a condensate pan heater like the one pictured in figure 6 of the CA IOUs' comment. (CA IOUs, No. 76 at p. 10) DOE has calibrated the AWEF2s of the efficiency levels analyzed in this final rule using results from this testing. DOE did not include electric resistance condensate pan heaters in its baseline representative units for single-packaged dedicated systems. Therefore, DOE did not analyze any design options to reduce the energy consumption of condensate pan heaters.

v. Design Option Order

In response to the September 2023 NOPR, ASAP *et al*. recommended that, in general, DOE should ensure that the order of design options analyzed in the engineering analysis prioritizes cost-effective design options ahead of ones that are not cost-effective. (ASAP *et al*., No. 77 at p. 2)

In the September 2023 NOPR and March 2024 NODA, DOE generally ordered design options by cost-effectiveness (*i.e.*, AWEF2 improvement/incremental cost). Design options with greater cost-effectiveness (*i.e.*, greater AWEF2 improvement per incremental cost) were implemented before less cost-effective design options. In some cases, due to performance characteristics of design options or manufacturer feedback, less cost-effective design options preceded more cost-effective options. For example, during interviews manufacturers indicated that if they were to equip units with a variable-speed condenser fan they would only consider ECMs, since all ECMs can be variable-speed if equipped with a variable-speed controller. Therefore, the ECM condenser fan design option always came before the variable-speed condenser fan design option.

ASAP *et al*. recommended that DOE consider a standard level for outdoor dedicated condensing units that assumes the use of a variable-speed condensing fan ("VSCF”). ASAP *et al*. commented that according to its and DOE’s respective analyses, VSCFs would be a cost-effective design option, particularly for the medium-temperature outdoor dedicated condensing units. ASAP *et al*. stated that the combination of design options at TSL 2 plus a VSCF would result in a discounted lifetime operating cost of several hundred dollars less than that of TSL 2. ASAP *et al*. recommended that DOE reorder the design options for the outdoor DCU classes such that the addition of a VSCF comes before a larger condensing coil and that DOE consider adopting standards that reflect the use of a VSCF. (ASAP *et al*., No. 77 at pp. 1–2)

Variable-speed or cycling condenser fans are two other examples of design options that required prerequisite design options. For most representative units in DOE's analysis, these design options generally did not improve the efficiency of a unit unless that unit was equipped with a larger condenser coil. For this reason, DOE applied the larger condenser coil design option before cycling or variable-speed condenser fans, despite the larger condenser coil appearing to be a less cost-effective design option in the September 2023 NOPR analysis and March 2024 NODA analysis.

DOE maintained the same design option ordering scheme for this final rule analysis. The specific criteria for ordering design options are discussed in Chapter 5 of the accompanying TSD.

vi. Larger Condenser Coils

In the September 2023 NOPR analysis, DOE analyzed improved condenser coils for all dedicated condensing units and low- and medium-temperature single-packaged dedicated systems. 88 FR 60746, 60777. In response to this analysis, AHRI commented that DOE should not consider increased condenser coils as a design option, because larger condenser coils cannot be considered independent of considering fan motors and fan blades. Additionally, AHRI commented that AHRI members have received customer complaints about increased coil sizes that make the unit footprint larger, which, AHRI states, is not always a customer preference in certain applications. (AHRI, No. 72 at p. 7)

In the September 2023 NOPR analysis, when DOE applied the larger condenser coil design option, the fan power was also increased to match the airflow needed by a larger coil. This fan power increase was modeled as either a larger fan or additional fans depending on the magnitude of the condenser coil size increase. In either scenario, the MPC of the representative unit accounts for the increased coil size as well as either the larger fan size or added fans through increased cost of motors, fan blades, and fan mounting assemblies. *See* section 5.7.2.2 of the NOPR TSD. Additionally, the September 2023 NOPR analysis captured the MPC and shipping increases related to the larger case size resulting from a larger condenser coil. In its review of the market, DOE has identified existing dedicated condensing units that have larger coil sizes consistent with the improved condenser coil design option DOE analyzed. DOE is not aware of any impacts to consumers that would prevent manufacturers implementing larger condenser coils for the equipment classes this design option was analyzed for. Based on its analysis, DOE has concluded that the increased condenser coil can be a cost-effective design option and therefore is considering it for this final rule.

vii. Floating Head Pressure Controls

In the June 2022 Preliminary Analysis, DOE analyzed head pressure controls as a design option for outdoor dedicated condensing system equipment classes. *See* section 5.7.2.7 of the preliminary analysis TSD for details. Head pressure controls allow outdoor condensing units' head pressure to "float" down to a minimum condensing pressure as the ambient air temperature falls. This allows the compressor to operate more efficiently and therefore reduces the power consumption of the system without reducing the capacity. In the June 2022 Preliminary Analysis DOE evaluated two design options pertaining to head pressure control for the representative units of outdoor dedicated condensing units and outdoor single-packaged dedicated systems analyzed. These two design options were floating head pressure and floating head pressure with an EEV.[49] DOE assumed fixed head pressure would be the baseline design. Based on information collected during previous rulemakings, DOE determined the minimum condensing pressure associated with these design options and converted all minimum condensing pressures to minimum condensing dewpoint temperatures so that the values would be refrigerant agnostic. DOE assumed this minimum condensing dewpoint would apply at the lowest ambient rating condition (*i.e.*, 35 °F). At the intermediate rating temperature of 59 °F, DOE estimated the head pressure for fixed and floating systems when using a TXV based on testing results. DOE did not have testing results for a system with an EEV, so DOE calculated the degree to which the pressure would "float" down based on an assumption that the condenser temperature difference (*i.e.*, difference between entering air and refrigerant temperature) would scale with the capacity. DOE used test results and scaling to estimate a minimum dewpoint offset at 59 °F. Minimum condensing dewpoints at the 35 °F C test point and at the 59 °F B test point are summarized in Table IV.20.

[49] Systems equipped with an EEV could potentially operate with an even lower head pressure because the greater flexibility of the electronic controls allows an EEV to have a wider range of orifice open area without leading to unstable operation in warm ambient conditions.

Table IV.20 Summary of June 2022 Preliminary Analysis Head Pressure Control Design Options

Design Option Description	Minimum Condensing Dewpoint at 35 °F (°F)	Minimum Condensing Dewpoint at 59 °F (°F)
Fixed head pressure	101.5	104.4
Floating head pressure	85	86.7
Floating head pressure with an electronic expansion valve	67	85.9

In addition to the minimum condensing dewpoints imposed by head pressure control strategies, different compressor types have different minimum condensing dewpoints. The minimum condensing dewpoint temperatures for hermetic, semi-hermetic, scroll, and rotary compressors used in the June 2022 Preliminary Analysis are listed in Table IV.21. Therefore, DOE determined the minimum condensing dewpoints at the B (59 °F) and C (35 °F) test points as the maximum of the minimum condensing dewpoint allowed by the floating head pressure control scheme and the compressor type of the representative unit. For example, at the 35 °F C test condition, representative units using hermetic compressors would not be able to float down to a minimum condensing dewpoint of 67 °F, even if installed with floating head pressure with an EEV, because those systems would be constrained to the higher of the minimum condensing dewpoints based on compressor type and head pressure control scheme; therefore, at the 35 °F C test condition, representative units with hermetic compressors would only be able to float to a head pressure that corresponds to a minimum condensing dewpoint temperature of 85 °F.

Table IV.21 Minimum Condensing Dewpoint Temperatures by Compressor Type Used in the June 2022 Preliminary Analysis

Compressor Type	Minimum Condensing Dewpoint Temperature (°F)
Hermetic	85
Semi-hermetic	67
Scroll	67
Rotary	67

For the September 2023 NOPR analysis, DOE tentatively determined that the minimum condensing dewpoint temperatures used for the floating head pressure design option in the June 2022 Preliminary Analysis were higher than needed. 88 FR 66710, 66715–66716; section 5.2.7.2 of the NOPR TSD. DOE aggregated interview feedback and tentatively determined that 71.8 °F is a representative minimum condensing dewpoint at the C test for walk-in refrigeration systems using the floating head pressure design option. DOE assumed that the difference between the C test and B test minimum condensing dewpoints would remain the same as the difference between the June 2022 preliminary analysis C and B test minimum condensing dewpoints. During interviews, manufacturers indicated that floating head pressure was a standard design on all walk-in condensing systems and that this minimum condensing dewpoint temperature could be achieved by systems using TXVs. Additionally, during interviews manufacturers stated that changing a TXV for an EEV would not allow for lower head pressure settings and manufacturers had received feedback from customers and field technicians that lower head pressure settings even on equipment with EEVs result in decreased reliability and increased warranty claims. Therefore, DOE did not consider an additional step down in head pressure (and minimum condensing dewpoint) associated with EEVs. The minimum condensing dewpoints used in the September 2023 NOPR analysis are summarized in Table IV.22.

Table IV.22 Minimum Condensing Dewpoint Temperatures Used in the September 2023 NOPR Analysis

Design Option Description	Minimum Condensing Dewpoint Temperature (°F) at Outdoor Ambient Temperature of 35 °F	Minimum Condensing Dewpoint Temperature (°F) at Outdoor Ambient Temperature of 59 °F
Fixed head pressure	101.5	104.4
Floating head pressure	71.8	73.5

Based on testing results and feedback from manufacturer interviews, DOE tentatively determined that most dedicated condensing systems would need this floating head pressure design option to achieve the current AWEF standards. As such, DOE considered floating head pressure controls in the baseline designs for all outdoor dedicated condensing system representative units in the September 2023 NOPR analysis and did not consider floating head pressure controls with an EEV as a design option. FR 66710, 66715–66716; section 5.2.7.2 of the NOPR TSD.

In response to the September 2023 NOPR, the CA IOUs commented that EEVs save energy compared to traditional floating head pressure coupled with a mechanical TXV, because EEVs have a much lower pressure differential requirement and therefore can function at lower discharge pressures than a mechanical TXV. (CA IOUs, No. 76 at p. 4) The CA IOUs stated that the EEV would only impact utility if it were improperly controlling reduction in head pressure or the compressor were oversized without variable-capacity control. (CA IOUs, No. 76 at pp. 4–5)

The CA IOUs also commented that DOE should consider a broader range of minimum condensing dewpoint temperatures than what was shown in Table 5.7.11 of the NOPR TSD to account for the energy savings from EEVs. The CA IOUs stated that semi-hermetic compressors can have saturated condensing temperatures ("SCTs") as low as 55 °F and scroll compressors can have SCTs as low as 40 °F. (CA IOUs, No. 76 at pp. 6–7)

The CA IOUs commented that DOE's statement that a lower condensing dewpoint temperature than what is published in compressor literature may lead to concerns about potential unit reliability only applies to systems with poor piping practices, bad superheat settings, compressor cycling, and oil return issues. The CA IOUs stated that a proper system should benefit from lower head pressure. (CA IOUs, No. 76 at pp. 7–8)

Similarly, ASAP *et al*. recommended that DOE consider EEVs as a design option for outdoor refrigeration systems. ASAP *et al*. commented that EEVs could allow refrigeration systems to operate at lower head pressure relative to TXVs, saving energy. ASAP *et al*. stated that EEVs are much more precise than mechanical TXVs in controlling temperatures and pressures; thus, a refrigeration system using an EEV may be able to operate at lower head pressures without impacting utility or reliability. ASAP *et al*. further commented that EEV floating head pressure controls are used in the market today and that the technology is likely to be implemented by manufacturers to improve outdoor refrigeration system efficiency. (ASAP *et al*., No. 77 at pp. 2–3) ASAP *et al*. reiterated their comments about EEVs in response to the March 2024 NODA. (ASAP *et al*., No. 90 at p. 1)

As previously discussed in this section, DOE received feedback during manufacturer interviews that minimum condensing dewpoints lower than 71.8 °F affect walk-in refrigeration system reliability and increase warranty claims regardless of the type of expansion device used in the system. Regardless of the type of expansion valve (*i.e.*, TXV or EEV) used in a system, a lower head pressure results in subcooling, which is more difficult to control, leading to a liquid-vapor mixture instead of a pure liquid entering the expansion device. As such, if manufacturers specified lower head pressures, WICF installers may adjust these back to a condensing dewpoint of 71.8 °F when installing in the field, negating any potential savings.

DOE notes that different compressors within the same type have different minimum condensing dewpoints (*i.e.*, SCTs, as referred to by the CA IOUs). The values presented in Table 5.7.11 of the September 2023 NOPR TSD are intended to be representative of a typical minimum condensing dewpoint for the given compressor type, not the absolute minimum possible. DOE reviewed compressor performance data for the scroll and semi-hermetic compressors analyzed in this final rule analysis and determined that the minimum condensing dewpoint values in Table 5.7.11 of the September 2023 NOPR TSD are too conservative. Based on publicly available compressor performance data, DOE determined that 50 °F is a representative minimum condensing dewpoint for scroll compressors and 60 °F is a representative minimum condensing dewpoint for semi-hermetic compressors. Therefore, DOE updated the minimum condensing dewpoints assumed for scroll and semi-hermetic compressors in this final rule analysis. As discussed previously, DOE determines the minimum condensing dewpoints at the B (59 °F) and C (35 °F) test points as the maximum of the minimum condensing dewpoint allowed by the floating head pressure control scheme and the compressor type of the representative unit. Since the floating head pressure control scheme only allows a minimum condensing temperature of 71.8 °F for the C test, and 73.5 °F for the B test, the reduction in minimum condensing dewpoint for scroll and semi-hermetic compressors does not impact this final rule analysis.

Additionally, as manufacturers do not have control of piping practices, superheat settings, and equipment oversizing in the field, they are forced to accommodate a variety of field installation situations with conservative factory settings and recommendations for minimum condensing dewpoint temperature. As specified in section 3.5.2.4 of the appendix C1 test procedure, walk-in refrigeration systems must be set up for testing according to applicable field installation instructions. While a reduction in head pressure may be possible to reduce energy for certain installations, DOE does not have confidence that this reduction in head pressure through the use of an EEV would be possible in all potential installation scenarios that a basic model could be used in.

At this time, DOE is not considering a reduction to the floating head pressure design options' minimum head pressure value in this final rule analysis and is not adding a design option to further reduce the minimum condensing dewpoint by using an EEV.

viii. Variable-Speed Compressors

In the September 2023 NOPR analysis, DOE considered variable-speed compressors as a maximum-technology design option for dedicated condensing units and low- and medium-temperature single-packaged dedicated systems. 88 FR 60746, 60776.

AHRI commented that DOE is considering variable-capacity compressors to meet the max-tech levels; however, manufacturers could face challenges sourcing variable-capacity compressors. (AHRI, No. 72 at p. 6) Based on compressor manufacturer literature, DOE has determined that variable-capacity compressors are available for walk-in refrigeration systems at this time. Therefore, DOE is considering variable-capacity compressors as a design option for this final rule analysis.

ix. Design Options Analyzed for Final Rule Analysis

See Table IV.23 for a full list of design options analyzed for dedicated condensing units and single-packaged dedicated systems in this final rule analysis.

Table IV.23 Final Rule Analysis Refrigeration System Design Options

	Dedicated Condensing Units	**Single-Packaged Dedicated Systems**
All Units	• Higher-efficiency compressors • Improved condenser coil • Higher-efficiency condenser fan motors	• Higher-efficiency compressors • Higher-efficiency condenser fan motors • Off-cycle and on-cycle evaporator fan control • Improved thermal insulation
Outdoor Units Only	• Crankcase heater controls • Variable-speed condenser fan control • Ambient subcooling • Head pressure controls	• Crankcase heater controls • Variable-speed condenser fan control • Ambient subcooling • Head pressure controls
Medium- and Low-Temperature Units Only		• Improved evaporator and condenser coil • Hydrocarbon refrigerants • Variable-speed compressors

The specifics of modeling each design option are discussed in chapter 5 of the accompanying TSD.

Baseline Efficiency

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 equipment class represents the characteristics of 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.

There are currently energy conservation standards for medium- and low-temperature indoor dedicated condensing systems and for medium- and low-temperature outdoor dedicated condensing systems. These standards were established based on an analysis of dedicated condensing unit representative units using the AWEF metric and test procedures in appendix C. In the May 2023 TP Final Rule, DOE established a new test procedure and metric, AWEF2, for walk-in refrigeration systems in appendix C1. In the September 2023 NOPR, DOE set baseline efficiency levels for medium- and low-temperature dedicated condensing unit representative units at the current minimum standard level using the appendix C test procedure (*see* appendix C to subpart R to 10 CFR part 431). For example, for a medium-temperature, outdoor dedicated condensing unit, DOE determined which technology options would just meet the current AWEF standard of 7.6 Btu/W-h using the appendix C test procedure. Once units had their baseline design options set, DOE conducted the rest of the efficiency analysis using the appendix C1 test procedure to determine AWEF2 values for each efficiency level, including baseline. When transitioning from one metric to another DOE must ensure that new standards based on the new metric do not result in backsliding. The method DOE used in the September 2023 NOPR to set baseline levels for units currently subject to standards accomplishes this by translating current AWEF baselines to AWEF2 baselines.

In the May 2023 TP Final Rule DOE also established new test procedures for single-packaged dedicated systems and high-temperature refrigeration systems. For this equipment that was not analyzed in previous walk-in rulemakings DOE used product catalogs, feedback from manufacturer interviews, and testing to set the baseline at the lowest efficiency level commonly seen on the market today. All analysis for these equipment classes was done according to appendix C1.

In response to the baselines set in the September 2023 NOPR, AHRI and Hussmann commented that on the 10.0 tab of the NOPR analysis spreadsheet, the baseline minimum condensing dewpoint temperature is much higher than that of currently produced equipment. AHRI and Hussmann suggested that it is currently more likely that baseline units are in the 80 °F range and not the 101 °F range. AHRI and Hussmann commented that the TSD references 180 psig head pressure, but that is not represented by actual refrigerant properties; likewise, AHRI and Hussmann commented that in the NOPR, DOE states head pressure will float down to 150 psig, but that value is not reflected in the analysis spreadsheet. (AHRI, No. 72 at p. 19; Hussmann, No. 75 at p. 9)

As discussed in the Floating Head Pressure Controls subsection under Design Options, the fixed head pressure design option that AHRI and Hussmann reference with the 101 °F minimum condensing dewpoint was not considered as a baseline design option for any walk-in refrigeration system. Based on manufacturer feedback during interviews, DOE determined that all walk-in refrigeration systems employ the floating head pressure design option at baseline. Therefore, DOE did not analyze any representative units with fixed head pressure in the September 2023 NOPR analysis. DOE is maintaining that all representative units of dedicated condensing units will have floating head pressure at baseline efficiency in this final rule analysis. *See* appendix 5A of the final rule TSD, which shows a full list of design options that each representative unit includes at baseline.

AHRI commented that past walk-in analyses of medium- and low-temperature units mistakenly focused only on scroll compressors and discus semi-hermetic reciprocating compressors. AHRI stated that as a result, the majority of walk-in OEMs transitioned from hermetic reciprocating compressors to scroll compressors on smaller-capacity units and similarly discus semi-hermetic reciprocating compressors on larger-capacity systems. AHRI commented that DOE never fully evaluated higher-efficiency fixed-speed reciprocating compressors in the previous WICF energy conservation standards rules. AHRI stated that this oversight rendered OEMs unable to use these market-standard compressors as the baseline. (AHRI, No. 72 at p. 6)

As mentioned previously, DOE uses products currently on the market to determine the characteristics of baseline representative units. DOE used compressor types of baseline units in the September 2023 NOPR based on currently available models. As AHRI indicated in its comment, the majority of these representative units used scroll and semi-hermetic compressors. However, DOE found several single-packaged dedicated condensing systems use hermetic reciprocating compressors. Therefore, DOE analyzed these representative units with hermetic reciprocating compressors rather than scroll or semi-hermetic compressors at the baseline in the September 2023 NOPR analysis. DOE is maintaining the compressor types used at baseline in the September 2023 NOPR in this final rule analysis.

AHRI and Lennox commented that many of the technologies outlined and listed as increasing efficiency are already in use on some standard equipment and would not further increase efficiency on those products. AHRI and Lennox listed these technologies already in use in some products as: higher-efficiency condenser fan motors; off-cycle evaporator fan controls; head pressure controls; crankcase heater controls; higher-efficiency evaporator fan motors; ambient subcooling; improved condenser coil; variable-speed condenser fan control; and evaporator fan control—on-cycle. (AHRI, No. 72 at p. 5; Lennox, No. 70 at pp. 4–5)

DOE recognizes that some design options analyzed may already be in use in standard equipment. For some representative units, higher-efficiency design options are used at baseline to reach the current AWEF standard. For example, the DC.M.I.009 representative unit has a larger condenser coil and ECM at baseline. On the contrary, the DC.M.O.009 representative unit has no higher-efficiency design options at baseline. Thus, DOE has concluded that the design options analyzed, including those mentioned by AHRI and Lennox, could be implemented in equipment to improve efficiency of certain representative units.

In response to comments received on the September 2023 NOPR, DOE revised the assumptions about baseline unit characteristics by increasing the off-cycle power and crankcase heater power of low-temperature dedicated condensing system equipment classes in the March 2024 NODA. 89 FR 18555, 18561–18562. As discussed in the March 2024 NODA, these adjustments were based on a review of manufacturer specifications for crankcase heater wattage and a review of low-temperature off-cycle power test data. *Id.*

In response to these off-cycle power increases, AHRI stated that the updated crankcase heater wattages for low-temperature dedicated condensing units and single-packaged dedicated systems are still low. AHRI requested actual test data with all test conditions reflective of off-cycle power for a wider sampling of crankcase heaters as well as effects on low-temperature outdoor units. AHRI stated it is aware that there are multiple methodologies OEMs are using to control units operating at low-temperature conditions, and it would like to see DOE evaluate how controls play into off-cycle power by testing real-world products. (AHRI, No. 86 at p. 8) RSG stated that the crankcase heater power values presented in Table II.4 of the NODA appear to be sufficient. RSG asked if a system incorporates more than one compressor, whether the crankcase heater allowance multiplies with the number of compressors and how that would factor into the calculations. (RSG, No. 89 at p. 2)

The off-cycle power data DOE used to inform the crankcase heater power and off-cycle controls power for low-temperature dedicated condensing systems is summarized in Table IV.24. DOE's March 2024 NODA analysis estimations are on average 3 percent greater than the measured power of the tested units. Additionally, DOE has determined that unit number 4 is an outlier and that the controls present on this unit that account for the additional off-cycle power are not generally representative of low-temperature units currently on the walk-in market. DOE's estimations of crankcase heater power are a function of a unit's net capacity and do not consider the number of compressors specified for the unit. Based on this test data and manufacturer specifications for crankcase heater wattages, DOE has determined that the methodology used to calculate the low-temperature dedicated condensing unit off-cycle power for the March 2024 NODA analysis is representative and, therefore, DOE used the same methodology for this final rule analysis. Details of this methodology are discussed in Chapter 5 of the final rule TSD.

Table IV.24 Summary of Low-Temperature Outdoor Dedicated Condensing Unit Off-Cycle Power Test Data

Unit Number	Approximate Net Capacity	Measured Off-Cycle Power (W)			NODA Analysis Baseline Ancillary Off-Cycle Power for a Representative Unit of the Same Capacity (W)
		A Test	B Test	C Test	
1	3,000	35	35	35	45
2	10,000	72	73	73	75
3	7,000	74	74	74	75
4	17,000	93	93	94	75

RSG suggested that off-cycle power for dedicated condensing units will be different than for single-packaged dedicated systems. RSG stated that off-cycle power for single-packaged dedicated systems may include evaporator fans, crankcase heaters, electronic controls, solenoids, and EEVs. (RSG, No. 89 at p. 2)

Both dedicated condensing units and single-packaged dedicated systems incorporate off-cycle evaporator fan power into their AWEF2 calculations. The DOE test procedure at appendix C1 for dedicated condensing units tested alone specifies that off-cycle evaporator fan power will be 20 percent of on-cycle evaporator fan power. *See* AHRI 1250-2020 equations 118, 137, 163, and 180. Depending on which evaporator fan control design option the baseline representative unit is equipped with (*i.e.*, no controls, cycling controls, or variable-speed controls), the baseline single-packaged dedicated systems analyzed in the March 2024 NODA may have baseline off-cycle evaporator fan power that is equal to 100, 50, or 20 percent of on-cycle evaporator fan power. DOE's single-packaged dedicated system off-cycle test data suggests that single-packaged dedicated systems will have ancillary off-cycle power (*i.e.*, off-cycle power excluding evaporator fan power) very similar to that of dedicated condensing units. DOE has validated the single-packaged dedicated system ancillary off-cycle power assumptions used in the March 2024 NODA analysis with this test data. See Table IV.25 for a comparison of single-packaged ancillary off-cycle test data and ancillary off-cycle power assumptions from the March 2024 NODA engineering analysis. DOE has determined that unit number 4 is not representative of typical single-packaged dedicated system off-cycle power, as the crankcase heater is a lower wattage than recommended by the compressor manufacturer.

Table IV.25 Summary of Single-Packaged Dedicated System Off-Cycle Power Test Data

Unit Number	Temperature	Approximate Net Capacity (Btu/h)	Measured Ancillary Off-Cycle Power (W)			NODA Analysis Baseline Ancillary Off-Cycle Power for a Representative Unit of the Same Capacity (W)
			A Test	B Test	C Test	
1	LT	5,000	62	70	70	75
2	LT	2,000	4	N/A	N/A	5
3	MT	2,000	1	N/A	N/A	0
4	MT	14,000	34	34	34	67

DOE maintained the baselining methodology from the September 2023 NOPR and March 2024 NODA in this final rule analysis.

<u>Higher Efficiency Levels</u>

Consistent with the analysis for previous walk-in refrigeration system rulemakings (*i.e.*, the June 2014 Final Rule and the July 2017 Final Rule), in the September 2023 NOPR, DOE added the remaining applicable design options that were not used in the baseline of each representative unit to determine efficiency levels above baseline. As discussed in the design option section, the increase in AWEF2 from each design option for each representative unit is calculated using appendix C1 and is calibrated using test data, stakeholder comments, and manufacturer interview feedback.

In response to the September 2023 NOPR, DOE received comments from stakeholders regarding the higher efficiency levels analyzed for dedicated condensing units and single-packaged dedicated systems.

The CA IOUs recommended that DOE consider including additional design options (*e.g.*, variable-speed evaporator fans, improved compressors, and larger condensing coils) for low-temperature outdoor single-packaged systems, as they are included for indoor low-temperature single-packaged systems. The CA IOUs stated that many indoor and outdoor systems offered by the same manufacturer differ only by their weatherproof housing, while the internal components remain the same. The CA IOUs commented that both indoor and outdoor single-packaged systems include reciprocating and scroll compressor options, resulting in different efficiencies. The CA IOUs also stated that manufacturers offer condensing coils of differing sizes, and manufacturers offer different efficiency condensing fan motor options (*i.e.*, ECM and PSC) for outdoor systems. Thus, the CA IOUs recommended that DOE consider additional design options, including larger condensing coils, for outdoor low-temperature packaged systems. (CA IOUs, No. 76 at pp. 10–11) DOE notes that many of the additional design options indicated by the CA IOUs (*e.g.*, variable-speed evaporator fans and larger condensing coils) are included in the baseline design for the representative units analyzed for outdoor low-temperature single-packaged dedicated units. DOE did not analyze improved compressors for outdoor low-temperature single-packaged dedicated system representative units, as the improved compressors (hermetic reciprocating propane compressors) identified for these units did not improve the AWEF2 of outdoor units.

Appendix 5A of the final rule TSD shows a full list of design options that each representative unit includes at baseline.

AHRI asserted that the low-temperature and indoor medium-temperature dedicated condensing system equipment classes are already the hardest categories to meet minimum AWEF and when considering the current AWEF standards, the proposed changes by DOE would require significant design modifications to achieve the new minimum AWEF2. (AHRI, No. 72 at p. 6)

DOE notes that it is obligated to consider all efficiency levels above baseline. Additionally, DOE considers the significance of the modifications necessary to achieve these efficiency levels through the cost analysis and the MIA. *See* section IV.C.2 for discussion of the cost analysis and section IV.J for discussion of the MIA. Some efficiency levels above baseline for the equipment classes specified by AHRI were found to be cost-effective and technologically feasible, so they were included in the proposed standard level in the September 2023 NOPR. DOE is maintaining the higher efficiency levels analyzed in the September 2023 NOPR analysis in this final rule analysis and is therefore analyzing the design options mentioned in AHRI's comment in this final rule analysis.

DOE maintained the methodology from the September 2023 NOPR to determine higher efficiency levels in this final rule analysis.

Engineering Spreadsheet

As part of the September 2023 NOPR, DOE published the engineering spreadsheet used to analyze dedicated condensing units and single-packaged dedicated systems ("September 2023 refrigeration system engineering spreadsheet"). *See* EERE-2017-BT-STD-0009-0052. DOE received specific stakeholder feedback regarding the content of the engineering spreadsheet, which is summarized and addressed in the following paragraphs.

AHRI and Hussmann commented that in the NOPR analysis spreadsheet, the formulas in cells F7 and F8 of tab 2.0 and cell E7 of tab 7.0 do not align with that found in the TSD. AHRI and Hussmann recommended DOE provide explanations for the calculations so a valid review could be done. (AHRI, No. 72 at p. 2; Hussmann, No. 75 at p. 9) As discussed in the September 2023 NOPR TSD, DOE developed a correlation between condenser core volume[50] and condenser load divided by condenser temperature difference. *See* section 5.7.2.2 of the September 2023 NOPR TSD. The equations in cells F7 and F8 of the September 2023 refrigeration system engineering spreadsheet use those correlations to calculate condenser coil core volume for the baseline and improved condenser coils.

AHRI and Hussmann commented that in the NOPR analysis spreadsheet, DOE assumes that all coil rows are 1.08 inches; however, AHRI and Hussmann commented

[50] DOE defined "condenser core volume" as fin area times finned length.

that some coils use different row spacing, which could be negatively impacted. (AHRI, No. 72 at p. 2; Hussmann, No. 75 at p. 9) DOE used 1.08 inches as a representative value for a coil row in the September 2023 NOPR based on teardowns, review of diagrams in product literature, and manufacturer interview feedback. DOE has determined that 1.08 inches appropriate represents the sizing of a coil row. Thus, in this final rule, DOE is maintaining a representative coil row size of 1.08 inches in the final rule engineering analysis spreadsheet.

AHRI and Hussmann recommended that DOE fix the errors in the NOPR analysis spreadsheet and redo all analyses before finalizing any new targets. (AHRI, No. 72 at p. 2; Hussmann, No. 75 at p. 9) DOE made several corrections to the September 2023 refrigeration system engineering spreadsheet for the March 2024 NODA. Stakeholder comments that informed these corrections are summarized and addressed in the March 2024 NODA. 89 FR 18555, 18563–18564. Additionally, DOE published an updated engineering spreadsheet for single-packaged dedicated equipment and dedicated condensing units. See EERE-2017-BT-STD-0009-0080. DOE did not receive any further comments regarding the engineering analysis spreadsheet in response to the March 2024 NODA. DOE posted an updated refrigeration systems engineering spreadsheet for this final rule analysis.[51]

[51] See *regulations.gov/docket/EERE-2017-BT-STD-0009/document*.

f. Unit Coolers

Refrigerants Analyzed

As discussed in section IV.C.1.e of this document, the October 2023 EPA Technology Transitions Final Rule requires the use of low-GWP refrigerants for walk-in coolers and freezers. A key concern about the transition to lower-GWP refrigerants relative to the performance of refrigeration systems is the potential for higher refrigerant glide to impact performance; however, as discussed previously in section IV.C.1.e of this document, increased refrigerant glide increases unit cooler performance. DOE based its unit cooler analysis on low-glide refrigerants. Specifically, DOE used R-404A to analyze medium- and low-temperature unit coolers and R-134a to analyze high-temperature unit coolers. 88 FR 60746, 60780. DOE expects that high-glide refrigerants would have better performance, thus it is expected that unit coolers will be able to meet the adopted standards with the refrigerant changes mandated by the October 2023 EPA Technology Transitions Final Rule.

DOE did not receive any comments in response to the refrigerants analyzed in the September 2023 NOPR for unit coolers. In response to the March 2024 NODA, Lennox stated that further test evaluation indicates the efficiency and capacity performance of R-454A is actually 3 to 4 percent lower than that of R-448A in unit coolers. (Lennox, No. 70 at p. 7) DOE notes that R-404A, not R-448A, was used in the unit cooler analysis. DOE analyzed the capacity of unit coolers certified in the CCD and compared identical unit cooler models certified with both R-404A and R-448A. DOE found that capacity for R-404A unit coolers was at least 25 percent less and on average 34 percent less than equivalent R-448A unit coolers. This results in at least a 6-percent reduction and an average reduction of 9 percent in AWEF2 when swapping R-448A for R-404A. As such, based on this and Lennox's assertions in its comments, DOE expects any analysis conducted using R-404A to be a conservative approach and that unit coolers would not suffer a performance penalty when switching from R-404A to R-454A. In this final rule analysis, DOE is maintaining the refrigerants analyzed in the September 2023 NOPR and using R-404A to analyze medium- and low-temperature unit coolers and R-134A to analyze high-temperature unit coolers.

Representative Units

The representative unit cooler capacities analyzed in the September 2023 NOPR are listed in Table IV.26.

Table IV.26 Representative Units Analyzed for Unit Coolers in September 2023 NOPR and Final Rule Analysis

Temperature	Class Code	Capacity (kBtu/h)
High (Non-Ducted)	UC.H	9
		25
High (Ducted)	UC.H.D	9
		25
Medium	UC.M	3
		9
		25
		54
		75
Low	UC.L	3
		9
		25
		54
		75

DOE did not receive comment on the representative unit cooler capacities analyzed in the September 2023 NOPR. Therefore, in this final rule, DOE analyzed the same representative units for unit coolers that it analyzed in the September 2023 NOPR.

Efficiency Levels for Medium- and Low-Temperature Unit Coolers

In the September 2023 NOPR, DOE analyzed medium- and low-temperature unit coolers using an efficiency-level approach. 88 FR 60746, 60781. To conduct this analysis, DOE constructed a database of medium- and low-temperature unit coolers by combining CCD data and manufacturer product literature. Throughout this final rule, this database is referenced as "the unit cooler performance database." The following subsections describe how the unit cooler performance database was constructed and how it was used to define the efficiency levels analyzed in this final rule. Additionally, comments pertaining to the unit cooler performance database and the unit cooler efficiency analysis that DOE received in response to the September 2023 NOPR and March 2024 NODA are summarized and addressed.

i. Constructing the Unit Cooler Performance Database

As discussed in the September 2023 NOPR, the CCD includes few unit coolers rated above baseline. 88 FR 60746, 60781. However, after evaluating certified unit cooler capacities, DOE tentatively determined that there are unit coolers on the market at efficiencies higher than baseline. As such, instead of modeling efficiency based on certified AWEF values, DOE calculated unit cooler AWEF2 in accordance with appendix C1 to subpart R of 10 CFR part 431 using certified capacity from the CCD, fan powers published in manufacturer literature, and default defrost power calculations based on test procedure equations in AHRI 1250-2020. DOE posted to the docket a version of the unit cooler performance database with identifying information and information obtained through confidential manufacturer interviews removed. *See* EERE-2017-BT-STD-0009-0064.

In response to the NOPR, AHRI and Lennox commented that DOE's unit cooler performance database should have used equation C45 of AHRI 1250-2020 to calculate the defrost heat (Btu/h) for low-temperature unit coolers instead of equations C25, C26, and C27 of AHRI 1250-2020, which are for unit coolers with hot gas defrost. (AHRI, No. 72 at p. 9; Lennox, No. 70 at p. 5) Equation C45 from AHRI 1250-2020 appendix C is used to calculate the defrost heat of single-packaged dedicated systems, matched pairs, or unit coolers tested alone, but all of these equipment have measured defrost power during the defrost test. As the measured defrost power of unit coolers is not certified in the CCD or readily published in most manufacturer literature, DOE instead estimated a representative defrost power for each unit cooler in the database using the defrost calculations for dedicated condensing units tested alone, which is why equations C46, C47, and C48 of AHRI 1250-2020, which are used for dedicated condensing units tested alone, were used. DOE notes that equations C46, C47, and C48 from AHRI 1250-2020 are identical to equations C25, C26, and C27.

Lennox commented that defrost heat seems low for unit coolers compared to tested values and off-cycle power seems high for unit coolers. (Lennox, No. 70 at p. 5) As discussed in this section, DOE calculated defrost heat for low-temperature unit coolers in the unit cooler performance database using the defrost calculations from AHRI

1250-2020 for dedicated condensing units tested alone. For unit coolers with two- or variable-speed fan motors, DOE assumed that off-cycle fan power would be based on the fan(s) running at 50-percent speed, the minimum speed allowed by the DOE test procedure. Section 4.2 of appendix C to AHRI 1250-2020. DOE calculated fan power for this 50-percent speed assuming this operation would consume 20 percent of the full speed power, based on equation 118 in AHRI 1250-2020. Since the defrost heat and off-cycle fan power in the unit cooler performance database are based on the industry test procedure, AHRI 1250-2020, DOE has determined that the values in the unit cooler performance database are representative. It is DOE's understanding that the defrost heat values in AHRI 1250-2020 were established based on a test program of representative electric-defrost low-temperature unit coolers spanning a range of capacities. Thus, DOE has determined that the defrost heat values can be considered to be representative.

Lennox also suggested that DOE verify net capacities of unit coolers through testing with all listed refrigerants. (Lennox, No. 70 at p. 5) DOE notes that testing the unit coolers in the unit cooler performance database with all listed refrigerants was not practical given time and resource constraints. The unit cooler database contains data that is certified to DOE; thus, DOE has determined that using the net capacities in the unit cooler database in its analysis is appropriate and representative of the market.

AHRI commented that DOE should not use the CCD net capacity and literature fan power to calculate AWEF2 because the AWEF values certified in the CCD are often shown as the minimum and literature fan power is not necessarily associated with either the unit's net capacity or AWEF in the CCD. (AHRI, No. 72 at p. 19) Lennox commented that the motor wattage data from catalogs may not be representative of actual performance. (Lennox, No. 70 at p. 5) Through a review of the market and available data, DOE has determined that fan powers found in product literature are the most representative fan powers available for the units included in the unit cooler performance database. Additionally, as discussed in the previous paragraphs, DOE used CCD net capacity, not CCD AWEF, to construct the unit cooler performance database. DOE expects that the net capacities certified in the CCD are appropriate and representative as they are certified to DOE.

AHRI recommended that DOE establish and validate a data-based basis for calculating AWEF2 through testing. (AHRI, No. 72 at p. 19) Since DOE has concluded that fan power, net capacity, and defrost power in the unit cooler performance database (the inputs for unit cooler AWEF2 calculations) are representative, DOE has determined that the calculated AWEF2s are representative and do not need extensive validation from testing.

In response to the September 2023 NOPR, Lennox stated that as unit cooler rows increase, unit cooler fans have to increase their power draw due to the increased internal static pressure ("ISP"). This comment is summarized and addressed in the March 2024 NODA. 89 FR 18555, 18564. As discussed in the March 2024 NODA, manufacturer product catalogs, which were the primary source of fan powers for the unit cooler performance database, generally do not show an increase in fan power as rows increase. *Id.* DOE acknowledged that an increase in ISP caused by additional rows would result in an increased fan power if all other system characteristics were held constant. DOE analyzed unit cooler systems using CoilDesigner and tentatively determined that increasing the number of heat exchanger rows from two to three or three to four would result in roughly a 6-percent increase in unit cooler fan power, and increasing heat exchanger rows from four to five would result in roughly a 4-percent unit cooler fan power increase.[52] Based on an analysis of the AWEFs in the unit cooler performance database, DOE tentatively determined that the most likely scenario is that catalogs report the maximum power draw for unit cooler fans. As such, unit coolers with fewer than four or five rows have overestimated fan powers in the unit cooler performance database. Based on these conclusions in the March 2024 NODA, DOE tentatively determined that the maximum technology levels proposed in the September 2023 NOPR were still technologically feasible, as the units used to set these values had accurate fan powers. As such, in the March 2024 NODA, DOE did not adjust the fan powers of any units in the unit cooler database.

In response to the March 2024 NODA, AHRI and Lennox stated that adding two more rows to the existing unit cooler coil significantly changes the dimension of the evaporator and adds static pressure to airflow, thereby increasing the motor power consumption. AHRI and Lennox stated that, therefore, the expected increase in AWEF2 should be less. AHRI and Lennox stated that the lower the capacity, the more reduced the AWEF2 standard should be. AHRI and Lennox stated that for these reasons, the costs are

[52] CoilDesigner is a heat exchanger coil simulation tool. CoilDesigner Version 4.8.20221.110 was used for this analysis.

underestimated, and they referred DOE to its member comments in response to the September 2023 NOPR. (AHRI, No. 86 at p. 4; Lennox, No. 87 at p. 6)

DOE agrees that unit cooler fan power should increase for higher-row unit coolers. Thus, DOE revised its unit cooler fan power analysis for this final rule. DOE adjusted the fan power of units in the unit cooler database assuming that the reported catalog fan power was accurate for units with the greatest number of tube rows and fins per inch for a given product family and brand, and that units with fewer rows and fewer fins per inch within that given family would have lower fan powers. The relationship between fan power and tube rows is discussed above. Regarding fan power trends with fins per inch, DOE assumed that reducing fins per inch from eight to six reduces fan power by 2.5 percent and that reducing fins per inch from six to four reduces fan power by 3.5 percent, based on review of literature reports of airflow trends versus both fins per inch and row numbers for unit coolers. The details of this fan power adjustment are described in chapter 5 of the final rule TSD. When implementing these changes to the analysis, the calculated AWEF2 values of the lower-row unit coolers increased, thus reflecting the trend noted by commenters, *i.e.*, that the AWEF2 improvement associated with row number increase should not be as great as DOE calculated based on the initial assumption that fan power does not increase as the number of rows increase. The cost changes that resulted due to this change are discussed in the Assigning Costs to Efficiency Levels subsection of section IV.C.2.f of this document.

In response to the March 2024 NODA unit cooler analysis, Hussmann stated that there is no way to review what DOE did for unit coolers unless they provide the database of information. (Hussmann, No. 88 at p. 4) Additionally, AHRI requested the updated unit cooler database with the number of rows for each unit cooler. (AHRI, No. 86 at p. 4) DOE notes that the unit cooler performance database docketed with the September 2023 NOPR analysis contained all the information DOE is able to disclose while retaining the anonymity of units in the database and not violating non-disclosure agreements of manufacturer interviews under which some data in the unit cooler performance database was collected. DOE notes that the posted unit cooler database provides all the inputs used for the AWEF2 calculation. As such, the unit cooler performance database docketed in support of this final rule analysis contains no additional information. Furthermore, DOE notes that in the unit cooler performance database that is docketed with this final rule, there are five less unit entries than in the unit cooler performance database that was docketed with the September 2023 NOPR. DOE determined that these units were not representative of the unit cooler market and therefore removed them. These five units were not used in the September 2023 NOPR efficiency analysis so the efficiency levels are unaffected by the removal of these units.

ii. Analyzing Representative Units Using the Unit Cooler Performance Database

As discussed in section 5.8.2 of the September 2023 NOPR TSD, DOE identified units in the unit cooler performance database that were a part of manufacturers' product configurations that had net capacities within 10 percent of each representative unit's net capacity and grouped them together. These groups of unit coolers with similar configurations and capacities were used to analyze the representative units selected for this analysis.

In response to this methodology used to analyze representative units, Hussmann commented that the representative models used from the unit cooler database are not representative of the broader population of models. Hussmann stated that while the only model selected to represent the UC.M.075 representative unit and the capacity point is 7 percent above the goal, there are 376 models in the same capacity range in the CCD, many of which are much closer to the goal capacity value. Hussmann stated that similarly, only two UC.L.075 models were selected for representation and are 8 to 9 percent from the goal capacity, while 373 models could have been used, many of which have capacity values much closer to the goal. Hussmann noted that for the lower capacity points, multiple units were selected that provide a range of models. Hussmann provided charts to show both the representative models and all possible models that could have been used, indicating models that it believed would have been better choices for representation. (Hussmann, No. 75 at pp. 3–5) DOE notes that it selected models for the NOPR analysis that not only were within 10 percent of the capacity goal but also differed only in the number of tube rows, to isolate the impact of this design option. The alternative selections mentioned by Hussmann have more differences than tube rows and thus could not be used to isolate the impact of the tube row addition. Figure IV.1 shows the calculated AWEF2 values for three-, four-, and five-row medium-temperature unit cooler models in the database using the methodology used in the NOPR but with fan power calculation adjusted as described in this section. The calculated AWEF2 values are compared in this figure to the EL 1 and EL 2 efficiency levels used in the analysis, indicating that the selected efficiency levels are appropriate.

iii. Baseline Efficiency

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 equipment class represents the characteristics of 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.

DOE concluded while conducting the NOPR analysis that baseline medium- and low-temperature unit coolers with a capacity less than or equal to 25 kBtu/h typically had two evaporator rows and baseline units with a capacity greater than 25 kBtu/h typically had three evaporator tube rows. Table IV.27 lists representative units and the number of baseline evaporator tube rows DOE used in the September 2023 NOPR.

Table IV.27 Representative Baseline Medium- and Low-Temperature Unit Cooler Evaporator Tube Rows from the September 2023 NOPR

Temperature	Capacity (kBtu/h)	Baseline evaporator tube rows
Medium	3	2
	9	2
	25	2
	54	3
	75	3
Low	3	2
	9	2
	25	2
	54	3
	75	3

In response to the September 2023 NOPR, DOE received comments on the baseline assumption for medium- and low-temperature unit coolers.

Lennox recommended that DOE further review unit cooler designs of the current market to ensure that the baseline design is representative of the current market and not a carryover from the prior WICF rulemaking. Lennox stated that the approach to add rows to two- and three-row unit cooler designs has likely already been implemented to attain the current AWEF standard levels. (Lennox, No. 70 at p. 4)

AHRI, Hussmann, and Lennox commented that section 5.8 in the TSD assumes all baseline coils are either two or three rows; however, many coils are already four rows to meet the current AWEF requirements. (AHRI, No. 72 at pp. 3–4 and No. 86 at p. 6; Hussmann, No. 75 at p. 1; Lennox, No. 70 at p. 4) AHRI stated that the presumption that most coils are two-row is erroneous, as the more common baseline is now four rows. (AHRI, No. 72 at p. 9) AHRI and Hussmann estimated that 5 percent of current coils are two row, about 30 percent are three row, and the remaining 65 percent are four row. (AHRI, No. 72 at pp. 3–4 and No. 86 at p. 6; Hussmann, No. 75 at p. 1) Lennox estimated that 5 percent of current coils are two row, about 30 percent are three row, and the remaining 55 percent are four row, 5 percent are five row, and 5 percent are six row. (Lennox, No. 70 at p. 4)

As discussed, DOE sets the baseline unit as a unit that just meets the current energy conservation standards. DOE analyzed the unit cooler performance database in response to these comments and found that 4 percent of units in the database have two-row coils, 22 percent have three rows, 52 percent have four rows, and 22 percent have five rows. Additionally, DOE plotted the AWEF and capacity of the medium-temperature units in the database while differentiating row numbers. *See* Figure IV.1. These plots show that baseline efficiency levels are achievable by three-row units for all capacities. As such, for this final rule analysis DOE updated the representative row numbers for each baseline unit to be three rows.

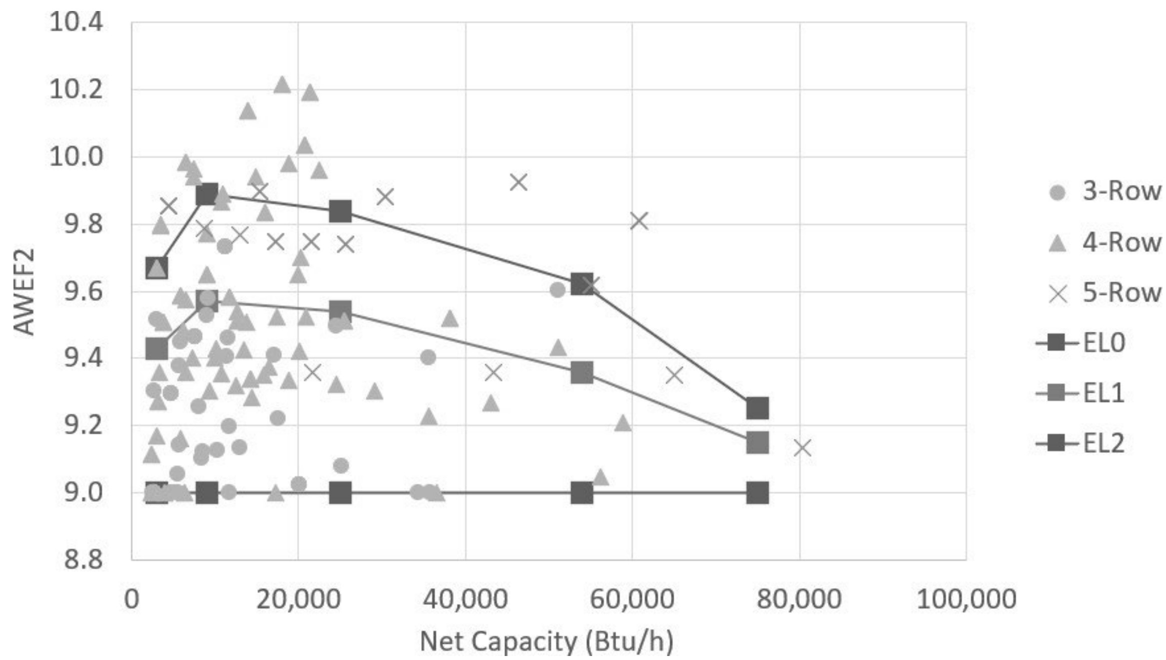

Figure IV.1 Medium-Temperature Unit Cooler Net Capacity Versus AWEF2 by Row Number

iv. Maximum Technology Levels

Using the unit cooler performance database, DOE found that the primary design option in unit coolers on the market today to improve efficiency is an improved evaporator coil. Specifically, DOE found that adding tube rows to unit cooler evaporators increases capacity and that, while fan power does increase, the fan power increase is significantly less than the capacity increase, resulting in more efficient units.

In the September 2023 NOPR, to set the maximum technology level for medium- and low-temperature unit coolers, DOE selected the highest-efficiency unit cooler available for each representative capacity from the unit cooler performance database. The highest-efficiency unit coolers at each representative capacity corresponded to an increase in two evaporator tube rows. Table IV.28 lists the unit cooler representative units evaluated in the September 2023 NOPR and the number of tube rows used to reach the highest efficiency level analyzed.

Table IV.28 Representative Maximum-Technology Medium- and Low-Temperature Unit Cooler Evaporator Tube Rows from the September 2023 NOPR

Temperature	Capacity (Btu/h)	Maximum-Technology Evaporator Tube Rows
Medium	3,000	4
	9,000	4
	25,000	4
	54,000	5
	75,000	5
Low	3,000	4
	9,000	4
	25,000	4
	54,000	5
	75,000	5

In response to the September 2023 NOPR, DOE received comment on the maximum technology evaporator tube rows.

AHRI questioned the AWEF2 values at EL 2 in DOE's NOPR analysis. AHRI commented that the source for EL 2 values was not provided, and if they came from the "unit cooler performance database," the information on the quantity of rows was not provided to evaluate. AHRI requested that DOE provide the number of rows for the list of models so AHRI can further assess the data. (AHRI, No. 72 at pp. 4–5) AHRI also stated that AWEF gains in the vicinity of 15 percent for unit coolers is an aggressive expectation for adding a row to coils. (AHRI, No. 72 at p. 9) Lennox also commented that the unit cooler database does not specify the number of coil rows, so Lennox is unable to analyze further. (Lennox, No. 70 at p. 4)

DOE determined the AWEF2 values based on the unit cooler performance database. As discussed previously in this section, DOE grouped units within a range of capacities into a single representative capacity. Then, DOE determined the efficiency and cost increase associated with adding one- and two-coil rows to the baseline model. DOE notes that the number of coil rows associated with each unit is confidential data informed by feedback obtained through manufacturer interviews. As mentioned previously, DOE is unable to publish this data publicly. Regarding AHRI’s assertion that a 15-percent increase in AWEF is an aggressive expectation for adding a coil row, DOE notes that only some representative units analyzed for low-temperature unit coolers have efficiency increases as high as 15 percent, and these correspond to an additional two rows added to baseline.

AHRI and Hussmann commented that DOE should conduct the unit cooler analysis assuming that three-row coils will move to four-row coils and that four-row coils will be maintained. (AHRI, No. 72 at p. 4; Hussmann, No. 75 at p. 2) In its review of the market, DOE found unit coolers that have coils with five rows across the range of representative unit capacities. Thus, DOE analyzed five-row coils as the maximum technology option for unit coolers.

Lennox commented that increasing four-row designs to five- and six-row designs is not cost-effective because adding coil rows has diminishing returns on improving efficiency. Lennox stated that effective heat exchange of adding rows drops because the heat has already been largely added to the refrigerant in the existing rows, therefore heat remaining in the air is lessened. (Lennox, No. 70 at p. 4)

In response to the March 2024 NODA, AHRI reiterated that increasing four-row unit coolers to five or six rows is not cost-effective and that additional rows have diminishing efficiency returns. (AHRI, No. 86 at pp. 6–7)

DOE notes that it did not identify any six-row unit coolers in the unit cooler performance database. In its analysis, DOE recognizes that increasing a four-row design to a five-row design results in a lower efficiency increase than increasing a three-row design to a four-row design and, therefore, the efficiency increase from EL 0 to EL 1 is greater than the efficiency increase from EL 1 to EL 2. Cost-effectiveness of any design option is determined by analyses in sections IV.F and IV.H of this document.

As shown in Figure IV.1, the max-tech levels from the September 2023 NOPR for medium-temperature unit coolers are achievable by four- and five-row unit coolers on the market today. In this final rule analysis, DOE is making the conservative assumption that all unit coolers would have to go to five-row coils at max-tech levels.

Defining maximum technology levels for unit coolers is discussed in more detail in chapter 5 of the final rule TSD.

v. Intermediate Efficiency Levels

As discussed in the September 2023 NOPR, all medium- and low-temperature unit cooler representative capacities had baseline and maximum technology efficiency levels that differed by more than one tube row. DOE defined an efficiency level for each of these representative units at the number of tube rows between their baseline and maximum technology levels. For example, if the baseline has three tube rows and the maximum technology had five tube rows, DOE defined an intermediate efficiency level at four tube rows. DOE's analysis of the market suggested that manufacturers only use full tube rows and, therefore, DOE only used whole-number tube rows for the analysis. DOE determined the efficiency of these intermediate efficiency levels using data from the unit cooler performance database. 88 FR 60746, 60782.

DOE did not receive comments on defining intermediate efficiency levels for unit coolers in response to the September 2023 NOPR; therefore, DOE is defining intermediate efficiency levels using the same methodology as was used in the September 2023 NOPR in this final rule analysis. In this final rule analysis, due to the change in tube-row assumptions for baseline and max-tech levels, DOE correspondingly assumes that all intermediate efficiency levels would use four tube rows.

Defining and determining the efficiency of intermediate efficiency levels is discussed in more detail in chapter 5 of the final rule TSD.

General Comments

In response to the September 2023 NOPR, DOE received several general comments about the unit cooler efficiency level analysis. Hussmann recommended that DOE address its concerns regarding its unit cooler analysis and consider the proposed revision to the AWEF2 standards before finalizing any new targets. (Hussmann, No. 75 at p. 7) Lennox stated that DOE must address various technical issues before proceeding with any new WICF energy conservation standard. Lennox further stated that DOE must review the baseline design assumptions and associated costs of attaining increased efficiency levels. (Lennox, No. 70 at pp. 3–4) Lennox recommended DOE further review that the methods to achieve improved efficiency are viable and that the associated costs are accurate (Lennox, No. 70 at p. 4) Lennox also stated that DOE must verify data inputs and correct errors in formulas and calculations before determining if amended AWEF standard levels are justified. (Lennox, No. 70 at p. 5) In the previous sections, DOE addressed specific concerns raised by stakeholders about the unit cooler efficiency level analysis to ensure it is technologically feasible. As such, DOE has determined that the unit cooler efficiency levels presented in the March 2024 NODA are technologically feasible. Their cost-effectiveness is assessed in sections IV.F and IV.H. of this final rule.

In response to the efficiency levels presented in the March 2024 NODA, AHRI asked for the updated analysis for the UC.L.009 representative unit and what the difference between the three different designs at baseline, EL 1, and EL 2 are. AHRI stated that it did not understand why Table 3.1 (of the NODA support document) lists two different design options but the analysis uses three different options. (AHRI, No. 86 at p. 4) DOE notes that the design option codes in Table 3.1 of the NODA support document are for dedicated condensing systems and single-packaged dedicated systems, as those were the equipment classes analyzed using a design-option analysis. The UC.L.009 representative unit was analyzed using an efficiency-level approach. As discussed in the previous sections, a baseline, intermediate, and max-tech level were defined for each medium- and low-temperature unit cooler representative unit. DOE found that the intermediate level generally represented an additional tube row being added to the baseline unit cooler heat exchanger, and the max-tech level represented two additional tube rows being added.

Design Options

In the September 2023 NOPR, DOE did not directly analyze any design options for medium- and low-temperature unit coolers as an efficiency-level analysis was conducted. In response to the efficiency-level analysis for medium- and low-temperature unit coolers, DOE received several comments about specific design options, which are summarized and addressed below.

NAFEM commented that DOE’s proposal to increase evaporator tube rows in order to increase efficiency for unit coolers is not a new technology but an extension of an existing technology. NAFEM commented that manufacturers’ options for adopting new technologies in order to increase energy efficiency are limited, which poses an issue and a challenge applicable to all permutations of walk-ins. (NAFEM, No. 67 at p. 3) As discussed in section IV.A.2.c of this document, the design options that DOE analyzes do not need to be new technologies. Based on the unit cooler performance database, DOE has determined that efficiency levels above baseline are possible to achieve. Additional evaporator coil rows are the primary technology option DOE has identified for manufacturers to meet these levels above baseline. Despite some units already employing additional tube rows, DOE has determined efficiency levels above baseline are achievable with this technology. Additionally, DOE notes that the standards finalized in this rulemaking are not prescriptive; manufacturers may comply with them using any technologies they see fit.

The CA IOUs recommended that DOE include evaporator fin density (up to eight fins per inch) as a design option for medium-temperature unit coolers. (CA IOUs, No. 76 at p. 2) The CA IOUs commented that although high fin densities may cause excessive ice buildup in low-temperature applications, this is not the case for medium-temperature applications. (CA IOUs, No. 76 at p. 2) DOE notes that standard medium-temperature unit cooler conditions have refrigerant temperatures below freezing. Therefore, during high-load conditions resulting in long on-cycles, frost can still form on the coils. For this reason, fin density higher than seven fins per inch may impact the functionality of medium-temperature evaporators. Therefore, DOE is only considering fin density up to six fins per inch in this analysis and screening out high fin densities based on the possibility of having adverse impacts to the equipment performance or functionality.

As discussed in the September 2023 NODA, DOE did not analyze permanent magnet synchronous ("PMS") motors as a design option for unit coolers in the September 2023 NOPR analysis due to the prescriptive requirements in EPCA (42 U.S.C. 6313(f)(1)(E)) requiring unit cooler motors under 1 hp use ECM or three-phase motors. 88 FR 66710, 66717.

In response to the September 2023 NOPR, the CA IOUs recommended that DOE consider PMS motors as the maximum technologically feasible option for evaporator fan motors because they are, on average, 15- to 27-percent more efficient than ECMs. The CA IOUs commented that in the 2014 Final Rule for walk-ins, DOE acknowledged that EPCA grants DOE the authority to permit alternative motor types for evaporator fan motors if DOE determines that, on average, those other motors use no more energy in evaporative fan applications than ECMs; therefore, the CA IOUs encouraged DOE to evaluate the PMS AC motors as a design option. (CA IOUs, No. 76 at pp. 3–4)

DOE acknowledges that EPCA grants the Secretary of Energy the authority to allow alternative motor types for WICF evaporator fan motors if the Secretary of Energy determines that, on average, those other motors use no more energy in evaporator fan applications than ECMs. (42 U.S.C. 6313(f)(2)(B)). DOE attempted to evaluate the performance of PMS fan motors in WICF evaporator fan applications. However, based on a review of the PMS motors currently on the market, these motors do not span the range of WICF fan wattages and revolutions per minute needed for proper operations. Therefore, at this time, DOE cannot make a determination regarding the energy consumption of PMS motors relative to the energy consumption of ECMs in WICF evaporator fan applications and is not analyzing PMS motors as a design option in this final rule.

High-Temperature Design-Option Approach

As discussed in the September 2023 NOPR, DOE was unable to construct a performance database for high-temperature unit coolers because there are no high-temperature units certified in the CCD; therefore, DOE conducted a design option approach for high-temperature unit coolers. 88 FR 60746, 60781. In the September 2023 NOPR, the design options remaining for unit coolers after screening were improved evaporator coil, improved evaporator fan blades, off-cycle evaporator fan control, and on-cycle evaporator fan control. However, DOE only analyzed improved evaporator coils and off-cycle evaporator fan controls. DOE had tentatively determined that improved evaporator fan blades do not effectively improve unit cooler efficiency, and therefore DOE did not analyze improved evaporator fan blades as a design option for high-temperature unit coolers. Additionally, on-cycle evaporator fan control requires a condensing system that varies cooling load to the unit cooler, and DOE is aware that not all high-temperature condensing systems are capable of this type of operation. As a result, DOE did not analyze on-cycle evaporator fan control as a design option for high-temperature unit coolers. This left off-cycle fan controls and improved evaporator coils as the only remaining design option for high-temperature unit coolers in the September 2023 NOPR analysis.

As discussed in the September 2023 NOPR, there are currently no energy conservation standards for high-temperature unit coolers; therefore, DOE could not use a current standard as the baseline for the high-temperature equipment classes. Instead, DOE used manufacturer literature to select baseline units that DOE has determined are representative of the baseline efficiency currently on the market. DOE determined potential design options applied to these units based on a review of manufacturer literature and feedback from high-temperature refrigeration system manufacturers. DOE validated the AWEF2 values used to define the high-temperature baseline efficiency level through testing. 88 FR 60746, 60782.

As discussed in the September 2023 NOPR, DOE defined the maximum technology level for high-temperature unit coolers as a representative unit with all the design options applied. As discussed in the unit cooler Efficiency Levels subsection of section IV.C.1.f of this document, the design options analyzed for high-temperature unit coolers were off-cycle evaporator fan controls and improved evaporator coils. In this NOPR, a maximum-technology high-temperature unit cooler includes both design options. 88 FR 60746, 60782.

DOE did not identify any intermediate efficiency levels for high-temperature unit coolers in the September 2023 NOPR analysis.

DOE received no comments in response to the high-temperature unit cooler design option analysis and is therefore maintaining this methodology in the final rule analysis. Details of this analysis can be found in Chapter 5 of the accompanying TSD.

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, and 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 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 teardowns supplemented with catalog (virtual) teardowns.

As discussed in the September 2023 NOPR, DOE identified the energy efficiency levels associated with walk-in components using testing, market data, and manufacturer interviews. Next, DOE selected equipment for the physical teardown analysis having characteristics of typical equipment on the market at the representative capacity. DOE gathered information from performing a physical teardown analysis to create detailed bills of materials ("BOMs"), which included all components and processes used to manufacture the equipment. DOE used the BOMs from the teardowns as inputs to calculate the MPC for equipment at various efficiency levels spanning the full range of efficiencies from the baseline to the maximum technology available. 88 FR 60746, 60782-60783. DOE estimated the MPC at each efficiency level considered for each representative unit, from the baseline through the maximum technology and then calculated the percentages attributable to each cost category (*i.e.*, materials, labor, depreciation, and overhead). These percentages are used to validate the assumptions by comparing them to manufacturers' actual financial data published in annual reports, along with feedback obtained from manufacturers during interviews. DOE uses these production cost percentages in the MIA (*see* section IV.J of this document).

a. Teardown Analysis

To assemble BOMs and to calculate the manufacturing costs for the different parts of walk-in components, DOE disassembled multiple envelope and refrigeration system units into their base parts and estimated the materials, processes, and labor required for the manufacture of each individual part, a process referred to as a "physical teardown." Using the data gathered from the physical teardowns, DOE characterized each part according to its weight, dimensions, material, quantity, and the manufacturing processes used to fabricate and assemble it.

DOE also used a supplementary method, called a "virtual teardown," which examines published manufacturer catalogs and supplementary component data to estimate the major physical differences between equipment that was physically disassembled and similar equipment that was not. For supplementary virtual teardowns, DOE gathered equipment data such as dimensions, weight, and design features from publicly available information, such as manufacturer catalogs.

For parts fabricated in-house, the prices of the underlying "raw" metals (*e.g.*, tube, sheet metal) are estimated on the basis of 5-year averages to smooth out spikes in demand. Other "raw" materials such as plastic resins, insulation materials, etc. are estimated on a current-market basis. The costs of raw materials are based on manufacturer interviews, quotes from suppliers, and secondary research. Past results are updated periodically and/or inflated to present-day prices using indices from resources such as MEPS Intl.,[53] PolymerUpdate,[54] the U.S. geologic survey ("USGS"),[55] and the Bureau of Labor Statistics ("BLS").[56]

---

[53] For more information on MEPS Intl, please visit *www.meps.co.uk/.*
[54] For more information on PolymerUpdate, please visit *www.polymerupdate.com.*
[55] For more information on the USGS metal price statistics, please visit *www.usgs.gov/centers/nmic/commodity-statistics-and-information.*
[56] For more information on the BLS producer price indices, please visit *www.bls.gov/ppi/.*

More information regarding details on the teardown analysis can be found in chapter 5 of the final rule TSD.

b. Cost Estimation Method

The costs of models are estimated using the content of the BOMs (*i.e.,* materials, fabrication, labor, and all other aspects that make up a production facility) to generate the MPCs. For example, these MPCs consider cost contributions from overhead and depreciation. DOE collected information on labor rates, tooling costs, raw material prices, and other factors as inputs into the cost estimates. For purchased parts, DOE estimated the purchase price based on volume-variable price quotations and detailed discussions with manufacturers and component suppliers. For fabricated parts, the prices of raw metal materials[57] (*i.e.*, tube, sheet metal) are estimated using the average of the most recent 5-year period. The cost of transforming the intermediate materials into finished parts was estimated based on current industry pricing at the time of analysis.[58]

During development of the analysis for the September 2023 NOPR, DOE held confidential interviews with manufacturers to gain insight into the walk-in industry and to request feedback on the engineering analysis. DOE used the information gathered from these interviews, along with information obtained through the teardown analysis and public comments, to refine its MPC estimates for this rulemaking. Next, DOE derived manufacturer markups using data obtained for past walk-in rulemakings in conjunction

[57] Fastmarkets, available at *www.fastmarkets.com/amm-is-part-of-fastmarkets.*
[58] U.S. Department of Labor, Bureau of Labor Statistics, Producer Price Indices, available at *www.bls.gov/ppi/.*

with manufacturer feedback. The markups were used to convert MPCs into manufacturer sales prices ("MSPs"). Further information on comments received and the analytical methodology is presented in the following subsections. For additional detail, *see* chapter 5 of the final rule TSD.

c. Low-GWP Refrigerants

DOE received comments in response to the September 2023 NOPR regarding the cost impacts of alternative refrigerants. AHRI, Hussmann, and Lennox commented that the safety standard would require additional components such as guards, grilles, labels, non-ignition sources, etc. that would result in increased cost. (AHRI, No. 72 at p. 10; Hussmann, No. 75 at pp. 10–11; Lennox, No. 70 at p. 7) Hussmann stated that associated costs to meet the safety requirements of using A2L or CO_2 refrigerants could add 20 to 400 percent to equipment costs, resulting in higher product prices for customers. (Hussmann, No. 75 at p. 14) NRAC commented that refrigeration systems would require added components, including safety shut-off valves, leak-detection sensors, and mitigation boards, and since these components are not readily available in the marketplace yet, costs cannot be determined. (NRAC, No. 73 at p. 3)

DOE also received the following comments in response to the March 2024 NODA. AHRI stated that the increases in MPC and MSP seem low when considering tooling, materials, and development costs required to fully address the capacity reduction due to high glide of refrigerants with less than 150 GWP. AHRI also stated that additional costs for A2L refrigerants will include at minimum the cost of A2L sensor, wiring, and control components for mitigation. AHRI and its members requested to see test data of products operating per the test procedure. AHRI stated that the rules for commercial refrigeration and acceptability are contained in SNAP 26 and that it has not yet been released. AHRI recommended that DOE wait for the release of SNAP 26 so it can be addressed properly. (AHRI, No. 86 at p. 8) Lennox also stated that the updated safety standards for A2L refrigerant require safety mitigation measures, in both the products as delivered and during installation, that DOE must consider. (Lennox, No. 87 at p. 5) RSG stated that there will be large costs associated with refrigerant leak detection and mitigation that should be factored into the overall costs associated with the deployment of refrigeration systems that operate with A2L refrigerants and that RSG would like to see those upfront costs of leak detection and mitigation factored into the LCC and PBP for this equipment to assist with determining the path forward. (RSG, No. 89 at p. 2)

DOE notes that on June 13, 2024, EPA published a Final Rule in the *Federal Register* regarding protection of stratospheric ozone: listing of substitutes under the Significant New Alternatives Policy Program ("SNAP") in commercial and industrial refrigeration, also known as SNAP 26. 89 FR 50410. In this Final Rule EPA listed R-454A and R-454C (among other refrigerants) as acceptable substitutes for cold storage warehouses[59], retail food refrigeration supermarket systems, and retail food remote condensing units. As these are the primary refrigerants DOE is assuming the walk-in refrigeration system industry will adopt (*see* Refrigerants Analyzed subsection of section

[59] R-454A is only an acceptable alternative for systems under 200 lbs of charge, which matches the restrictions finalized in the October 2023 EPA Technology Transitions Final Rule.

IV.C.1.e of this document), DOE has determined that a lack of certainty around SNAP approval is no longer a factor in the refrigerant transition.

DOE acknowledges that the transition to lower GWP refrigerants may impact the cost of WICF refrigeration systems. Considering the safety requirements outlined in UL 60335-2-89, DOE has concluded that walk-in dedicated condensing systems using A2L refrigerants would require the addition of a refrigerant leak detection system. Therefore, DOE included the cost of a refrigerant leak detection system in all dedicated condensing units and single-packaged dedicated system representative units analyzed. Because the refrigerant leak detection system is required independent of efficiency, DOE applied this cost across all baseline and higher efficiency levels analyzed. Therefore, this had no impact to the incremental MPCs analyzed. Details of this cost addition are outlined in chapter 5 of the final rule TSD.

Additionally, based on the properties of R-454A and the current design of walk-in refrigeration systems, DOE has concluded that there would likely be modest tooling and development conversion costs to convert the condenser, evaporator, and refrigerant piping of an R-448A system to use R-454C. *See* section IV.C.2.g of this document for further discussion on DOE’s accounting for how tooling and development costs are incorporated into MPCs.

In response to the March 2024 NODA, DOE received the following comments specifically relating to single-packaged dedicated systems. AHRI and Lennox stated that DOE significantly underestimated a <1-percent cost increase to achieve a 34-percent increase of AWEF2 while considering HFC refrigerant for transition for the following representative units: SP.M.O.009, SP.M.I.009, SP.L.O.006, SP.L.I.006, and SP.L.O.002. AHRI and Lennox commented that DOE should have looked at the EPA technology transition rule on self-contained products. AHRI and Lennox stated that while the charge amount is a challenge to achieve the performance requirement, achieving a higher AWEF2 number could cause a tremendous cost increase. AHRI stated the ballpark number could be in the range of 30–40 percent vs. DOE's estimation of less than 1 percent. AHRI and Lennox stated that for SP.M.O.002 and SP.L.I.002, DOE's estimated MPC increases of 42 percent and 31 percent, respectively, may be underestimated for lower GWP refrigerants requiring potential changes to heat exchangers and cabinetry. AHRI and Lennox stated that for the SP.L.I.002 representative unit, DOE has only considered up to EL 4 at TSL 1 and TSL 2, which does not include propane or any other low-GWP refrigerant. AHRI stated that propane must be considered part of the AWEF2 if DOE is intending to adopt TSL 1 or TSL 2. AHRI stated that this could also impact the MPC. AHRI and Lennox stated that there is no consideration of heat exchanger design impact or any additional components to be accommodated to achieve higher AWEF2. (AHRI, No. 86 at p. 9; Lennox, No. 87 at pp. 7–8)

As indicated previously in this section, DOE acknowledges that the transition to lower GWP refrigerants may result in increased equipment costs across WICF refrigeration systems. However, DOE has determined based on the information available at this time, that any change in cost to manufacture equipment that is compatible with lower GWP refrigerants is not likely to significantly affect incremental costs to improve efficiency analyzed in this rulemaking (*i.e.*, the costs to implement these changes will likely be similar at each efficiency level). AHRI did not specify what cost it is requesting to be included in this analysis of single-packaged dedicated systems. Based on manufacturer feedback, it is DOE's understanding that major changes to heat exchangers and cabinetry would not be necessary for single-packaged dedicated systems' transition to low-GWP refrigerants. Given the lack of specific data provided by AHRI on what the cost increases for single-packaged dedicated systems would be attributed to, DOE has maintained the cost approach from the March 2024 NODA in the final rule cost analysis.

d. More Efficient Single-Speed Compressors

In the September 2023 NOPR, DOE analyzed higher-efficiency compressors for dedicated condensing units and single-packaged dedicated systems. The higher-efficiency compressor design options included both higher-efficiency single-speed compressors and variable-speed compressors. For single-packaged dedicated systems, DOE considered both higher-efficiency single-speed compressors and variable-speed compressors in the September 2023 NOPR. However, DOE did not consider higher-efficiency single-speed compressors for dedicated condensing units in the September 2023 NOPR. *See* section 5.7.2.1 of the September 2023 NOPR TSD for further discussion. In response to the comments received on the September 2023 NOPR from ASAP *et al*. and the CA IOUs (ASAP *et al*., No. 77 at p. 2; CA IOUs, No. 76 at pp. 8–9), for the March 2024 NODA, DOE reviewed publicly available compressor performance data and identified compressors with capacities roughly between 50 and 60 kBtu/h that have higher efficiencies than the compressors in that capacity range used in the September 2023 NOPR analysis. DOE determined that compressors in that capacity range could be used on the following representative units: DC.M.O.054, DC.M.I.054, and DC.M.O.124. In the March 2024 NODA, DOE presented updated cost-efficiency curves that incorporated more-efficient single-speed compressors as design options on those three representative units. DOE requested comment on the updated cost-efficiency results for the 54 kBtu/h indoor and outdoor medium-temperature dedicated condensing units and the 124 kBtu/h outdoor medium-temperature dedicated condensing unit presented in section 3 of the NODA support document. 89 FR 18555, 18560–18561.

In response to the March 2024 NODA, AHRI stated that since there are multiple technologies (*i.e.*, scroll and semi-hermetic compressors) offered above the capacities of 54 kBtu/h, the cost is underestimated by as much as 40 percent in some cases. (AHRI, No. 86 at pp. 7–8) Lennox stated that DOE significantly underestimated costs for compressors with improved efficiency. (Lennox, No. 87 at p. 5) Based on these comments, it is unclear to DOE if the commenters are stating that the costs are underestimated because they believe that, in some cases, units would need to swap a scroll compressor for a semi-hermetic compressor or if the costs are underestimated because the costs of swapping for a higher efficiency compressor of the same type (scroll or semi-hermetic) are too low. As discussed in the March 2024 NODA, DOE analyzed compressors at efficiencies that have options for both scroll and semi-hermetic compressors to ensure that the analysis only included compressors that did not remove consumer choice. 89 FR 18555, 18560. For the DC.M.O.054, DC.M.I.054, and DC.M.O.124 representative units modeled in the engineering analysis, DOE associated the incremental cost for a higher-efficiency compressor with the cost of swapping a representative scroll compressor with a higher-efficiency scroll compressor, as DOE determined that scroll compressors are more representative for these representative units than semi-hermetic compressors. Without further clarity about why this incremental cost is being underestimated, DOE maintained its methodology for the final rule cost analysis. DOE notes that it reviewed and updated compressor pricing for the final rule cost analysis to align with current pricing trends. *See* chapter 5 of the final rule TSD for further details on how component costs were updated.

e. Variable-Speed Compressors

In response to the September 2023 NOPR, ASAP *et al*. commented that DOE may be overestimating the cost of variable-speed compressors and, as a result, the economic analysis does not show levels incorporating variable-speed compressors to be cost-effective. ASAP *et al*. commented that in DOE's NOPR analysis for CRE, DOE used a lower incremental cost associated with variable-speed compressors; thus, ASAP *et al*. recommended that DOE further investigate the cost of variable-speed compressors for walk-ins. (ASAP *et al*., No. 77 at p. 3) In the September 2023 NOPR, DOE was unable to collect sufficient cost information for variable-speed compressors from product teardowns and manufacturer interviews. Therefore, DOE calculated the cost of variable-speed compressors using compressor pricing data previously collected from teardowns of other refrigeration and HVAC products to develop a price multiplier to estimate the cost increase of a variable-speed compressor compared to a single-speed compressor. For the final rule analysis, DOE was still unable to find sufficient cost information for variable-speed compressors specifically used for walk-ins. In contrast, variable-speed compressors are more prevalent in the CRE market and, as a result, DOE was able to ascertain price information for compressors used for CREs through product teardowns and online quotes. DOE notes that those compressor prices would not be directly applicable to walk-ins, as application temperatures and refrigerated volumes for CREs differ from those of walk-ins. Because of the differing availability for compressors, DOE estimates that a variable-speed compressor for a walk-in dedicated condensing system has a larger incremental cost compared to CRE. Ultimately, DOE maintained the methodology used to estimate incremental costs for variable-speed compressors for dedicated condensing systems used in the September 2023 NOPR in this final rule.

f. Unit Coolers

In the September 2023 NOPR, DOE developed linear cost-efficiency correlations for each representative unit, which DOE used to determine the MPC increase from the baseline efficiency level to the higher efficiency levels for unit coolers. For additional details, *see* section 5.8.6 of the September 2023 NOPR TSD. For the September 2023 NOPR, DOE did not consider that adding rows to the unit cooler heat exchanger would require an increase in cabinet size when determining the MPCs associated with each efficiency level. In response, AHRI, Hussmann, and Lennox commented that current unit cooler coil and cabinet designs are optimized around four-row designs and increasing efficiency would be more costly than what DOE estimated when considering packaging, freight, materials, and scrap. (AHRI, No. 72 at pp. 3–4, 9; Hussmann, No. 75 at pp. 2, 12; Lennox, No. 70 at p. 4) DOE subsequently updated its analysis for the March 2024 NODA to account for costs related to expanding the cabinet to accommodate additional tube rows. 89 FR 18555, 18564. The average cost adder associated with expanding cabinet sizes was $11 for the representative capacities DOE analyzed. DOE notes that most of the cost adder is comprised of material costs for additional cabinet sheet metal and packaging associated with an expanded cabinet. DOE did not include capital expenditures, such as retooling investments required for an expanded cabinet, in the MPCs. For further discussion on this, *see* section IV.C.2.g of this document.

In response to the March 2024 NODA, Lennox and AHRI stated that the baseline MPC for unit coolers are about 50 percent low and that they are unable to comment on the incremental costs for EL 1 and EL 2 due to uncertainty surround the definition of the higher efficiency levels (AHRI, No. 86 at p. 5; Lennox, No. 87 at pp. 5–6) AHRI and Hussmann stated that the $11 cost adder applied to higher efficiency unit coolers seems low, particularly for larger capacity units. (AHRI, No. 86 at p. 8; Hussmann, No. 88 at p. 2) For this final rule analysis, DOE reviewed its cost modeling methodology considering these comments regarding underestimated costs. Upon reviewing product literature and the representative units being modeled, DOE updated several inputs to the unit cooler cost modeling, which may be better aligned with industry's cost estimates. Regarding the $11 cost adder, DOE maintained the methodology used to develop the cost adder. With updates to material pricing, DOE still found that $11 was the average cost adder and that the cost adder did not vary significantly with capacity. *See* chapter 5 of the final rule TSD for further details on the updates made to MPC modeling for unit coolers. For further discussion of the capital conversion costs associated with additional tube rows, *see* section IV.J.3.a of this document.

<u>Assigning Costs to Efficiency Levels</u>

In the September 2023 NOPR analysis, DOE developed cost-efficiency curves for unit coolers by correlating cost with AWEF2 for groups of similar units within designated capacity ranges. As discussed previously, the changes made in this final rule analysis to adjust the fan power of some units in the unit cooler performance database will result in a different relationship between cost and AWEF2. As DOE was developing these new relationships, it identified a change in methodology that would increase the number of units considered in the cost analysis and more closely align the incremental costs of each efficiency level to the increased manufacturer production cost of adding additional tube rows to unit cooler heat exchangers. Whereas DOE's NOPR analysis previously correlated costs directly with AWEF2, DOE estimated costs for efficiency levels above baseline would be associated with tube row increases for this final rule. Additionally, DOE slightly revised baseline costs for each representative unit to use more data from the unit cooler database in an effort to assign more representative costs to the units analyzed. The updated costs are presented in Appendix 5A of the final rule TSD and the details of the revised cost methodology are discussed in chapter 5 of the final rule TSD.

g. Capital Expenditures Represented in MPCs

In response to the September 2023 NOPR, Lennox disagreed with the costs associated with components cited for each TSL in the NOPR and sections 5.7 and 5.8 of the NOPR TSD. Lennox stated that the costs must consider current design and capital costs associated to realize the advancements. Lennox commented that moving from four-row to five-row coils or increasing equipment face area will require sweeping changes likely to increase the cost significantly over DOE’s estimates. Lennox commented that DOE’s estimated cost of larger condenser coils overlooks capital costs, which Lennox stated would be a significant cost factor. (Lennox, No. 70 at pp. 8–9) AHRI and Hussmann also stated that capital costs should be included when estimating costs for unit coolers with more than four tube rows. (AHRI, No. 72 at pp. 3–4; Hussmann, No. 75 at pp. 1–2)

In response to the March 2024 NODA, AHRI reiterated that because unit coolers are optimized around four-row coils, increasing efficiency by adding tube rows would be much more costly than estimated by DOE, considering major tooling and other factors. AHRI and Lennox stated that DOE underestimated cost increases for MPCs and MSPs associated with requirements for walk-ins to use A2L refrigerants, considering tooling, materials, and development costs. (AHRI, No. 86 at pp. 6–7; Lennox, No. 87 at p. 5)

Regarding the 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 requires 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 yet 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. Regarding the development costs, DOE 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.

h. Manufacturer Markups and Shipping Costs

To account for manufacturer non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting MSP is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission 10-K reports[60] filed by publicly traded manufacturers whose combined equipment range includes walk-ins. DOE also relied on data published in the June 2014 Final Rule and information gathered from manufacturer interviews to develop the initial manufacturer markup estimates. DOE maintained the industry average manufacturer markups used in the September 2023 NOPR and March 2024 NODA for this final rule analysis. *See* chapter 12 of the final rule TSD or section IV.J.2.d of this document for additional detail on the manufacturer markups.

In the September 2023 NOPR analysis, DOE estimated a per-unit shipping cost for each dedicated condenser and single-package dedicated system representative unit at each efficiency level based on the size and weight of the given unit. 88 FR 60746, 60784. Design options such as larger condenser coils resulted in larger per unit shipping costs due to the increased size and weight associated with the design option. These shipping

[60] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system.* Available at *www.sec.gov/edgar/search/* (last accessed May 7, 2024).

costs were incorporated into consumer prices. DOE did not estimate a per-unit shipping cost for unit coolers because DOE assumed that higher efficiency unit coolers would not require increased shipping costs as a result of additional tube rows or other efficiency-improving technologies; therefore, there would be no incremental shipping cost associated with higher efficiency levels. As discussed in section IV.C.2.f of this document, DOE accounted for the incremental cost of efficiency improving technologies for unit coolers as part of the manufacturing production cost. DOE maintained its shipping cost methodology for refrigeration systems from the March 2024 NODA. For further discussion on the methodology used for estimating shipping costs, as well as some minor analytical updates made to the shipping costs for non-display doors and panels, *see* chapter 5 of the final rule TSD.

3. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency curves in the form of maximum daily energy consumption (in kWh/day) versus MSP (in dollars) for doors, R-value (in h-ft^2-°F/Btu) versus MSP (in dollars) for panels, and AWEF2 (in Btu/(W-h)) versus MSP (in dollars) for refrigeration systems. The methodology for developing the curves started with determining the energy consumption or efficiency for baseline equipment and MPCs for this equipment. For the equipment classes that used the design option approach, DOE implemented design options above baseline using the ratio of cost to savings and implemented only one design option at each efficiency level. Design options were implemented until all available technologies were employed (*i.e.*, at a max-tech level). For the equipment classes that used the efficiency level approach, DOE increased the efficiency level using the ratio of cost to savings above baseline until the maximum efficiency level was reached. *See* chapter 5 of the final rule TSD for additional details on the engineering analysis and appendix 5A of the final rule TSD for complete cost-efficiency results.

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 product to cover business costs and profit margin.

DOE developed baseline and incremental markups for each actor in the distribution chain. Baseline markups are applied to the price of products 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.[61]

[61] Because the projected price of standards-compliant products is typically higher than the price of baseline products, 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.

Regarding its markup analysis in the September 2023 NOPR analysis, DOE received comments from AHRI, Hussmann, and Lennox.

Lennox commented that the NOPR Table IV.22 indicates a significantly discounted incremental markup from the baseline markup, which Lennox stated is not aligned with business practices. Lennox commented that significantly reduced margins can cause manufacturers to exit the market. Lennox commented that businesses strive to maintain margin percentages to meet investor expectations for return on investment. Lennox additionally commented that when previous DOE rulemakings have impacted equipment manufactured by Lennox, the increased cost associated with increased efficiency standard levels has not resulted in lower markup percentages. Lennox recommended that DOE apply a consistent markup level reflective of the current market markup to reflect current practices to maintain investor expectations in terms of return on investment. (Lennox, No. 70 at pp. 5–6)

In response to Lennox, DOE notes that, as previously mentioned, the incremental markup is meant to reflect the changes in a firm's variable costs that are associated with improving efficiency and change as a function of equipment MSP. These incremental markups are determined for each agent in the distribution channel and described in detail in chapter 6 of the final rule TSD. With regard to capturing the businesses practice of maintaining margins to meet investor expectations, DOE refers to the manufacturer markup, which is applied to the MPCs to arrive at the MSPs and captures a manufacturer's profit margin (constant markup). The MSPs derived in the engineering analysis and used in the LCC and PBP analyses and NIA reflect a constant manufacturer markup 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. *See* section IV.C.2.h or section IV.J.3.b of this document for additional information.

As part of this analysis, DOE identifies key market participants and distribution channels. For walk-in coolers and freezers, the main parties in the distribution chain are: direct-to-consumer sales (national accounts), HVAC and refrigeration contractors, walk-in cooler and walk-in freezer distributors, OEMs, and wholesalers. The magnitude, in terms of units shipped through each channel, is shown in Table IV.29.

In the context of this analysis, OEMs are mostly manufacturers of envelope insulation panels who may also sell and install entire walk-in units to final consumers. Manufacturers of entire walk-in units assemble a combination of purchased and manufactured components at either the manufacturer's plant or at the customer site. Table IV.29 shows the distribution channels DOE defined for this analysis. Table IV.30 summarizes the baseline markups and incremental markups developed for walk-in equipment. The markups shown in this table reflect national average values for the given markup. In the subsequent LCC analysis, regional markup multipliers were developed and used to capture regional variation in mechanical contractor markups as well as State-to-State differences in sales taxes. Also, in the LCC analysis, the relative shipments to new construction and to the replacement market vary by equipment class, resulting in some slight differences between sales-weighted average baseline and average incremental markups by equipment class. After identifying the six distribution channels listed in

Table IV.29, DOE relied on economic data from the U.S. Census Bureau[62] and other sources[63] to determine how prices are marked up as equipment is passed from the manufacturer to the customer.

Lennox, supported by AHRI, commented that its analysis of e-commerce channels for dedicated condensing equipment, unit coolers, and single-package refrigeration unit systems demonstrates (today) that e-commerce is a channel used to source refurbished used equipment. Lennox stated that dedicated condensing units and unit coolers require knowledgeable personnel to specify the equipment. Further, Lennox commented that EPA's technology transition to low-GWP refrigerants including A2Ls and CO_2 coming to the market can increase the complexity of selection (of equipment) substantially, which may adversely affect the rate of e-commerce adoption. Additionally, Lennox commented that single-package refrigeration units, on the other hand, could have increased e-commerce adoption because of the self-contained nature of the equipment and its simpler application. (Lennox, No. 70 at pp. 7–8; AHRI, No. 72 at p. 11)

Lennox commented it is not aware of readily available information on the size of the e-commerce channel. (*Id.*) Hussmann commented that few of its customers leverage e-commerce in limited applications through internal systems, and they are an insignificant driver in terms of sales. (Hussmann, No. 75 at p. 11)

[62] U.S. Census Bureau. Electrical, Hardware, Plumbing, and Heating Equipment and Supplies: 2020. 2020. Washington, D.C. Report No. EC-02-421-17.
[63] Heating, Air Conditioning & Refrigeration Distributors International. *2012 Profit Report (2011 Data)*. 2012. Columbus, OH.

For this final rule analysis, DOE agrees with Lennox's (and AHRI's) position that the e-commerce distribution channel is primarily used for refurbished/used equipment and that e-commerce may become a viable means of distribution of dedicated condensing and unit cooler equipment in the future. However, DOE notes that refurbished/used equipment is outside the scope of this rulemaking and therefore not considered in this analysis and that future distribution through e-commerce is uncertain. Because of these uncertainties, DOE has not included the e-commerce distribution channel in this analysis and has maintained the approach used in the September 2023 NOPR analysis.

Table IV.29 Distribution Channel Weights

Distribution Channel	Dedicated Condensing Units and Unit Coolers	Display Doors	Panels and Non-Display Doors	Single-Packaged Dedicated Systems	Unit Coolers for Multiplex*
Direct (National Account)	0.03	0.30	0.45	-	0.45
Contractors	0.03	0.14	0.11	0.5	0.01
Distributors	0.34	0.56	0.44	0.5	0.05
OEM	0.18	-	-	0.75	0.05
Wholesale	0.42	-	-	0.15	0.45
Grand Total	1.00	1.00	1.00	1.00	1.00

* Unit coolers are sold into applications where they are connected to both dedicated and multiplex condensing systems. While multiplex condensing systems are not currently within scope, unit coolers connected to them are.

Table IV.30 Distribution Channel Shares and Markups

Equipment Class Code	Equipment Family	Baseline Markup	Incremental Markup
DC.L.O	DC	2.03	1.37
DC.L.I	DC	2.03	1.37
DC.M.O	DC	2.03	1.37

DC.M.I	DC	2.03	1.37
UC.L	UC	2.03	1.37
UC.M	UC	2.03	1.37
UC.L – Multiplex	UC	1.98	1.46
UC.M – Multiplex	UC	1.98	1.46
FP.L	P and NDD	1.32	1.19
PS.L	P and NDD	1.32	1.19
PS.M	P and NDD	1.32	1.19
NM.L	P and NDD	1.32	1.19
NM.M	P and NDD	1.32	1.19
NO.L	P and NDD	1.32	1.19
NO.M	P and NDD	1.32	1.19
DW.L	DD	1.71	1.29
DW.M	DD	1.71	1.29
SP.M.I	SP	1.53	1.18
SP.M.O	SP	1.53	1.18
SP.L.I	SP	1.53	1.18
SP.L.O	SP	1.53	1.18
SP.H.I	SP	1.53	1.18
SP.H.O	SP	1.53	1.18
SP.H.I.D	SP	1.53	1.18
SP.H.O.D	SP	1.53	1.18

Key: DC = dedicated condensing unit; UC = unit cooler; P = panel, NDD = non-display door; DW = display door, SP = single-packaged dedicated system.

Chapter 6 of the final rule TSD provides details on DOE's development of markups for walk-in coolers and freezers.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of walk-in coolers and freezers at different efficiencies in representative U.S. commercial buildings, and to assess the energy savings potential of increased walk-in efficiency. The energy use analysis estimates the range of energy use for walk-ins in the field (*i.e.,* as they are actually used by consumers) stated as annual energy consumption ("AEC"). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards. DOE's methodology for this final rule is unchanged from that presented in its September 2023 NOPR analysis.

1. Trial Standard Levels

In the September 2023 NOPR, DOE analyzed the benefits and burdens of three trial standard levels ("TSLs") for the considered walk-in doors, panels, and refrigeration systems. These TSLs were developed by combining specific efficiency levels for each of the equipment classes analyzed by DOE in the engineering analysis. TSL 3 in the September 2023 NOPR represented the efficiency levels that use the combination of design options for each representative unit at the maximum technologically feasible level. TSLs 1 and 2 in the September 2023 NOPR represented combinations of efficiency levels of all representative units that each provided progressively more energy savings while delivering a positive savings benefit to consumers. At TSLs 1 and 2, the efficiency levels for non-display doors and structural panels were constrained such that improvements to insulation were harmonized across non-display doors and structural panels to avoid a circumstance where DOE would propose a standard where one component would necessitate increased insulation thickness, but not the other. Thus, the efficiency levels at TSLs 1 and 2 were aligned to reflect design options where the insulation thickness is harmonized and results in positive NPV for both non-display doors and structural panels.

Aligning the insulation thickness of non-display doors and panels avoids a potential unintended consequence where the installation of replacement non-display doors could trigger the replacement of some, or all, of the attached walk-in enclosure panels because the thickness of the components do not match. DOE sought comment in the September 2023 NOPR on its assumptions and rationale for harmonizing panel and non-display door thicknesses at a given TSL. 88 FR 60746, 60786.

In response to the September 2023 NOPR, RSG stated agreement with DOE's proposal to harmonize panel and door thickness as this move should have a positive impact across the industry. (RSG, No. 69 at p. 2) Kolpak also agreed that panels and non-display doors should be of the same thickness so that the doors and panels are flush. (Kolpak, No. 66, Attachment 1 at p. 2) In light of the comments received from RSG and Kolpak, DOE maintained its approach from the September 2023 NOPR harmonizing structural panel and door insulation thicknesses for a given TSL.

ASAP *et al*. recommended that DOE revisit the proposed efficiency levels for certain single-packaged equipment classes. ASAP *et al*. referenced DOE's stated intent for TSL 2 (*i.e.*, the proposed level) to represent the combination of design options that results in the greatest energy savings with a positive net present value at 7 percent for a given equipment class. ASAP *et al*. asserted for several single-packaged equipment classes, it appears that the proposed standards do not reflect DOE's intended criteria for TSL 2. In particular, ASAP *et al*. stated that the following equipment classes for WICF refrigeration systems could be revisited: (1) in the case of outdoor medium-temperature single-packaged dedicated systems (SP.M.O), DOE proposed efficiency level "EL" 1, but

EL 3 appears to be cost-effective; (2) in the case of outdoor low-temperature single-packaged dedicated systems (SP.L.O), DOE proposed the baseline level, but EL 2 appears to be cost-effective; (3) in the case of indoor high-temperature single-packaged dedicated systems (SP.H.I), DOE's LCC results show positive savings at TSL 3 (equivalent to EL 2 for both representative units), and it is unclear whether DOE has selected the correct EL to satisfy the TSL 2 criteria for this equipment class; and (4) in the case of ducted indoor and outdoor, high-temperature single-packaged dedicated systems (SP.H.I.D and SP.H.O.D) equipment classes, TSL 2 is stated to represent EL 6 (4.83 AWEF) for the SP.H.OD 7 kBtu/h representative unit, but the proposed standard is only 4.41 AWEF, which does not correspond to any evaluated EL. (ASAP *et al.*, No. 77 at p. 6)

Similarly, the CA IOUs recommended that DOE consider crankcase heater controls and enhanced thermal insulation design options in TSL 2 for low-temperature outdoor single-packaged systems (SP.L.O). The CA IOUs stated that, according to DOE's engineering analysis, the crankcase heater controls increase the efficiency of outdoor low-temperature packaged systems with minimal additional cost, and that improved thermal insulation improves AWEF2 with minimal cost. (CA IOUs, No. 76 at p. 11)

As mentioned previously, in the September 2023 NOPR, TSL 2 represented combinations of efficiency levels that provided progressively more energy savings than TSL 1 while maintaining positive savings benefit to consumers. 88 FR 60746, 60786. In the March 2024 NODA, DOE analyzed three slightly different TSLs than what was analyzed in the September 2023 NOPR. In the March 2024 NODA, TSL 1 represented the efficiency levels that yield AWEF2 values closest to those AWEF2 values that align with TSL 2 from the September 2023 NOPR, and TSL 3 represented max-tech efficiency levels. DOE notes that while LCC analysis results often can correlate with national impact analysis ("NIA") results, this is not always the case. In the case of non-ducted high-temperature single-packaged dedicated systems analyzed in the September 2023 NOPR, the LCC savings were positive, but the NIA results were negative for TSL 3. 88 FR 60746, 60850. Additionally, in light of the comments received by ASAP *et al*. and the CA IOUs, DOE analyzed a new intermediate TSL 2 in the March 2024 NODA. Specifically, DOE mapped: (1) EL 8 to TSL 2 for SP.M.O.002 and EL 3 to TSL 2 for SP.M.O.009; (2) EL 2 to TSL 2 for SP.L.O, which represents a level with crankcase heater controls; (3) EL 2 to TSL 2 for SP.H.I; (4) EL 2 and 6 to TSL 2 for SP.H.I.D and SP.H.O.D, respectively. In the case of non-ducted high-temperature single-packaged dedicated systems analyzed in the September 2023 NOPR, the LCC savings were positive, but the NIA results were negative for TSL 3. 89 FR 18555, 18565-18566. In this final rule, DOE is adopting TSL 2 for refrigeration systems, which as discussed in this paragraph is consistent with the suggestions of ASAP *et al*.

Regarding ASAP *et al*.'s comment about the ducted indoor and outdoor, high-temperature single-packaged dedicated systems, DOE's engineering and economic analysis was based on representative external static pressures for the evaporator and condenser sections of the system. However, when developing the equation for the proposed standards, DOE applied an additional adjustment factor to the AWEF2 value that corresponds to TSL 2 to account for the potential range in external static pressures that could be allowed for different systems. As such, the AWEF2 values that result from the equation proposed in the September 2023 NOPR are lower than the AWEF2 values that correspond to the representative units at TSL 2, to account for additional energy that would be used in a test to deliver the higher external static pressure (half of the maximum allowed for the system, in accordance with the test procedure) for such systems that have higher pressure capability. These adjustment factors were based on the highest external static pressure available on the market for the given equipment class. DOE adopted this approach rather than set standards for ducted high-temperature dedicated systems that vary both with capacity and external static pressure capability.

In the March 2024 NODA, DOE presented three TSLs for refrigeration systems and non-display doors. For refrigeration systems, TSL 3 included the efficiency levels that use the combination of design options for each representative unit at the max-tech level. TSL 1 represented the efficiency levels in the NODA that yielded AWEF2 values closest to those AWEF2 values of the proposed standards (TSL 2) in the September 2023 NOPR. TSL 2 was an intermediate TSL that was higher than TSL 1 but below the max-tech level. For non-display doors, TSL 3 included the efficiency levels that used the combination of design options for each representative unit at the max-tech level. TSL 1 and TSL 2 were intermediate TSLs between baseline and TSL 3. 89 FR 18555, 18565-18567.

In this final rule, DOE analyzed three TSLs for walk-in doors, panels, and refrigeration systems. For display doors and panels, DOE analyzed the same three TSLs as it did in the September 2023 NOPR, where TSL 3 was the max-tech efficiency levels and TSL 1 and 2 were set to the baseline because the consumer savings were negative for all the other available efficiency levels. To summarize here for display doors connected to a TSL 2 refrigeration system: For low-temperature display doors at EL 1, the improvement from 3-pane glass with argon fill to 3-pane glass with krypton fill results in an average LCC impact of -$5 with 67 percent of consumers having a net cost. At EL 2 (max-tech), the improvement for low-temperature display doors from 3-pane glass with krypton fill to 2-pane vacuum-insulated glass results in an average LCC impact of -$1,062 with 100 percent of consumers having a net cost. For medium-temperature display doors at EL 1, the improvement from 2-pane glass with argon fill to 3-pane glass with argon fill results in an average LCC impact of -$29 with 94 percent of consumers having a net cost. At EL 2 (max-tech), the improvement for medium-temperature display doors from 2-pane glass with argon fill to 2 pane vacuum-insulated glass results in an average LCC impact of -$1,304 with 100 percent of consumers having a net cost. For panels connected to a TSL 2 refrigeration system: For low-temperature floor panels (PF.L) at EL 1, the improvement from 3.5 inches of insulation to 4 inches of insulation results in an average LCC impact of -$0.16 per ft^2 with 91 percent of consumers having a net cost. At EL 2 with the improvement to 5 inches of insulation the average LCC impact is-$0.19 per ft^2 with 74 percent of consumers having a net cost. At EL 3 (max tech) with the improvement is to 6 inches of insulation the average LCC impact is -$0.52 per ft^2 with 83 percent of consumers having a net cost. For low-temperature structural panels (PS.L) at EL 1, the improvement from 4 inches of insulation to 5 inches of insulation results in an average LCC impact of -$0.10 per ft^2 with 67 percent of consumers having a net cost. At EL 2 (max tech) with the improvement is to 6 inches of insulation the average LCC impact is-$0.24 per ft^2 with 70 percent of consumers having a net cost. For medium-temperature structural panels (PS.M) at EL 1, the improvement from 3.5 inches of insulation to 4 inches of insulation results in an average LCC impact of -$0.47 per ft^2 with 100 percent of consumers having a net cost. At EL 2 with the improvement is to 5 inches of insulation the average LCC impact is -$1.37 per ft^2 with 100 percent of consumers having a net cost. At EL 3 (max tech) with the improvement is to 6 inches of insulation the average LCC impact is -$2.37 per ft^2 with 100 percent of consumers having a net cost. Detailed consumer results are presented by EL in appendix 8C of this final rule TSD.

For non-display doors, dedicated condensing units, and single-packaged dedicated systems, DOE generally analyzed the same three TSLs as it did in the March 2024 NODA.[64] For unit coolers, DOE generally analyzed the same three TSLs as it did in the September 2023 NOPR.[65]

Table IV.31 Envelope Components Efficiency Level by Representative Unit Mapping for TSL 3

Equipment Class	TSL 3
Display Doors	
DW.L	2
DW.M	2
Non-display Doors	
NM.L	5
NM.M	6
NO.L	5

[64] DOE notes that in this final rule, TSL 2 for low-temperature, outdoor dedicated condensing units matches the mapping of the March 2024 NODA TSL 1, not the March 2024 NODA TSL 2. This difference only changed the efficiency level mapping of the highest capacity representative unit.

[65] For the highest capacity representative unit of medium-temperature unit coolers the efficiency level mapped in TSL 1 and 2 has changed from efficiency level 2 in the September 2023 NOPR to efficiency level 0 in this final rule.

NO.M	6
Panels	
PF.L	3
PS.L	2
PS.M	3

Table IV.32 Refrigeration Systems Efficiency Level by Representative Unit Mapping for TSL 3

Equipment Class	Capacity (kBtu/h)								
	2	3	6	7	9	25	54	75	124
Dedicated Condensing Systems									
DC.L.I		2			1	3	2		
DC.L.O		3			5	8	5	4	
DC.M.I					1	3	4	3	
DC.M.O					8	8	9	8	9
Single-packaged Dedicated Condensing Systems									
SP.H.I	2			2					
SP.H.I.D	2			2					
SP.H.O	6			6					
SP.H.O.D	6			6					
SP.L.I	7		2						
SP.L.O	4		4						
SP.M.I	5				3				
SP.M.O	9				5				
Unit Coolers									
UC.H					1	1			
UC.H.D					1	1			
UC.L		2			2	2	2	2	
UC.M		2			2	2	2	2	

Table IV.33 Envelope Components Efficiency Level by Representative Unit Mapping for TSL 2

Equipment Class	TSL 2
Display Doors	
DW.L	0
DW.M	0

Non-display Doors	
NM.L	3
NM.M	3
NO.L	3
NO.M	3
Panels	
PF.L	0
PS.L	0
PS.M	0

Table IV.34 Refrigeration Systems Efficiency Level by Representative Unit Mapping for TSL 2

Equipment Class	Capacity (kBtu/h)								
	2	**3**	**6**	**7**	**9**	**25**	**54**	**75**	**124**
Dedicated Condensing Systems									
DC.L.I		1			0	2	1		
DC.L.O		2			4	7	4	2	
DC.M.I					0	2	3	2	
DC.M.O					3	3	4	3	4
Single-packaged Dedicated Condensing Systems									
SP.H.I	2			2					
SP.H.I.D	2			2					
SP.H.O	5			5					
SP.H.O.D	6			6					
SP.L.I	4		1						
SP.L.O	2		2						
SP.M.I	3				1				
SP.M.O	8				3				
Unit Coolers									
UC.H					0	0			
UC.H.D					1	1			
UC.L		2			2	2	2	2	
UC.M		2			2	2	2	0	

Table IV.35 Envelope Components Efficiency Level by Representative Unit Mapping for TSL 1

Equipment Class	TSL 1
Display Doors	
DW.L	0
DW.M	0
Non-display Doors	
NM.L	1
NM.M	1
NO.L	1
NO.M	1
Panels	
PF.L	0
PS.L	0
PS.M	0

Table IV.36 Refrigeration Systems Efficiency Level by Representative Unit Mapping for TSL 1

Equipment Class	Capacity (kBtu/h)								
	2	3	6	7	9	25	54	75	124
Dedicated Condensing Systems									
DC.L.I		1			0	2	1		
DC.L.O		2			4	7	4	2	
DC.M.I					0	2	2	2	
DC.M.O					2	2	2	2	2
Single-packaged Dedicated Condensing Systems									
SP.H.I	1			2					
SP.H.I.D	2			2					
SP.H.O	5			5					
SP.H.O.D	5			6					
SP.L.I	4		1						
SP.L.O	0		1						
SP.M.I	3				1				
SP.M.O	8				3				
Unit Coolers									
UC.H					0	0			
UC.H.D					1	1			
UC.L		1			2	1	2	1	

UC.M		2			1	2	1	0	

When setting standards equations that vary with capacity for refrigeration systems of walk-ins, DOE used as a guide the efficiency levels of the selected TSL. The AWEF2 values associated with these efficiency levels can vary as a function of representative capacity. For example, for the outdoor, medium-temperature dedicated condensing units, DOE analyzed five representative units (at five different capacities). At each TSL, each representative unit may be mapped to a different efficiency level that may correspond to a different AWEF2 value. Once a TSL has been selected to propose or adopt, DOE developed an equation to define the selected standard level at all capacities (not just the representative capacities analyzed). The equation aligns with the efficiency levels of the representative units associated with the selected TSL. The equation may take the form of a set of equations to more closely follow the analyzed ELs. To avoid setting a standard made up of an excessive number of equations, DOE may use a line providing a best fit through a set of efficiency levels and capacities. In this final rule, DOE is setting standards equations for refrigeration systems as a function of capacity for most equipment classes by using sets of equations that provide a balance of limiting the number of equations covering the relevant capacity range and maintaining reasonable consistency with the AWEF2 associated with the selected TSL. For medium-temperature unit coolers, the finalized standard represents fewer equations than presented in the March 2024 NODA, while also considering both the September 2023 NOPR and March 2024 NODA comments and not overshooting the representative capacity efficiency levels associated with the selected TSL.

DOE used a line of best fit that is a function of door surface area to develop the non-display door standards equations presented in the September 2023 NOPR, March 2024 NODA, and this final rule. Each equipment class for doors has three representative units (small, medium, and large surface area). Similar to refrigeration systems, at each TSL, each representative unit is mapped to an efficiency level that corresponds to a different DEC value. For the TSL that is selected, DOE used a line of best fit through the DEC values of each representative unit to determine the first two terms of the standard equations. For the remaining terms of the standard equations, which correspond to the allowances for additional electrical components, DOE developed coefficients to represent the additional energy consumption allowance for a component which are then multiplied by a 1 or a 0 based on the presence or absence of that component in a basic model. DOE maintained this approach for setting the amended standards equations for non-display doors in this final rule.

2. Energy Use of Envelope Components

DOE used the results of the engineering analysis to determine the annual electrical energy consumption of each walk-in envelope component (*i.e.*, panels, non-display doors, and display doors). For panels, the AEC is calculated as the energy consumption per unit area of the panel for heat infiltration through the panel or door. For doors that use electricity directly from electricity-consuming components (*i.e.*, lighting and/or anti-sweat heaters), DOE calculated the associated increased refrigeration load from the electricity-consuming components and added it to the total to obtain the daily refrigeration load. This refrigeration load was divided by the annual energy efficiency ratio ("AEER") of the shipment-weighted average of refrigeration system equipment classes grouped by temperature rating to estimate the associated energy use. DOE multiplied the daily electrical energy consumption by the number of days per year to obtain the AEC. DOE then determined the total electrical energy consumption associated with each envelope component by (1) calculating the refrigeration energy consumption required to compensate for heat infiltration through the envelope based on the assumed connected refrigeration system, and (2) adding any direct electrical energy consumed by component. The refrigeration load was calculated by multiplying the U-factor for the component by the reference temperature difference between the exterior and the interior, as specified in the DOE test procedure.

DOE notes that the energy savings from improved insulation or reduced heat infiltration would be realized as reduced load on the attached refrigeration systems; however, for the purpose of reporting savings to determine any potential amended standard, these energy savings are attributed to the individual envelope component in question.

DOE did not receive any comments regarding its energy use analysis pertaining to envelope components and has therefore maintained its approach from the September 2023 NOPR analysis.

Table IV.37 Applied AEERs by Equipment Class

Equipment Class	Baseline	Trial Standard Level		
		1	2	3
DC.L.I	5.53	5.67	5.67	5.98
DC.L.O	8.24	8.39	8.39	9.69
DC.M.I	11.63	12.15	12.32	13.40
DC.M.O	16.07	16.21	16.72	21.90
SP.L.I	4.29	4.76	4.76	4.95
SP.L.O	6.54	6.62	6.65	6.90
SP.M.I	11.38	12.09	12.09	12.25
SP.M.O	15.64	16.47	16.47	16.58

3. Energy Use of Refrigeration Systems

DOE calculated the AEC of the refrigeration system assuming it is matched to a walk-in envelope with the appropriate refrigeration load. Further, DOE assumes that this refrigeration load is fixed in both the no-new standards and amended standards cases.

The engineering analysis uses a design-option approach that, for each design-option combination, adds a feature that increases efficiency. Hence, equipment class can be represented by a group of efficiency level indicators matching the engineering design option.

For each equipment class, the engineering analysis evaluates the performance of the dedicated condensing unit, unit cooler, or single-packaged dedicated system, and for each representative capacity, the performance data are passed to the energy use calculation. The data and equations used to calculate the annual energy use depend on the type of equipment and are available in chapters 7, 8, and associated appendices of the

TSD. The unit coolers that are not attached to dedicated condensing units are assumed to be paired with a compressor rack with constant net capacity; these are referred to as multiplex applications. Low-temperature unit coolers include the impact of energy consumption during the defrost cycle. For refrigeration systems, the net capacity is affected by the design options added, so at each efficiency level the run hours are adjusted to ensure that the amount of heat removed is constant across all efficiency levels. For outdoor systems, the compressor and condenser performance are also affected by ambient temperature, and this effect is incorporated into the energy use calculation. Detailed equations and input data are presented for each equipment type in chapter 7 of this final rule TSD.

a. Nominal Daily Run Hours

The daily run hours for baseline units are assumed to be 16 hours for medium- and high-temperature systems and 18 hours for low-temperature systems based on guidelines typically used in sizing refrigeration systems. DOE assumed that systems were sized at design temperatures of 95 °F for outdoor units and 90 °F for indoor units. DOE also assumed an oversize factor of 20 percent is included, which has the effect of reducing the daily run hours by a factor of 1/1.2. These assumptions are unchanged from the June 2014 Final Rule and the July 2017 Final Rule. 79 FR 32050, 32083; 82 FR 31808, 31842. During the rest of the time, the system is in off-mode, so the only energy consumption is from the controls, crankcase heat, and evaporator fan.

AHRI commented that DOE's application of 16 hours per day run time is significantly low. AHRI suggested using, based on engineering manual guidelines for a range of applications, the following nominal run-time hours: (AHRI, No. 72 at p. 11)

- 35 °F room with no timer: 16 hours,
- 35 °F room with timer: 16 hours,
- Blast coolers/freezers with positive defrost: 18 hours,
- Storage freezer 18 hours,
- Coolers with hot gas or electric defrost 18 hours, and
- 50 °F rooms and higher with coil temperatures above 32 °F: 20–22 hours.

(Id.)

Additionally, NRAC presented the following run-time hours: high-temperature 20 hours, medium-temperature 16 hours, and low-temperature 18 hours. (NRAC, No. 73 at p. 2)

In response to AHRI and NRAC, DOE notes that the run-time guidelines provided for low- and medium-temperature equipment are in alignment with those used by DOE in the September 2023 NOPR analysis. With regard to the comments regarding the run-time hours of high-temperature equipment, DOE notes that the values submitted by AHRI are identical to those submitted by Lennox in the September 2023 NOPR where it was noted that the run-time guidelines Lennox provided were specifically for determining the box cooling load for prep-room applications; and DOE then noted that these guidelines encompass equipment not currently covered by the standard. 88 FR

60746, 60789. It continues that DOE's response is still valid, where applying 16 hours as the nominal run-time hours for high-temperature single-packaged dedicated condensing systems and unit coolers is appropriate as a modeling assumption because the intended cooling temperature of high-temperature equipment is like that of medium-temperature systems at 35 °F. 88 FR 60746, 60789.

For this final rule, DOE is maintaining its modeling assumption of 16 hours per day of nominal daily run hours for high-temperature equipment and maintaining its modeling assumptions from the September 2023 NOPR for all other classes. DOE notes that it will continue in its subgroup analysis to examine high-temperature equipment where the nominal run time is 20 hours per day to approximate consumers with walk-ins with high warm air-infiltration (*e.g.*, prep rooms) as a separate consumer subgroup analysis. *See* section IV.I.1 of this document. DOE's applied run-time hours are shown in Table IV.38.

Table IV.38 Applied Nominal Daily Run Hours

Temperature	Hours per day
Low	18
High	16
Medium	16

4. Estimated Annual Energy Consumption

Table IV.39 through Table IV.42 show the average annual energy consumption for the equipment considered in this final rule.

Table IV.39 Annual Energy Consumption Estimates for Panels (kWh/year per ft²)

Equipment Class	Connected Refrigeration System	Baseline	TSL 1	TSL 2	TSL 3
PF.L	Baseline	5.9	5.9	5.9	4.1
	TSL 1	5.8	5.8	5.8	4.0
	TSL 2	5.8	5.8	5.8	4.0
	TSL 3	5.3	5.3	5.3	3.6
PS.L	Baseline	7.9	7.9	7.9	5.8
	TSL 1	7.7	7.7	7.7	5.7
	TSL 2	7.7	7.7	7.7	5.7
	TSL 3	7.0	7.0	7.0	5.2
PS.M	Baseline	4.4	2.2	2.2	1.5
	TSL 1	2.2	2.2	2.2	1.5
	TSL 2	2.1	2.1	2.1	1.5
	TSL 3	1.8	1.8	1.8	1.2

Table IV.40 Annual Energy Consumption Estimates for Display Doors (kWh/year)

Equipment Class	Connected Refrigeration System	Baseline	TSL 1	TSL 2	TSL 3
DW.L	Baseline	2,693	2,693	2,693	2,323
	TSL 1	2,655	2,655	2,655	2,291
	TSL 2	2,654	2,654	2,654	2,291
	TSL 3	2,470	2,470	2,470	2,140
DW.M	Baseline	783	783	783	710
	TSL 1	774	774	774	703
	TSL 2	763	763	763	694
	TSL 3	685	685	685	628

Table IV.41 Annual Energy Consumption Estimates for Non-display Doors (kWh/year)

Equipment Class	Connected Refrigeration System	Baseline	TSL 1	TSL 2	TSL 3
NM.L	Baseline	3,353	2,357	1,385	1,207
	TSL 1	3,316	2,328	1,367	1,192
	TSL 2	3,316	2,328	1,367	1,192
	TSL 3	3,141	2,189	1,279	1,121
NM.M	Baseline	891	478	284	246
	TSL 1	883	472	281	243
	TSL 2	873	464	276	239
	TSL 3	802	410	243	213
NO.L	Baseline	5,282	3,514	2,160	1,790
	TSL 1	5,223	3,468	2,130	1,767
	TSL 2	5,222	3,468	2,130	1,767
	TSL 3	4,942	3,250	1,989	1,659
NO.M	Baseline	1,700	833	477	382
	TSL 1	1,685	823	470	378
	TSL 2	1,667	809	463	372
	TSL 3	1,535	713	407	333

Table IV.42 Annual Energy Consumption Estimates for Refrigeration Systems (kWh/year)

Equipment Class	Baseline	TSL 1	TSL 2	TSL 3
DC.L.I	26,535	25,887	25,887	24,538
DC.L.O	40,826	40,093	40,093	34,715
DC.M.I	12,235	11,709	11,545	10,615
DC.M.O	17,794	17,633	17,097	13,054
SP.H.I	2,275	2,035	1,999	1,999
SP.H.I.D	3,897	3,258	3,258	3,258
SP.H.O	3,184	2,820	2,820	2,769
SP.H.O.D	5,264	4,159	4,147	4,147
SP.L.I	6,522	5,877	5,877	5,652
SP.L.O	8,629	8,515	8,476	8,176
SP.M.I	6,356	5,979	5,979	5,903
SP.M.O	5,952	5,650	5,650	5,613
UC.H	4,625	4,625	4,625	4,571

UC.H.D	6,588	6,159	6,159	6,159
UC.L	45,993	43,845	43,190	43,190
UC.M	17,333	16,975	16,865	16,785

Chapter 7 of the final rule TSD provides further details on DOE's energy use analysis for walk-ins.

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 walk-ins. 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 an appliance or product over the life of that product, consisting of total installed cost (MSP, 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 product.

- 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 product 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 walk-ins 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 product.

1. Consumer Sample

For each considered efficiency level in each equipment class, DOE calculated the LCC and PBP for a nationally representative set of commercial consumers. As stated previously, DOE developed household samples from the 2018 Commercial Buildings Energy Consumption Survey ("CBECS 2018").[66] For each sample, DOE determined the energy consumption for the walk-ins and the appropriate energy price. By developing a representative sample of commercial consumers, the analysis captured the variability in energy consumption and energy prices associated with the use of walk-ins.

Inputs to the LCC calculation include the installed cost to the consumer, operating expenses, the lifetime of the product, 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 AEC, energy prices and price

---

[66] U.S. Energy Information Administration. *Commercial Buildings Energy Consumption Survey 2018*, 2022.

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 Monte Carlo simulations to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and walk-ins user samples. The model calculates the LCC for equipment at each trial standard level per simulation run. The analytical results include a distribution of 30,000 data points for refrigeration systems and 10,000 data points for envelope components, 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 consumer, product efficiency is chosen based on its probability. If the chosen equipment's 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 are already projected to purchase more-efficient products in a given case, DOE avoids overstating the potential benefits from increasing equipment efficiency.

DOE calculated the LCC and PBP for consumers of walk-ins as if each were to purchase new equipment in the expected year of required compliance with new or amended standards. Amended standards would apply to walk-ins manufactured after

December 31, 2028 for refrigeration equipment, and January 1, 2028 for envelope components after the date on which any new or amended standard is published.[67] (42 U.S.C. 6313(f)(5)(B)(i)) At this time, DOE estimates publication of a final rule in late 2024; therefore, for purposes of its analysis, DOE used 2028 as the first year of compliance with any amended standards for walk-ins for envelope components, and 2029 for refrigeration systems because the compliance date is late in the calendar year.

Table IV.43 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 model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the TSD and its appendices.

Table IV.43 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. Adjusted the price provided in 2024$ in the engineering analysis to 2023$.[68] Used historical data to derive a price scaling index to project product costs in the high and low benefits case – cost is assumed constant in the reference case
Installation Costs	Additional costs associated with control commissioning.
Annual Energy Use	The total annual energy use multiplied by the buildings containing WICF. Variability: Based on the CBECS 2018.

[67] Refrigeration equipment refers to equipment classified under this rulemaking as: dedicated condensing systems, single-packaged dedicated condensing systems, and unit coolers (*see* section IV.A.1.c of this document). Envelope components refer to the equipment classified under this rulemaking as: display doors, non-display doors, and panels (*see* sections IV.A.1.a and IV.A.1.b of this document).
[68] DOE adjusted the equipment prices determined in the engineering analysis in 2024$ to 2023$ using the implicit price deflator for GDP from the Bureau of Economic Analysis.

Energy Prices	Electricity: Based on EEI average rate data for 2023. Variability: Regional energy prices determined for 4 census regions.
Energy Price Trends	Based on *AEO2023* price projections.
Maintenance Costs	Assumed no change with efficiency level.
Repair Costs	Assumed to change with efficiency level
Product Lifetime	Average: between 8.5 and 12 years.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Compliance Date	Envelope Components: January 1, 2028, Refrigeration Systems: December 31, 2028 (Analytical: January 1, 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, product lifetimes, and discount rates are not used for the PBP calculation.

2. Equipment Cost

To calculate consumer equipment costs, DOE multiplied the MSPs 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.

Senneca and Frank Door commented that there were inconsistencies between DOE's documentation of the applied historical price index between the September 2023 NOPR and TSD as DOE cited multiple producer price index ("PPI") indices. Senneca and Frank Door further noted that in their opinion, any PPI index would be inappropriate for projecting the future price of non-display doors. (Senneca and Frank Door, No. 78 at pp. 8–10)

DOE's analysis limits the impacts of potential future price uncertainty as it pertains to the cost impacts to consumers and more broadly to the Nation. For WICFs, DOE identified two potential historical producer price indices to create upper and lower analytical bounds on walk-in prices, which DOE used to inform its decision in this final rule. DOE notes that it has not applied any price trends in its reference case, indicating that prices will remain static relative to inflation into the future—as it did in the September 2023 NOPR. In response to Senneca and Frank Door's comment that there were inconsistencies between the documentation and applied price indices in the TSD and September 2023 NOPR, DOE acknowledges the typographical error in the September 2023 NOPR notice*, Table IV.35 Excerpt from PPI industry data for Air-conditioning, refrigeration, and forced air heating equipment mfg-Refrigeration condensing units, all refrigerants, except ammonia (complete), not seasonally adjusted (ID PCU3334153334155)* which is corrected here in this final rule; *see* Table IV.44. While Senneca and Frank Door is of the opinion any PPI index would be inappropriate for projecting the future price of non-display doors, they did not provide an alternative methodology that they considered appropriate; nor did they provide information or data which DOE could use with its current methodology. DOE notes that the PPI series of historical data used in the September 2023 NOPR was series PCU3334153334153 for *Commercial refrigerators and related equipment*, ("CRE") while not specifically for walk-in doors, include the production of doors for commercial refrigerators–which are both solid and transparent in design and an appropriate analog for walk-in non-display, and display doors. In the absence of more specific information, DOE will continue to use the PPI trend for CRE (PPI PCU3334153334153) that includes equipment with solid (non-display) doors.

For this final rule analysis, DOE continued to use the same methodology as the September 2023 NOPR to determine the high and low trends, where DOE examined historical PPI data for commercial refrigerators and related equipment manufacturing available between 1980 and a portion of 2024 from the BLS. [69, 70] Even though this PPI series may also contain prices of refrigeration equipment other than walk-ins, this is the most disaggregated price series that are representative of walk-ins. DOE assumes that this PPI is a close proxy to historical price trends for walk-ins. The PPI data reflect nominal prices, adjusted for product quality changes. The inflation-adjusted (deflated) price index for commercial refrigerators and related equipment manufacturing was calculated by dividing the PPI series by the Gross Domestic Product Chained Price Index.

As in the September 2023 NOPR a spike in the trend of annual real prices between 2021 and 2022 can be observed. However, when the PPI is examined at a month-by-month level, the nominal PPI from 2022 through 2024 shows the PPI to leveling off. Additionally, the engineering analysis was conducted in 2024 and captures this increase in terms of walk-in equipment prices. DOE notes that it has captured the

[69] At the time of writing data were available through April of 2024.
[70] Product series ID: PCU3334153334153. Available at *www.bls.gov/ppi/.*

impact of this spike, if it were realized, as a constant increase in real prices in the low economic benefits scenario results shown in section V.C of this document.

Table IV.44 Excerpt from PPI industry data for Air-conditioning, refrigeration, and forced air heating equipment mfg-Commercial refrigerators and related equipment, not seasonally adjusted (ID PCU3334153334153)

Year	Period	Label	Observation Value	1-Month % Change
2021	M01	2021 Jan	248.40	0.9
2021	M02	2021 Feb	249.80	0.6
2021	M03	2021 Mar	255.10	2.1
2021	M04	2021 Apr	256.40	0.5
2021	M05	2021 May	263.40	2.7
2021	M06	2021 Jun	269.40	2.3
2021	M07	2021 Jul	273.59	1.6
2021	M08	2021 Aug	275.10	0.6
2021	M09	2021 Sep	283.17	2.9
2021	M10	2021 Oct	296.90	4.8
2021	M11	2021 Nov	299.69	0.9
2021	M12	2021 Dec	307.78	2.7
2022	M01	2022 Jan	328.94	6.9
2022	M02	2022 Feb	339.72	3.3
2022	M03	2022 Mar	346.80	2.1
2022	M04	2022 Apr	365.32	5.3
2022	M05	2022 May	367.63	0.6
2022	M06	2022 Jun	369.44	0.5
2022	M07	2022 Jul	382.04	3.4
2022	M08	2022 Aug	382.04	0.0
2022	M09	2022 Sep	382.04	0.0
2022	M10	2022 Oct	388.50	1.7
2022	M11	2022 Nov	390.56	0.5
2022	M12	2022 Dec	390.56	0.0
2023	M01	2023 Jan	392.04	0.4
2023	M02	2023 Feb	392.04	0.0
2023	M03	2023 Mar	400.79	2.2
2023	M04	2023 Apr	400.79	0.0
2023	M05	2023 May	400.79	0.0
2023	M06	2023 Jun	399.66	-0.3
2023	M07	2023 Jul	399.66	0.0
2023	M08	2023 Aug	399.66	0.0

2023	M09	2023 Sep	399.66	0.0
2023	M10	2023 Oct	401.62	0.5
2023	M11	2023 Nov	401.62	0.0
2023	M12	2023 Dec	401.62	0.0
2024	M01	2024 Jan	397.91	-0.9
2024	M02	2024 Feb	403.05	1.3
2024	M03	2024 Mar	403.05	0.0
2024	M04	2024 Apr	403.05	0.0

ASAP *et al*. requested that DOE harmonize its approach to projecting future prices of equipment with variable-speed controllers with its ongoing rulemaking for Commercial Refrigerators, Freezers, and Refrigerator-Freezers ("CRE"). 88 FR 70238. (ASAP et al., No. 77 at p. 3)

In response to ASAP *et al.*, which requested that DOE include the declining price trend for variable-speed controllers as it has applied in its CRE analysis, DOE has not included this trend in its reference case, consistent with the analysis presented in the September 2023 NOPR, but has included it in the high benefits sensitivity scenario. Further, the MPCs of the controllers themselves to which the trend is applied are not significant enough when compared to the total LCC impacts that they would change DOE's policy decision regarding amended standards, see Table IV.45.

Table IV.45 Control Costs as a Fraction of MPC

Equipment Class	Nominal Capacity (kBtu/h)	EL	Design Option	Controls MPC ($)	MPC ($)	% of MPC
DC.L.I	3	2	CMPVS	80	1,405	6%
	9	1	CMPVS	80	2,797	3%
	25	3	CMPVS	80	5,794	1%

	54	2	CMPVS	80	14,210	1%
DC.L.O	3	3	CMPVS	85	2,001	4%
	9	3	VSCF	8	1,984	0%
	9	5	CMPVS	88	3,051	3%
	25	5	VSCF	15	3,964	0%
	25	8	CMPVS	103	6,487	2%
	54	3	VSCF	28	9,260	0%
	54	5	CMPVS	108	15,065	1%
	75	4	CMPVS	126	54,951	0%
DC.M.I	9	1	CMPVS	80	1,739	5%
	25	3	CMPVS	80	2,563	3%
	54	4	CMPVS	80	4,164	2%
	75	3	CMPVS	80	5,606	1%
DC.M.O	9	6	VSCF	7	1,393	0%
	9	8	CMPVS	87	2,016	4%
	25	6	VSCF	17	2,114	1%
	25	8	CMPVS	96	2,985	3%
	54	7	VSCF	25	3,665	1%
	54	9	CMPVS	105	4,963	2%
	75	6	VSCF	45	4,315	1%
	75	8	CMPVS	127	5,989	2%
	124	7	VSCF	55	8,957	1%
	124	9	CMPVS	138	11,564	1%
SP.H.O	2	5	VSCF	4	1,112	0%
	7	4	VSCF	7	2,025	0%
SP.H.O.D	2	5	VSCF	8	1,184	1%
	7	5	VSCF	17	2,082	1%
SP.L.I	2	7	CMPVS	80	2,279	3%
	6	2	CMPVS	80	3,113	3%
SP.L.O	2	4	CMPVS	83	2,073	4%
	6	4	CMPVS	90	3,249	3%
SP.M.I	2	5	CMPVS	80	1,475	5%

	9	3	CMPVS	80	2,798	3%
SP.M.O	2	4	VSCF	4	1,076	0%
	2	9	CMPVS	83	1,608	5%
	9	3	VSCF	11	2,323	0%
	9	5	CMPVS	90	2,931	3%

DOE received no other comments on its future price trend. For this analysis, DOE maintained the same approach for determining future equipment prices as in the September 2023 NOPR and assumed that equipment prices would be constant over time in terms of real dollars, *i.e.,* constant 2023 prices.

a. Application of the Low-GWP Refrigerant Transition to Specific Regions

As discussed in section IV.C.1.e of this document, the States of California and Washington require the use of sub-150-GWP refrigerants. As discussed in section IV.C.2.c of this document, DOE has determined that an increase in MSP to use sub-150-GWP refrigerants will affect dedicated condensing systems of 25 kBtu/h capacity as a function increased efficiency. In the September 2023 NOPR, DOE conducted its LCC analysis at the geographic level of census regions, where the region containing the States of California and Washington is the Western Region (Region 4).[71] To approximate any additional costs to consumers derived from the State level initiatives in California and Washington associated with moving to low-GWP refrigerants, DOE applied the cost of the additional design options determined in section IV.C.1.e of this document to the fraction of consumers in the Western Census Region based on population as a sensitivity

[71] *See www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf.*

analysis, see appendix 8E of the final rule TSD.[72] These weights and additional design option costs are shown in Table IV.46. DOE notes that these additional consumer costs are the results of state regulations and would be incurred in the absence of this final rule.

Table IV.46 Low-GWP Refrigerant Cost Adders

EC	Capacity (kBtu/h)	Census Region	EL	TSL	Cost Adder ($)	Weight
DC.M.O	25	4	0	Baseline	1.56	0.59
					0	0.41
			2	1	86.22	0.59
					0	0.41
			3	2	128.25	0.59
					0	0.41
DC.M.I			0	Baseline	95.21	0.59
					0	0.41
			2	1 & 2	389.72	0.59
					0	0.41

3. Installation Cost

a. Refrigeration Systems

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. In the September 2023 NOPR, DOE found that the data from RSMeans 2023[73] ("RSMeans") did not indicate that installation costs would be impacted with increased efficiency improvement. 88 FR 60746, 60794.

---

[72] *See www.census.gov/data/tables/time-series/demo/popest/2020s-state-total.html.*

[73] Reed Construction Data, *RSMeans Facilities Maintenance & Repair 2023 Cost Data Book, 2023*.

However, for refrigeration systems in the September 2023 NOPR DOE tentatively concluded that in the standards case there would be costs associated with improvements to controls. 88 FR 60746, 60795. As this rulemaking covers walk-in equipment where each type of equipment is considered a “package” unto itself, and any control or sensor improvement would be part of said package; therefore, there would be no additional costs for control installation, but there would be additional costs for control configuration prior to equipment commissioning. RSMeans shows that the amount of time to configure most controls is half an hour of labor, while for variable-capacity HVAC drives—used as a proxy for variable-capacity refrigeration compressors—the amount of labor is 2 hours. DOE assumed the average nonunion shop rate to be $154 (2023$) per hour.[74] The difference in approach from the September 2023 NOPR and this final rule is that DOE has removed the commission charges associated with the crankcase heater and variable-speed condenser fan motors design options (CCHC, VSCF) as these are factory configured to provide optimal operation. DOE did not find any evidence that control configuration scales with equipment capacity and did not include any additional control configuration costs related to equipment costs. 88 FR 60746, 60795.

Table IV.47 Example Installation Costs by TSL for Low-Temperature Dedicated Condensing Systems

Representative Unit	TSL	Installation Cost
DC.L.I - 003	0	0
DC.L.I - 003	1	0
DC.L.I - 003	2	0
DC.L.I - 003	3	308
DC.L.I - 009	0	0
DC.L.I - 009	1	0
DC.L.I - 009	2	0

[74] *See* series 230953103620 and 230953103680.

DC.L.I - 009	3	308
DC.L.I - 025	0	0
DC.L.I - 025	1	0
DC.L.I - 025	2	0
DC.L.I - 025	3	308
DC.L.I - 054	0	0
DC.L.I - 054	1	0
DC.L.I - 054	2	0
DC.L.I - 054	3	308
DC.L.O - 003	0	0
DC.L.O - 003	1	0
DC.L.O - 003	2	0
DC.L.O - 003	3	308
DC.L.O - 009	0	0
DC.L.O - 009	1	154
DC.L.O - 009	2	154
DC.L.O - 009	3	462
DC.L.O - 025	0	0
DC.L.O - 025	1	154
DC.L.O - 025	2	154
DC.L.O - 025	3	462
DC.L.O - 054	0	0
DC.L.O - 054	1	154
DC.L.O - 054	2	154
DC.L.O - 054	3	462
DC.L.O - 075	0	0
DC.L.O - 075	1	0
DC.L.O - 075	2	77
DC.L.O - 075	3	154

b. Cooler and Freezer Panels

In the September 2023 NOPR, DOE included an added \$0.50 per ft^2 of installation cost for panels with greater than 4 inches of insulation thickness to cover the cost of facing the panel with non-corrosive steel. 88 FR 60746, 60796.

ASAP *et al*. and RBA commented they were concerned that DOE is adding additional unwarranted installation costs for panel insulation greater than 4 inches, and that DOE's analysis appeared to assume that all walk-in panels with insulation greater than 4 inches would have a \$0.50 per ft^2 installation cost increase associated with required thermal barriers for non-sprinklered building installations. ASAP *et al*. and RBA commented that the metal facing requirement is only relevant for non-sprinklered buildings, which they expect to represent a very small portion of walk-in installations—walk-ins under 400 ft^2 in area. Additionally, ASAP *et al.* and RBA commented that metal facing requirement to be inclusive of panels with 4 inches of insulation in non-sprinklered buildings. (ASAP *et al*., No. 77 at p. 5; RBA, No. 68 at pp. 1–2)

DOE revised the installation cost for medium-temperature structural panels: since DOE assumes a baseline low-temperature panel is 4 inches thick, there would be no additional installation charges for low-temperature panels in the amended standards case. To address additional installation costs for medium-temperature structural panels for WICF under 400 ft^2 DOE maintained the installation cost of \$0.50 per ft^2 for medium-temperature panels equal to or greater than 4 inches thick and applied the additional installation costs to the fraction of small businesses in the consumer sample (*see* chapter 8 of the final rule TSD).

For further information on the derivation of installation costs, *see* chapter 7 of the final rule TSD.

4. Annual Energy Consumption

For each consumer from the consumer sample (*see* section IV.F.1of this document), DOE determined the energy consumption for walk-ins of the different efficiency levels determined in the engineering analysis (*see* section IV.C of this document) for each TSL (*see* section IV.E.1 of this document) using the approach described previously in section IV.E of this document.

5. 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 changes 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's Typical Bills and Average Rates reports.[75,76] Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the

[75] Edison Electric Institute, *Typical Bills and Average Rates – Summer 2023*, 2024, ISBN: 978-1-938066-08-5.
[76] Edison Electric Institute, *Typical Bills and Average Rates – Winter 2023*, 2023, ISBN: 978-1-938066-05-4.

commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[77]

For this final rule, DOE maintained the methodology it used in the September 2023 NOPR analysis where electricity prices vary by sector and region. 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 walk-ins. DOE derived average and marginal annual non-residential (commercial and industrial) electricity prices using data from EIA's Form EIA-861 database (based on "Annual Electric Power Industry Report"),[78] Edison Electric Institute's Typical Bills and Average Rates Reports, and information from utility tariffs. Electricity tariffs for non-residential consumers can be very complex, with the principal difference from residential rates being the incorporation of demand charges. The presence of demand charges means that two consumers with the same monthly electricity consumption may have very different bills, depending on their peak demand. For this analysis, DOE used marginal electricity prices to estimate the impact of demand charges for consumers of walk-ins and EIA's most recent publication of *Annual Energy Outlook 2023* ("*AEO2023*") to estimate future energy prices (*see* section IV.F.5.a of this document). DOE developed discount rates from estimates of the finance cost for consumers and commercial businesses that

[77] 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*.
[78] Available at *www.eia.doe.gov/cneaf/electricity/page/eia861.html.*

purchase walk-ins. More detail on the methodology used to calculate the marginal electricity rates can be found in appendix 8B of the final rule TSD.

Table IV.48 Marginal and Average Electricity Prices by Census Division and Sector Size (2023$/kWh)

Sector	Average Electricity Price $/kWh	Marginal Electricity Price $/kWh	Census Region
Large Food Sales	0.194	0.170	1
Large Food Service	0.100	0.083	
Large Other	0.117	0.097	
Small Food Sales	0.134	0.107	
Small Food Service	0.194	0.170	
Small Other	0.100	0.083	
Large Food Sales	0.117	0.097	2
Large Food Service	0.134	0.107	
Large Other	0.194	0.170	
Small Food Sales	0.100	0.083	
Small Food Service	0.117	0.097	
Small Other	0.134	0.107	
Large Food Sales	0.203	0.186	3
Large Food Service	0.127	0.117	
Large Other	0.144	0.132	
Small Food Sales	0.165	0.153	
Small Food Service	0.203	0.186	
Small Other	0.127	0.117	
Large Food Sales	0.144	0.132	4
Large Food Service	0.165	0.153	
Large Other	0.203	0.186	
Small Food Sales	0.127	0.117	
Small Food Service	0.144	0.132	
Small Other	0.165	0.153	

a. Future Electricity Prices

To estimate energy prices in future years in the September 2023 NOPR analysis, DOE multiplied the 2022 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.[79] To estimate price trends after 2050, DOE assumed constant real prices at the 2050 rate. 88 FR 60747, 60797.

Senneca and Frank Door commented that there is no basis for DOE to assume that energy prices will remain static after 2050, noting that the prices would fluctuate. (Senneca and Frank Door, No. 78 at pp. 6–7) DOE agrees with Senneca and Frank Door that when average annual electricity prices are observable in retrospect, they indeed fluctuate. The future price projection estimated in *AEO2023* is a modelled projection, and AEO has determined that its projections beyond 2050 are too uncertain to include at this time. DOE is required to estimate the value of energy savings in its analysis and needs a price of electricity for future years beyond 2050 to accomplish this task. For DOE to add manufactured fluctuations to this projection for the sake of aesthetics would introduce unneeded uncertainties to this analysis. Finally, by maintaining constant prices at 2050 levels, DOE is in effect minimizing the benefits of this rulemaking because the price at 2050 is the lowest over the period from 2022 to 2050. For this final rule, DOE will maintain the use of static 2050 prices in its future commercial electricity prices for years beyond the horizon of the *AEO2023* projection.

[79] EIA. *Annual Energy Outlook 2023 with Projections to 2050*. Available at *www.eia.gov/forecasts/aeo/* (last accessed February 13, 2023). Note: *AEO2023* is the most recent edition as the EIA is not publishing a 2024 edition.

6. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing equipment components that have failed in an appliance; 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.

DOE received comments regarding its modeling assumptions for maintenance and repair costs where DOE applied to each an annual cost of 10 percent in response to the September 2023 NOPR. 88 FR 60746, 60797.

AHRI commented that the technologies listed are currently used today but could not comment on actual dollars associated with them. (AHRI, No. 72 at p. 11) RSG commented that shifts toward WICF technologies described in the screening analysis (*see* chapter 4 of the TSD) would most certainly increase maintenance and repair costs by significant amounts. RSG added that these costs would be for specialized component sourcing/availability, specialized service training, special safety concerns, and mitigation, etc. (RSG, No. 69 at p. 2) Hussmann agreed with the views presented by AHRI regarding information about the maintenance and repair costs of WICFs with the technologies described in section IV.C of the September 2023 NOPR. (Hussmann, No. 75 at p. 11)

ASAP *et al*., the CA IOUs, and Senneca and Frank Door, commented that they disagreed with the applied maintenance and repair costs. (ASAP *et al*., No. 77 at p. 4; CA IOUs, No. 76 at pp. 11–12; Senneca and Frank Door, No. 78 at p. 7)

Senneca and Frank Door provided no details regarding the appropriateness of the applied maintenance and repair costs.

ASAP *et al*. commented that the assumed maintenance costs contributed heavily to negative LCC savings at higher efficiency levels. ASAP *et al*. further encouraged DOE to examine its commercial air conditioning rule—where it was assumed that maintenance costs did not increase with improved efficiency; and in its CRE NOPR where additional labor ($15 per year) was considered for the cleaning of microchannel condenser coils.[80,81] ASAP *et al*. encouraged DOE to adopt maintenance costs modeling assumptions where additional costs would only apply to larger condenser coil design options. (ASAP *et al*., No. 77 at p. 4)

The CA IOUs requested that DOE reconsider its maintenance cost modeling assumptions. The CA IOUs commented DOE's assumption that maintenance and repair costs are equal to 10 percent of the unit total cost per year is not accurate. The CA IOUs commented that the maintenance costs for condenser coil cleaning are not directly

---

[80] U.S. Department of Energy, *Energy Conservation Program: Energy Conservation Standards for Air-Cooled Commercial Package Air Conditioners and Heat Pumps Direct Final Rule,* EERE–2022–BT–STD–0015, May 2024, https://www.regulations.gov/document/ EERE–2022–BT–STD–0015
[81] U.S. Department of Energy, *Energy Conservation Program: Energy Conservation Standards for Commercial Refrigerators, Freezers, and Refrigerator-Freezers Notice of Proposed Rulemaking,* EERE–2017–BT–STD–0007, October 2023, https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0056

proportional to coil size (or cost); rather, the cost is due to the refrigeration technician's labor to access the walk-in condenser coil. The CA IOUs provided information on typical refrigeration technician charges of $100 to $250 per hour depending on the region, with a minimum of an hour for any service call, while other technicians have a "flat truck roll fee" ranging between $50 and $150 per service call.[82] Further, the CA IOUs maintained that the labor-cost difference to clean a small or a larger coil is therefore relatively small compared to the total cost of arriving on site and cleaning condenser coils. The CA IOUs added that the maintenance costs for refrigerant leak repair and recharging depend on the condensing unit location relative to the unit cooler (refrigerant piping length). (CA IOUs, No. 76 at p. 11)

The CA IOUs further commented that other components like EEVs and variable-speed condenser fans improve efficiency and may increase unit costs but can also increase the life of componentry due to the reduced number of times the fan cycles on and off. The CA IOUs recommended evaluating the repair cost of refrigeration components (*i.e.*, contactors, start relays, fan motors, expansion valves, thermostats) based on the component's average useful life and the component's price and maintenance costs based on reliable data sources such as average labor rates, time, and fixed charges by refrigeration technicians. (CA IOUs, No. 76 at p. 12)

---

[82] A truck roll is changed when a field technician gets dispatched to a customer or other field agent's location to solve a problem with an asset.

This comment aligns with AHRI's comment that increased repair and maintenance costs would be commensurate with the increased usage rate employed to achieve minimum efficiency. (AHRI, No. 72 at p. 11)

AHRI and Hussmann commented that electronically commutated variable-speed condenser fan motors require an electronic control module. AHRI and Hussmann commented that use of this sort of motor requires the use of diagnostic tools to troubleshoot the ECM, which would add to costs and servicing of systems. AHRI and Hussmann added that such motors are normally programmed at the factory for parameters such as head pressure and the outdoor ambient temperature along with run-time. AHRI and Hussmann commented that therefore, DOE should also consider costs for this for both OEMs and service technicians as part of the analysis. (AHRI, No. 72 at p. 7; Hussmann, No. 75 at p. 11)

Based on the comments received, DOE revisited its maintenance costs modeling assumptions for this final rule analysis.

For panels, maintenance activities encompass periodic cleaning and visual inspection for damage. DOE is only considering improvements to efficiency by increasing the thickness of polyurethane foam for cooler and freezer panels. When examining the per ft^2 of MPC for panels, DOE's analysis shows that the cost delta between baseline and max tech panel thickness is approximately \$1 (one) per ft^2. DOE finds the material cost for repair to be marginal and without significant difference to the no-new-standards case; as such, DOE did not apply repair costs as a function of panel efficiency.

Display door and non-display door maintenance activities encompass periodic cleaning, visual inspection of all components, lubrication, and component adjustments to account for wear from use (*e.g.,* adjusting the door sweep, fastener tightness). There is no indication that the time required to perform these activities would be a function of improved efficiency.[83,84,85,86]

Similarly, for refrigeration systems, maintenance activities encompass—but are not limited to—visual periodic inspection of all components for wear (*e.g.,* fastener tightness, component pitting), cycle-check of all modes, lubrication, and cleaning (motor, evaporator, condenser coils, drains/lines, etc.). *Ibid.*

Based on the comments received and manufacturer's literature cited, DOE has concluded that maintenance costs are unlikely to materially change with improved efficiency for walk-in panels and non-display doors. For refrigeration systems, DOE agrees with the CA IOUs and ASAP *et al.* that there may be a potential increased labor associated with cleaning refrigeration systems; however, it would be marginal when compared to the cost of dispatching a technician to perform the periodic maintenance.

---

83 *frankdoor.com/plugins/pdfJS/web/viewer.html?file=/webFiles/files/3/Installation/DropTrac%20Installation.pdf.*

84 *frankdoor.com/plugins/pdfJS/web/viewer.html?file=/webFiles/files/10/Installation/Torsion%20Springs.pdf.*

85 *imperialbrown.com/sites/default/files/2017-10/ICC5%20Full%20Manual%20Book_130130.pdf.*

86 *norlake.com/wp-content/uploads/2020/07/132617-Walk-in-Manual.pdf.*

DOE has therefore concluded that the difference in maintenance costs between equipment in the no-new-standards and the amended standards case would be minimal and is not included in this final rule. To account for the circumstances described by AHRI and Hussmann where additional repair costs may be required for troubleshooting some components DOE has continued to apply the 10 percent MPC per year to account for the increase in material and labor (troubleshooting) cost associated with troubleshooting and remedying functional issues.

7. Equipment Lifetimes

Because the basis for the lifetime estimates in the literature for walk-in equipment is uncertain, DOE used distributions to estimate the lifetimes of walk-in systems and envelope components in the field. The resulting survival function, which DOE assumed has the form of a cumulative Weibull distribution, provides an average and median appliance lifetime. DOE used different Weibull distributions to estimate the lifetimes for similar equipment types.

DOE received multiple comments regarding the lifetimes of walk-ins. AHRI and Lennox stated that walk-in lifetimes were generally understood to be 7 to 9 years—depending on usage and maintenance. (AHRI, No. 72 at pp. 5–6 and No. 86 at p. 9; Lennox, No. 70 at p. 6 and No. 87 at pp. 3–4)

NAFEM agreed with DOE’s lifetimes of 20 years for insulated panels and doors. (NAFEM, No. 67 at p. 3) ASAP *et al*. commented that DOE should consider increasing the lifetimes of walk-in panels, citing an industry report estimating door and panel lifetimes to be between 12 and 25 years—as well as the fact that manufacturers offer warranties of 15 to 20 years for walk-in panels—suggesting that the expected lifetimes of walk-in panels significantly exceed DOE's estimations. (ASAP *et al*., No. 77 at p. 4) By way of support, ASAP *et al.* provided the warranty agreement from PAR Engineering Inc., which offers a 20-year warranty on its panel installations.[87] In response to ASAP *et al.* and NAFEM, DOE notes that it represents lifetimes as a distribution of values, and for panels in the September 2023 NOPR this distribution was characterized with a minimum, maximum, and average lifetime of 2, 25 and 12 years respectively. Further DOE examined the warranty periods from other manufacturers and found that for panels, these ranged from 1 year[88,89] through the 20 years, with warranties offered to the original purchasers of panels typically in the 10- to 15-year range.[90, 91, 92, 93, 94, 95, 96, 97, 98]

[87] *www.commercialcooling.com/wp-content/uploads/Commercial-Cooling-20-Year-Standard-Panel-Warranty.pdf* (Last Accessed: May 10, 2024).
[88] *kpsglobal.com/terms-and-conditions/for-sale-warranty/* (Last Accessed: May 30, 2024)
[89] *aicheatexchangers.com/wp-content/uploads/2020/09/AIC-Warranty-Statement-LWI-17-02.pdf* (Last accessed: May 30, 2024)
[90] *https://norlake.com/wp-content/uploads/2020/07/walk-in-refrigeration-warranties-089604.pdf* (Last Accessed: May 30, 2024)
[91] https://assets.welbilt.com/m/2b0660daf5344f58/original/Warranty-Policy.pdf? _ hstc=70905295.ac632688bb7470ba06bf11662e737cbd.1717093685617.1717093685617.1717093685617.1&__hssc=70905295.1.1717093685617&__hsfp=3523199817 (Last Accessed: May 30, 2024)
[92] *https://www.kolpak.com/Service/Kolpak-Warranty* (Last Accessed: May 30, 2024)
[93] *https://imperialbrown.com/sites/default/files/2017-09/Walk-ins%20Warranty_0.pdf* (Last Accessed: May 30, 2024)
[94] *https://www.everidge.com/wp-content/uploads/2018/08/ThermalRite-Warranty-Final-6.4.2020.pdf* (Last Accessed: May 30, 2024)
[95] *https://leerinc.com/wp-content/uploads/2021/10/Leer-Inc.-Walk-In-Warranty-Packet_v0921.pdf* (Last Accessed: May 30, 2024)
[96] *https://www.uscooler.com/support/warranty/* (Last Accessed: May 30, 2024)
[97] *http://www.americanpanel.com/materials/Service/APC_Walk-in_Warranty_02-22.pdf* (Last Accessed: May 30, 2024)
[98] *http://www.ballyrefboxes.com/Bally_FAQ/Bally_warranty.asp* (Last Accessed: May 30, 2024)

Based on the comments received and literature examined DOE is maintaining the lifetime from the September 2023 NOPR for all doors and panels. DOE notes that the lifetimes, for modeling purposes, are characterized as a distribution and this distribution for panels accounts for lifetimes greater than 20 years. For this final rule DOE updated the lifetimes for refrigeration equipment to the values shown in Table IV.49.

Additionally, DOE maintained the modeling assumption of a minimum service lifetime of 2 years for all equipment classes. This reflects the fact that many units are purchased with a warranty that effectively guarantees that the unit will remain in operation during the warranty period. 88 FR 60746, 60798.

Table IV.49 shows the revised (*italicized*) minimum, maximum and average lifetimes for walk-in envelope components and refrigeration systems.

Table IV.49 Lifetimes for Walk-In Equipment (years)

Equipment Category	**Analysis**	**WICF Equipment Lifetimes (years)**			
		Display Doors	**Panels**	**Non-display Doors**	**Refrigeration Equipment**
Minimum Lifetime	NOPR	2	2	2	2
	Final Rule	2	2	2	2
Average Lifetime	NOPR	12	12	8.5	*10.5*
	Final Rule	12	12	8.5	*8.5*
Maximum Lifetime	NOPR/Final Rule	25	25	12	20

As discussed in section IV.B.1.b of this document, although better thermally insulating frame systems for non-display doors exist on the market, some stakeholder comments suggested that such frame designs may have reduced structural rigidity compared to traditional (*e.g.*, wood) framing systems. While the presence of this design feature in the walk-in market does indicate its suitability in a range of current applications and suggests it does not have a detrimental impact on product performance or lifetime, DOE is also aware that there is variability in structural loads that walk-in doors may be subject to (see generally discussion during the NOPR public meeting as part of the previous rulemaking cycle for this equipment, EERE-2008-BT-STD-0015-0088 at pp. 238–241) and recognizes that there may be remaining uncertainty regarding the structural suitability of the best thermally-insulating frame systems available on the market in certain applications, and the extent to which structural performance of the door frame may affect product lifetime. More specifically, in the absence of structural performance data, DOE cannot be certain whether the differences in non-display door framing systems currently in the market are due to manufacturer design preferences or specific durability requirements; *e.g.*, large sliding doors manufactured separately from the walk-in in which they are installed may warrant a frame with greater structural durability than doors manufactured together with the surrounding panels as a complete system. If these framing system decisions are driven by durability considerations in such specific cases then establishing standards that DOE expects would necessitate thermally-improved frame designs could result in the need for earlier replacement of certain non-display doors in such applications. Those additional replacement costs would outweigh the savings in operating costs brought about through energy efficiency improvements.

Given the application-specific nature of this aspect of non-display door design and construction, DOE does not have information on the frequency with which earlier replacement might be required in certain circumstances, or how much sooner such a replacement might be required compared to the average 8.5 year service lifetime assumed in this analysis. Hence, DOE cannot accurately estimate the magnitude of the lifetime impact (if any) of the thermally-improved frame design option, and has not included it in its analysis. Given these uncertainties, DOE instead developed an upper bound sensitivity analysis for consideration as part of the selection of standard levels. The sensitivity analysis assumes that in certain circumstances a consumer might experience a reduction in lifetime. As there is no data or information that DOE is aware of regarding the relationship between the structural performance of the door frame and how it may affect product lifetime DOE made the modelling assumption for this sensitivity that lifetimes could be reduced by as much as one-half, *i.e.*, requiring replacement at 4.3 years instead of 8.5 years. For example, for a baseline low-temperature motorized non-display door (NO.L), connected to a TSL 2 refrigeration system, the total installed cost is estimated to be $6,931 with an average lifetime of 8.5 years (see Table IV.49). In a circumstance where the consumer of a low-temperature motorized non-display door (NO.L) with the thermally improved frame design were to experience a reduction in lifetime by one-half (from 8.5 years to 4.3 years), the consumer would be faced with having to purchase a new standards-case door to maintain the same service lifetime as a non-display door without the thermally improved frame design. As shown in Table IV.50, for those consumers, this would decrease their overall life-cycle cost savings benefits under such a circumstance due to the need to purchase and install replacement equipment earlier than they would have under the no-new-standards case. At TSL 3, this could reduce the LCC savings benefits to a loss over the 8.5-year timespan of approximately -$8,369. Similarly, for a NO.L at TSL 2 the decrease in overall life-cycle costs savings benefits could be reduced to -$7,935. DOE notes that this sensitivity is not intended to be representative of the non-display door market as a whole nor any specific segment of the market, but to address stakeholder concerns regarding the robustness of thermally improved frames in certain circumstances and as a consideration in assessing the benefits and burdens of this rule, as discussed in section V.C.1.b. of this document.

Table IV.50 Sensitivity of LCC Savings with a 4.3-year Lifetime while maintaining an 8.5-year Service Requirement (2023$)

TSL	Equipment Class			
	NM.M	NM.L	NO.M	NO.L
2	-3,497	-2,628	-8,991	-7,935
3	-4,135	-3,135	-9,734	-8,369

8. Discount Rates

The discount rate is the rate at which future expenditures are discounted to estimate their present value. DOE employs a two-step approach in calculating discount rates for analyzing customer economic impacts (*e.g.,* LCC). The first step is to assume that the actual cost of capital approximates the appropriate customer discount rate. The second step is to use the capital asset pricing model (“CAPM”) to calculate the equity capital component of the customer discount rate. For this final rule, DOE estimated a statistical distribution of commercial customer discount rates of walk-in consumers by calculating the cost of capital for the different types of walk-in owners.

DOE's method views the purchase of a higher-efficiency appliance as an investment that yields a stream of energy cost savings. DOE derived the discount rates for the LCC analysis by estimating the cost of capital for companies that purchase walk-ins. For private firms, the weighted average cost of capital ("WACC") is commonly used 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 their cost of capital is the weighted average of the cost to the firm of equity and debt financing, as estimated from financial data for publicly traded firms in the sectors that purchase walk-ins.[99] As discount rates can differ across industries, DOE estimates separate discount rate distributions for a number of aggregate sectors with which elements of the LCC building sample can be associated.

AHRI commented that in a recent refrigerator rulemaking, AHAM brought to DOE's attention the fact it does not take into account operating costs, including energy, as deductible business expenses for Federal and some State income taxes. AHRI cited equation 8.6 from the Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Walk-In Coolers and Walk-In Freezers TSD, which explicitly refers to the tax effects on the cost of debt for commercial customers. AHRI asked if DOE has modified its LCC model to include the effects of the

[99] Previously, Damodaran Online provided firm-level data, but now only industry-level data is available, as compiled from individual firm data, for the period of 1998–2018. The data sets note the number of firms included in the industry average for each year.

deductibility of operating costs for income tax purposes for commercial customers in its LCC analysis, and if not, why not? (AHRI, No. 72 at p. 8)

In the February 2023 NOPR for Energy Conservation Program: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers, AHAM commented that operating costs and the depreciation of capital investments are deductible costs for commercial end-users from Federal and State corporate income taxes. Further, AHAM suggested that DOE should incorporate the effects of tax deductibility in the LCC analysis. 89 FR 3026, 3053–3054. DOE maintains its response from the January 2024 Direct Final Rule for Energy Conservation Program: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers, where DOE noted that in the comment, the estimation of commercial discount rates accounts for the tax deductibility of the energy costs and capital investment depreciation and therefore the net present value of the future operating cost savings in the LCC analysis already reflect that effect. 89 FR 3026, 3054. Therefore, DOE did not modify its LCC model for this final rule.

DOE received no further comments on its discount rate methodology and analysis used in the September 2023 NOPR analysis and maintained its approach for this final rule. *See* chapter 8 of this final rule TSD for further details on the development of consumer discount rates.

9. Energy Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of equipment efficiencies under the no-new-standards case (*i.e.*, the case without amended or new energy conservation standards) in the compliance year. This approach reflects the fact that some consumers may purchase equipment with efficiencies greater than the baseline levels in the absence of new or amended standards.

To estimate the energy efficiency distribution of walk-ins for 2028 and 2029, DOE used information provided from stakeholders and records from DOE's CCMS database. The estimated market shares for the no-new-standards case for walk-in cooler and freezer panels and doors are shown in Table IV.51. *See* chapter 8 of the final rule TSD for further information on the derivation of the efficiency distributions. DOE did not change its approach from the March 2024 NODA in this final rule analysis.

AHRI commented that it has yet to observe customer demand for higher efficiency walk-in equipment (dedicated condensing systems, unit coolers, and single-packaged units) versus equipment meeting the baseline (current) walk-ins standard. (AHRI, No. 72 at p. 12)

Regarding refrigeration systems, DOE agrees with the statement from AHRI, and continues with the modeling assumption from the September 2023 NOPR that all walk-in cooler and freezer refrigeration systems would be at baseline in the no-new-standards case. For non-display doors and panels (for which DOE did not receive any comments in response to the September 2023 NOPR or March 2024 NODA), DOE will continue to apply the rates of more-efficient designs found in DOE's CCMS database.[100] DOE related the fraction of designs in the CCMS database to the different panel and non-display door efficiency levels based on the percentage reduction in daily energy consumption (kWh/day) (see sections IV.C.1.c and IV.C.1.d of this document). 88 FR 60746, 60798–60799.

Table IV.51 Distribution of Efficiencies in the No-New-Standards Case for Panel and Non-Display Doors by Efficiency Level

Efficiency Level	Equipment Classes						
	NM.L	NM.M	NO.L	NO.M	PF.L	PS.L	PS.M
0	72%	62%	100%	97%	34%	64%	51%
1	13%	7%	0%	3%	48%	25%	23%
2	11%	9%	0%	0%	13%	11%	19%
3	0%	2%	0%	0%	6%		8%
4	0%	2%	0%	0%			
5	4%	1%	0%	0%			
6		17%		0%			

The LCC Monte Carlo simulations draw from the efficiency distributions and randomly assign an efficiency to the walk-in coolers and freezers 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.

[100] U. S. Department of Energy. *Compliance Certification Database*. 2023. *www.regulations.doe.gov/certification-data/* (last accessed Feb. 1, 2023).

10. Payback Period Analysis

The payback period 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. Payback periods 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 product 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 a product 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. 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 amended standards would be required.

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.[101] 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.

As in the September 2023 NOPR, to calculate projected shipments of each equipment type, DOE uses a two-step approach. In the first step, the annual shipments of completed walk-in installations (hereafter referred to as "boxes") of all types are calculated using a stock model, where principal inputs are commercial floor space projections and the average lifetime of a walk-in box. In the second step, the various types of refrigeration systems and envelopes are partitioned over the shipments of the entire market for boxes.

DOE modeled the shipments of walk-in boxes to three commercial building sectors: food sales, food service, and *other*. Projections of the growth in floor space for each of these sectors are taken from the *AEO2023* Reference case.[102] To estimate the

[101] 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.
[102] U.S. Energy Information Administration. *Annual Energy Outlook 2023*.

lifetime of walk-in boxes, DOE used the distribution from the LCC (*see* chapter 8 of this final rule TSD).

Shipments of walk-in coolers and freezers are driven by new purchases and stock replacements due to failures. In each year, the model calculates total stock by vintage and then estimates the number of units that will fail. The number of units that fail determines the replacement shipments in that year. Shipments to new installations are determined by market saturation (number of boxes per square foot) multiplied by the new floor space constructed in that year. As walk-in boxes have been in use for several decades, DOE assumed that market saturations are constant.

AHRI, supported by Hussmann and Lennox, commented that historical data do not suggest a move to "larger" equipment, specifically; they have observed growth across multiple product lines, including "smaller" capacity products. AHRI, Hussmann, and Lennox commented that there is a gap in considering the small unit (less than 1 horsepower) market size as an artifact of having left this out in original assessments and possibly omitting market contributors such as wine cellars, and this would inappropriately skew market percentages toward larger sizes. (AHRI, No. 72 at p. 12; Hussmann, No. 75 at p. 11; Lennox, No. 70 at p. 8)

DOE thanks AHRI, Hussmann and Lennox for their comments regarding the growth of "smaller" capacity units. However, no information or data were provided by the commenters and there is no publicly available data on the subject that DOE can credibly analyze. For this analysis, DOE continued to maintain the constant market shares for refrigeration equipment as presented in the September 2023 NOPR analysis.

1. Price Elasticity

Economic theory suggests that changes in the price of walk-in components resulting from this standard could potentially affect the number of shipments due to the price elasticity of demand. This might take the form of either a decrease in shipments in cases where purchase costs increase or an increase in shipments in cases where life-cycle costs decrease. But this general economic theory applies differently in different contexts and, based on the information available to DOE, indicates that shipments will not be meaningfully affected by today's final rule.

RSG commented that in its experience, increased equipment costs for more-efficient equipment may drive a reduction in new sales and the necessity of maintaining current equipment and/or buying old or used equipment, stunting the benefits of improved efficiency regulations. (RSG, No. 69 at p. 2)

For this analysis, DOE continues to use the assumption in the September 2023 NOPR analysis that a decrease in shipments is unlikely in the walk-in market. DOE maintains that changes in purchasing behavior are unlikely due to the essential nature of the equipment and the lack of available substitutes. Moreover, the substantial savings to consumers over the lifetime of the equipment is expected to positively affect consumer purchasing incentives. DOE examined the impacts of amended standards on shipments as a sensitivity in appendix 9A of the final rule TSD. This sensitivity shows that the potential impact from increased prices for the amended standards to be a reduction in overall FFC energy savings of 1.07 and 0.35 percent for refrigeration systems and envelope components, respectively. Based on these considerations, and the lack of contradictory information, DOE continues to assume that the shipments do not change between the base case and amended standards case.

2. Shipments Results

The projected walk-in box shipments results shown in Table IV.52 are inclusive of the different analytical compliance dates for envelope components (2028) and refrigeration systems (2029). The analysis accounts for envelope component shipments from 2028 through 2057, and for refrigeration system s from 2029 (the analytical start) through 2058.

Table IV.52 Projected Shipments of WICF Boxes for Select Years 2028–2058

Year	Food Sales	Food Service	Other	Total
2028	24,570	34,664	92,387	151,621
2029	24,617	34,847	92,907	152,371
2030	24,774	35,203	93,873	153,849
2035	25,761	37,350	98,700	161,811
2040	26,415	38,884	102,655	167,954
2045	27,279	40,832	107,376	175,487
2050	27,938	42,357	111,863	182,158
2055	28,607	43,854	115,758	188,219
2057	28,962	44,576	117,847	191,384
2058	28,989	44,709	118,110	191,807

H. National Impact Analysis

The NIA assesses the national energy savings ("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.[103] ("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 walk-in refrigeration systems sold from 2029 through 2058, and walk-in panels and doors sold from 2028 through 2057.[104]

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

[103] The NIA accounts for impacts in the United States and U.S. territories.
[104] Because the anticipated compliance date is late in the year for refrigeration systems, December 31, 2028, for analytical purposes, DOE conducted the analysis for shipments during the period 2029–2058. Similarly, the anticipated compliance date for panels and doors, January 1, 2028, for analytical purposes, DOE conducted the analysis for shipments during the period 2028-2057.

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.

DOE uses a software model to calculate the energy savings and the national consumer costs and savings from each TSL. The NIA model uses typical values (as opposed to probability distributions) as inputs.

Table IV.53 summarizes the inputs and methods DOE used for the NIA analysis for the final rule. Discussion of these inputs and methods follows the table. *See* chapter 10 of the final rule TSD for further details.

Table IV.53 Summary of Inputs and Methods for the National Impact Analysis

Inputs	**Method**
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	December 31, 2028 (2029 Analytical year) for Systems, January 1, 2028, for Envelopes
Efficiency Trends	Constant
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	A repair is function of design option for Systems, no change for Envelopes. Maintenance costs is constant for all equipment.
Energy Price Trends	*AEO2023* projections (to 2050) and constant thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2023*.
Discount Rate	3 percent and 7 percent
Present Year	2024

1. Product 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 amended-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. To project the trend in efficiency absent amended standards for walk-in coolers and freezers over the entire shipments projection period, DOE maintained constant efficiencies.

DOE used the shipments-weighted energy efficiency distribution for 2028 for envelope components and 2029 for refrigeration systems (the assumed date of compliance with a new standard) as a starting point. To represent the distribution of walk-in energy efficiencies in 2028 and 2029, DOE used the same market shares as used in the no-new-standards case for the LCC analysis (*see* section IV.C.1 of this document). The approach is further described in chapter 10 of the final rule TSD.

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 (2028 and 2029). In this scenario, the market shares of products 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 products above the standard would remain unchanged.

DOE did not receive any comments regarding a future shift toward more-efficient walk-ins, and maintained the modeling assumptions from the September 2023 NOPR where efficiency would remain constant over time in this analysis. 88 FR 60746, 60801.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case ("TSL") and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each 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 walk-ins. Further, due to the nature of the walk-ins used in commercial applications, those using the equipment would not likely have knowledge of the equipment's efficiency and would not likely alter their usage behavior based on the equipment's efficiency—an assumption agreed with by AHRI, Hussmann, and RSG. (AHRI, No. 72 at p. 12; Hussmann, No. 75 at p. 11; RSG, No. 69 at p. 2) Because of this, as in the September 2023 NOPR, DOE has not applied a rebound effect for this analysis. 88 FR 60746, 60801.

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 greenhouse gas and other emissions in the national impact analyses 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 document, 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[105] that EIA uses to prepare its *Annual Energy Outlook*. 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 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.

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

[105] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2023*, DOE/EIA-0581(2023), May 2023. Available at *https://www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2023).pdf* (last accessed July 3, 2024).

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.2 of this document, DOE developed walk-in price trends based on historical PPI data. DOE applied the same trends to project prices for each equipment class at each considered TSL. As discussed in section IV.F DOE maintained constant real prices throughout this analysis. DOE's projection of equipment prices is described in appendix 10C of the final rule TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different equipment price projections on the consumer NPV for the considered TSLs for WICFs. In addition to the default price trend, DOE considered two equipment price sensitivity cases: (1) a price decline case based on lower 95-percent of the estimated parameter from exponential fit using the commercial refrigerator PPI from 1980 to 2023 and (2) a price increase case based on the upper 95-percent of the estimated parameter from exponential fit using the commercial refrigerator PPI from 2005 to 2023. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C 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, DOE used constant real prices at 2050 levels. 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. 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.[106] 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.

[106] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. Available at *www.whitehouse.gov/omb/information-for-agencies/circulars* (last accessed May 31, 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.

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. The principal users of WICF are food and beverage sales and service. For this final rule, DOE analyzed the impacts of the considered standard levels on the following two subgroups: (1) consumers with high warm air-infiltration applications, and (2) small businesses.

1. High Warm Air-infiltration Applications

In response to comments to the September 2023 NOPR DOE is maintaining the subgroup to approximate the impacts for businesses where walk-ins are operated in environments with higher warm air-infiltration. This would have the effect of putting a greater cooling load on the refrigeration equipment, thus increasing run hours. For this subgroup DOE has assumed 20 daily run hours for all refrigeration system equipment.

AHRI and Lennox commented that it would be feasible to expect that customers operating in regions where electricity is more expensive than the national average and in high warm air applications will be incentivized to reduce their energy cost to purchase a refrigeration system with efficiencies higher than a customer operating in regions where the electricity costs are lower than or at the average national rate. (AHRI, No.72 at p. 12; Lennox, No. 70 at p. 8) DOE agrees with AHRI and Lennox's comments that consumers in regions with higher electricity prices may be incentivized to purchase more efficient equipment. However, this is at odds with other comments from AHRI where it has yet to observe customer demand for higher efficiency walk-in equipment (dedicated condensing systems, unit coolers, and single-packaged units) versus equipment meeting the base (current) walk-ins standard. (AHRI, No. 72 at p. 12) As neither AHRI or Lennox submitted any evidence to support the notion of changing consumer purchase or operating behavior, and, as discussed in IV.F.9 DOE agrees with the statement from AHRI, and continues with the modeling assumption from the September 2023 NOPR did not include regional variations in purchasing or operating behaviors.

The results of this analysis can be found in Table V.51, which show increased benefits for all equipment in terms of LCC savings. This is a direct result of the increased hours of operation.

2. Small Businesses

This subgroups analysis used subsets of the CBECS 2018 sample composed of businesses that are small businesses in the consumer sample (*see* section IV.F.1 of this document for a full discussion of the consumer sample). DOE used the LCC and PBP model to estimate the impacts of the considered efficiency levels on these subgroups. DOE used adjusted electricity costs and discount rates to better reflect the costs experienced by small businesses. DOE did not receive any comments regarding the small business subgroup analysis from the September 2023 NOPR and maintained the same approach for this final rule.

Table IV.54 Electricity Costs for Small Businesses (2023$/kWh)

Sector	Region	Average	Marginal
Small Food Sales	1	0.203	0.186
Small Food Service		0.203	0.186
Small Other		0.203	0.186
Small Food Sales	2	0.127	0.117
Small Food Service		0.127	0.117
Small Other		0.127	0.117
Small Food Sales	3	0.144	0.132
Small Food Service		0.144	0.132
Small Other		0.144	0.132
Small Food Sales	4	0.165	0.153
Small Food Service		0.165	0.153
Small Other		0.165	0.153

Table IV.55 Distribution of Discount Rates for Small Businesses

Sector	Discount Rate (%)	Weight
Small Food Sales	0.06	0.03
	0.07	0.10
	0.07	0.46
	0.08	0.24
	0.09	0.05
	0.10	0.05
	0.12	0.05
	0.12	0.02
Small Food Service	0.14	0.02
	0.08	0.05
	0.08	0.33
	0.09	0.37
	0.10	0.10
	0.11	0.04
	0.12	0.07

	0.13	0.03
	0.03	0.00
Small Other	0.00	0.00
	0.04	0.02
	0.06	0.04
	0.06	0.09
	0.07	0.12
	0.09	0.18
	0.09	0.19

The results of the small business subgroup analysis show increased consumer benefit across most equipment, as shown in Table V.49 through Table V.51. The increase in benefits is driven by the higher electricity prices attributed to small business customers.

Chapter 11 in the final rule TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of amended energy conservation standards on manufacturers of walk-ins and to estimate the potential impacts of such standards on direct 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 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, equipment 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. To capture the uncertainty relating to manufacturer pricing strategies following 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 walk-in manufacturing industry based on the market and technology assessment, preliminary manufacturer interviews, and publicly available information. This included a top-down analysis of walk-in door, panel, and refrigeration system 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 walk-in manufacturing industry, including company filings of form 10-K from the SEC,[107] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures* ("*ASM*"),[108] and reports from Dun & Bradstreet.[109]

In Phase 2 of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of 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:

---

[107] U.S. Securities and Exchange Commission, *Electronic Data Gathering, Analysis, and Retrieval (EDGAR) system*. Available at *www.sec.gov/edgar/search/* (last accessed March 7, 2024).
[108] U.S. Census Bureau, *Annual Survey of Manufactures*. "Summary Statistics for Industry Groups and Industries in the U.S (2022)." Available at *www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html* (last accessed March 7, 2024).
[109] The Dun & Bradstreet Hoovers login is available at *app.dnbhoovers.com* (last accessed March 7, 2024).

(1) creating a need for 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 walk-ins 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 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, 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 an 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 2057, 30 years after the 2028 compliance date for doors and panels. For refrigeration systems, the GRIM arrives at a series of annual cash flows beginning in 2024 (the base year of the analysis) and continuing to 2058, 30 years after the modeled 2029 compliance date. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of walk-in doors, panels, and refrigeration systems, DOE used a real discount rate of 9.4 percent, 10.5 percent, and 10.2 percent, respectively, 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. 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 products can affect the revenues, gross margins, and cash flow of the industry. In this rulemaking, DOE relied on a design-option approach for doors, panels, dedicated condensing units, and single-packaged dedicated systems. DOE relies on both a design-option and an efficiency-level approach for unit coolers, depending on the equipment class. For a complete description of the MPCs, *see* chapter 5 of the final rule TSD or section IV.C of this document.

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) extending 30 years after the expected compliance date. 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.

To calculate projected shipments of each equipment type, DOE uses a two-step approach. In the first step, the annual shipments of completed WICF installations (also referred to as "boxes") of all types are calculated using a stock model, with principal inputs that include commercial floor space projections and the average lifetime of a WICF box. In the second step, the various types of refrigeration systems and envelopes are partitioned over the shipments of the entire market for boxes. *See* chapter 9 of the final rule TSD for additional details or section IV.G of this document.

c. Capital and Product 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) capital conversion costs; and (2) product conversion costs. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new compliant product designs can be fabricated and assembled. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with new or amended energy conservation standards.

DOE relied on information derived from manufacturer interviews, equipment teardown analyses, and the engineering models, as well as data collected in support of the June 2014 Final Rule, to evaluate the level of capital and product conversion costs manufacturers would likely incur at the considered standard levels. In interviews, DOE asked manufacturers to estimate the capital conversion costs (*e.g.*, changes in production processes, equipment, and tooling) to implement the various design options. The data generated from the equipment teardown and engineering analyses were used to estimate the capital investment in equipment, tooling, and conveyor required of OEMs at each efficiency level, considering such factors as product design, raw materials, purchased components, and the fabrication method. Changes in equipment, tooling, and conveyer, supplemented by feedback from confidential manufacturer interviews, were then used to estimate capital conversion costs. In interviews, DOE also asked manufacturers to estimate the redesign effort and engineering resources required at various efficiency levels to quantify the product conversion costs. Manufacturer data were aggregated to protect confidential information.

For manufacturers of refrigeration systems, DOE also included the costs associated with appendix C1, as finalized in the May 2023 TP Final Rule. 88 FR 28780. Using individual model counts from the CCD and efficiency distribution assumptions in the shipments analysis, DOE estimated the industry costs associated with re-rating compliant models in accordance with appendix C1.

For this final rule, DOE refined its capital and product conversion cost analysis but generally maintained its methodology from the September 2023 NOPR. Specifically, DOE updated its conversion cost estimates from the September 2023 NOPR to 2023$ for this final rule. For capital conversion costs, DOE incorporated updated estimates of equipment, tooling, conveyer, and space generated from the equipment teardown and engineering teardown analyses. For refrigeration systems, DOE conducted further research into the specific production equipment currently being used by walk-in OEMs to fabricate tube-and-fin heat exchangers and incorporated updated equipment specifications and costs. In response to comments, DOE adjusted its analysis to more accurately account for how implementing design options on representative units of different capacities would contribute to capital conversion cost estimates. As a result of these updates, DOE found that unit coolers would require capital conversion costs beyond the retooling cost estimated in the September 2023 NOPR. For unit coolers, in response to stakeholder comments, DOE revised its capital conversion cost analysis to reflect the assumed distribution of row number frequency using results from its unit cooler database (*see* Table IV.56). For product conversion costs, DOE incorporated the most recent BLS wage data into its estimates.[110] *See* chapter 12 of the final rule TSD for further details on the updates made to conversion cost estimates.

Table IV.56 Coil Row Frequency From Unit Cooler Database

Number of Rows	Distribution
2	4.0%
3	22.0%
4	52.1%
5	21.8%

[110] Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Mechanical Engineers. (May 2023) Available at: *www.bls.gov/ooh/architecture-and-engineering/mechanical-engineers.htm.* (Last accessed June 20, 2024).

For product conversion costs, in response to stakeholder comments to the September 2023 NOPR regarding the increase in testing and certification costs associated with new safety standards (*i.e.*, UL 60335-2-89) (*see* AHRI, No. 72 at pp. 2–3 and No. 86 at p. 3), DOE also doubled refrigeration system product conversion costs associated with UL testing and industry certification for this final rule.

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 amended standard. The conversion cost figures used in the GRIM can be found in section V.B.2 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 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. DOE addresses comments in response to the September 2023 NOPR related to its manufacturer markup scenarios in section IV.J.3.b of this document.

Under the preservation of gross margin percentage scenario, DOE applied a uniform "gross margin percentage" across all efficiency levels, 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. If MPCs increase with efficiency, this scenario implies that the per-unit dollar profit will increase. Consistent with the September 2023 NOPR and March 2024 NODA, DOE assumed a gross margin percentage of 31 percent for display doors, 33 percent for non-display doors, 24 percent for panels, and 26 percent for refrigeration systems.[111] Manufacturers tend to believe it is optimistic to assume that they would be able to maintain the same gross margin percentage if their production costs increase, particularly for minimally efficient equipment. Therefore, this scenario represents a high bound of industry profitability under 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.

[111] The gross margin percentages of 31 percent, 33 percent, 24 percent, and 26 percent are based on manufacturer markups of 1.45, 1.50, 1.32, and 1.35, respectively.

In the preservation of operating profit scenario, if 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 adjusting 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 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. Therefore, operating profit in percentage terms is typically reduced between the no-new-standard case and the standards cases.

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

Kolpak commented that increasing door and/or panel thickness would decrease manufacturing capacity, increase manufacturing costs, and increase its carbon footprint. (Kolpak, No. 66 at p. 2) RSG stated general agreement with DOE’s estimates of capital conversion costs at each TSL analyzed in the September 2023 NOPR for WICF doors, panels, and refrigeration systems. RSG commented that the highest impact for walk-in non-display doors and panels would be attributed to increased insulation thickness. RSG estimated one new charging station would be required at each manufacturing location at a cost of approximately $200,000. (RSG, No. 69 at pp. 2–3)

DOE agrees with commenters that increasing non-display door and/or panel thickness would increase production costs and could impact manufacturing capacity due to longer cure times. DOE accounts for these factors in its MPCs (*see* section IV.C of this document or chapter 5 of the final rule TSD) and conversion cost analysis (*see* section IV.J.2.c of this document or chapter 12 of the final rule TSD).

Hussmann commented that DOE's assumption regarding the September 2023 NOPR capital conversion costs between TSL 1 and TSL 2 will be similar is faulty in the case of unit coolers, because moving to five-row coils will require a much larger investment than just moving up to four coils, due to current manufacturer optimization around two- to four-row coils. (Hussmann, No. 75 at p. 12) AHRI similarly commented that DOE's assumption that for unit coolers, the capital conversion costs between TSL 1 and TSL 2 presented in the September 2023 NOPR will be similar because they can rely on similar tooling investments is incorrect, as moving to five-row coils will require a much larger capital investment than just moving up to four-row coils. AHRI stated that manufacturers have optimized around two- to four-row coils and requiring a switch to five rows represents a major change that has not been accounted for. (AHRI, No. 72 at p. 13)

In the September 2023 NOPR, DOE did not consider that adding additional rows to the unit cooler heat exchanger would require an increase in cabinet size when determining the MPCs and capital investments associated with each efficiency level. DOE based this assumption on manufacturers' unit cooler product catalogs, which included unit cooler case dimensions. In response to stakeholder comments to the September 2023 NOPR, DOE updated its analysis in the March 2024 NODA and assumed that the unit cooler case would have to be expanded to accommodate an additional row at the max-tech efficiency level for every unit cooler representative unit and presented updated unit cooler cost efficiency curves in the March 2024 NODA support document.[112] In response to comments to the March 2024 NODA regarding underestimating incremental costs associated with additional rows, DOE reexamined its cost modeling for unit coolers for this final rule. Based on further review of product literature and its modeling of representative units, DOE updated several inputs to the unit cooler cost modeling, which may be better aligned with industry's cost estimates. The updated costs are presented in appendix 5A of the final rule TSD and details of the revised cost methodology are discussed in chapter 5 of the final rule TSD. For this final rule, DOE also revised its capital conversion cost estimates for unit coolers to reflect the additional tooling and equipment costs associated with incorporating additional rows to unit cooler heat exchangers. DOE further revised its capital conversion cost estimates for unit coolers to account for the estimated row frequency distribution of models on the market. *See* section V.B.2.a of this document and chapter 12 of the final rule TSD for unit cooler conversion cost estimates.

[112] "Detailed Data for Engineering Analysis and National Impact Analysis for the Notice Of Data Availability Pertaining to Walk-in Coolers And Walk-In Freezers." Available at *www.regulations.gov/document/EERE-2017-BT-STD-0009-0079*.

AHRI and Lennox stated that it was difficult to provide feedback on the September 2023 NOPR refrigeration system conversion cost estimates at each TSL due to discrepancies in the design options assumed at baseline and the costs associated with higher efficiency levels. AHRI and Lennox generally disagreed with the component costs presented in the September 2023 NOPR as they stated that costs needed to reflect state-of-the-art design and true capital costs to realize the advancements. AHRI and Lennox commented that the costs at efficiency levels that necessitate larger heat exchangers should include the capital costs, which would be a significant cost factor. AHRI and Lennox cited as an example moving from four-row to five-row coils, or increasing face area, which would require sweeping changes due to capital costs beyond what is indicated in appendix 5A.5 of the September 2023 NOPR TSD. (AHRI, No. 72 at p. 13; Lennox, No. 70 at pp. 8–9)

In response to the March 2024 NODA, AHRI reiterated that because unit coolers are optimized around four-row coils, increasing efficiency by adding tube rows would be much more costly than estimated by DOE, considering major tooling and other factors. AHRI and Lennox stated that DOE underestimated cost increases for MPCs and MSPs associated with requirements for walk-ins to use A2L refrigerants, considering tooling, materials, and development costs. (AHRI, No. 86 at pp. 6–7; Lennox, No. 87 at p. 5)

Regarding the underlying assumptions of the WICF refrigeration system engineering analysis, *see* section IV.C of this document or chapter 5 of the final rule TSD for details on the analyzed design options and efficiency levels. Regarding the capital investments associated with increasing the size of the heat exchanger, DOE accounts for the incremental increase in 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 production costs derived in the engineering analysis already include estimates of capital investments in the form of depreciation costs. *See* section IV.C.2.g of this document for further discussion on how DOE estimates depreciation costs and chapter 5 of the final rule TSD for additional details on the cost model and estimation of MPCs. *See* chapter 12 of the final rule TSD for the breakdown of production costs (*i.e.*, material, labor, depreciation, overhead) used in the MIA.

b. Manufacturer Markup Scenarios

In terms of baseline assumptions, AHRI commented it is unclear whether DOE preserved margin percentage in its financial calculations, and, if not, AHRI commented the correct approach should be to preserve margin percentage and not just margin dollars. (AHRI, No. 72 at pp. 5–6)

For the September 2023 NOPR, DOE analyzed two manufacturer markup scenarios in its MIA: (1) the preservation of gross margin percentage and (2) the preservation of operating profit. DOE assumed a fixed gross margin percentage in its LCC and PBP analyses for the September 2023 NOPR. In other words, the LCC and PBP results reflect the conservative assumption that manufacturers would preserve gross margin percentage (not just per-unit dollars), which aligns with AHRI's suggestion. DOE maintained that approach for this final rule analysis.

c. Manufacturing Capacity Constraints

RSG stated its agreement that meeting higher efficiency levels than what was proposed in the September 2023 NOPR for walk-in non-display doors and panels would impact its capacity and capability to deliver product by the 2027 compliance date analyzed in the September 2023 NOPR. As an example, RSG commented that each additional inch of foamed non-display door or panel can double production time according to internal manufacturing studies. (RSG, No. 69 at p. 3)

DOE agrees with commenters that increasing non-display door and/or panel thickness would impact manufacturing capacity due to longer cure times. As with standards proposed in the September 2023 NOPR, the design options analyzed for the efficiency levels adopted in this final rule do not include increased insulation thickness for non-display doors or panels.

AHRI stated agreement with DOE's analysis that the limited number of suppliers of vacuum-insulated glass, along with the associated substantial cost increase for the conversion, would sharply limit the availability of walk-in display doors and non-display doors within the compliance timeframe proposed in the September 2023 NOPR. (AHRI, No. 72 at p. 13)

Aligned with the standards proposed in the September 2023 NOPR, DOE notes that it is not adopting more-stringent efficiency levels for display doors in this final rule. *See* section V.B.2.c of this document for a discussion on manufacturing capacity and section V.C.1 for a discussion of the analyzed TSLs and their associated benefits and burdens.

DuPont commented that its specialty XPS production lines have historically been capacity constrained. DuPont commented that should panel efficiency standards be increased, WICF-specific XPS capacity with increased insulation thickness would be reduced. DuPont stated that more stringent efficiency levels for WICFs would result in increases in insulation procurement to sustain demand. DuPont included a table to demonstrate this, showing volume increases of 14 percent (to meet EL 1) to 71 percent (to meet max-tech) for coolers and 25 percent (to meet EL 1) to 50 percent (to meet max-tech) for freezers, based on thicker insulation requirements. DuPont commented that if XPS production volume remained consistent and there were no alternative insulation product to XPS, given key specialty XPS technical performance properties in this WICF application, then increased WICF efficiency standards could result in a proportionate decrease in WICF panel and non-display door area production capacity, due to XPS supply constraints. DuPont supported the panel and non-display door efficiency levels proposed in the September 2023 NOPR, noting that requiring increased insulation thickness would potentially create a WICF supply shortage. (DuPont, No. 74 at pp. 1–2)

In this final rule, DOE is adopting TSL 1 for non-display doors and no-new-standards for panels, which DOE believes manufacturers can meet without increasing insulation thickness of non-display doors and panels. As such, DOE does not expect there would be capacity constraints related to sourcing XPS for walk-ins as a direct result of this rulemaking.

Regarding constraints for walk-in systems, RSG noted that component availability, especially regarding A2L special components (*e.g.*, compressors, sensors, *etc*.), seem to be tracking for general availability by 2026. RSG commented that 2027 is likely the earliest viable compliance date to harmonize industry, design, test, and regulation. (RSG, No. 69 at p. 3)

AHRI and Lennox commented that there would likely be significant manufacturing constraints and engineering resource constraints if DOE requires manufacturers to comply with energy efficiency standards for walk-in refrigeration systems by 2027 (the compliance year analyzed in the September 2023 NOPR). Specifically, AHRI and Lennox stated that some manufacturers have limited internal laboratory capacity and are obligated to use third-party laboratories, which are currently at maximum capacity. AHRI and Lennox further stated that until the transition to low-GWP refrigerants is complete, tests cannot be suspended and rooms modified to support the May 2023 TP Final Rule—a process that could delay WICF production by 8 to 12 months. In addition to the engineering and testing time, AHRI and Lennox noted that manufacturing and related component fabrication and reconfiguration of production lines would require a significant amount of effort while manufacturers are preoccupied with ramping up testing and production of low-GWP walk-in refrigeration systems. AHRI and Lennox also commented that current supply chain challenges and long lead times from component suppliers could delay the building of prototypes and subsequent laboratory testing. AHRI and Lennox emphasized that the standards proposed in the September 2023 NOPR calling for an efficiency increase of up to 15 percent might require a complete redesign of the product. (AHRI, No. 72 at p. 14; Lennox, No. 70 at p. 9)

Hussmann commented that it agrees with the views presented by AHRI. (Hussmann, No. 75 at pp. 12–13)

AHRI commented that the standards proposed in the September 2023 NOPR makes it difficult to have a complete equipment offering, particularly for low-temperature condensing units and, to some extent, unit coolers. AHRI commented it expects major application gaps even with extensive unit redesign and utilization of all major, identified energy-saving measures. (AHRI, No. 72 at p. 20)

DOE recognizes that testing and redesigning walk-in refrigeration systems to comply with EPA's refrigerant regulations and DOE's amended energy conservation standards requires engineering time, laboratory resources, and capital investment. DOE analyzed the potential impacts of the December 2022 EPA Technology Transitions NOPR in its September 2023 NOPR. Based on the December 2022 EPA Technology Transitions NOPR, DOE modeled the walk-in refrigeration system industry transitioning to low-GWP refrigerants prior to EPA's proposed January 1, 2025 compliance date. However, EPA has since finalized refrigerant restrictions affecting walk-in refrigeration systems with a January 1, 2026 compliance date (*i.e.*, the October 2023 EPA Technology Transitions Final Rule). As such, walk-in refrigeration system manufacturers will have an additional year to comply with the October 2023 EPA Technology Transitions Final Rule compared to the timeline detailed in the December 2022 EPA Technology Transitions NOPR. Furthermore, in this final rule, DOE is adopting a compliance date of December 31, 2028 (modeled as 2029, the first full year of compliance) for refrigeration systems to help alleviate potential laboratory and engineering resource constraints related to the dual development associated with EPA and DOE regulations. *See* section III.A.2 of this document for additional discussion on the DOE compliance date.

d. Cumulative Regulatory Burden

RSG cited innovation and design cycle as the primary challenges posed by cumulative regulatory burden. RSG commented that DOE proposals can place manufacturers in a cycle of chasing the regulation, with less focused time and freedom to innovate for better overall solutions. (RSG, No. 69 at p. 3) Lennox commented that manufacturers face a significant cumulative regulatory burden resulting from multiple DOE standards and equipment-specific regulatory actions taken by other Federal agencies, which will negatively affect WICF manufacturers by causing OEMs to invest more time, money, and resources in testing and manufacturing products to comply with the DOE standards. Lennox recommended that DOE consider the impact of related State regulations, safety codes, and various standards changes when proposing new or amended standards for walk-ins. (Lennox, No. 70 at pp. 10–11)

NRAC commented that refrigerant regulation (*e.g.*, October 2023 EPA Technology Transitions Final Rule) and changes to safety standards (*i.e.*, UL 60335-2-89) contribute to cumulative regulatory burden and will require significant engineering resources and laboratory testing. (NRAC, No. 73 at p. 3)

AHRI and Hussmann commented that there is significant cumulative regulatory burden associated with DOE energy conservation standards, EPA regulations (*i.e.*, transition to low-GWP refrigerants, PFAS/PFOA regulations), and changes to safety standards, as well as various State regulations. AHRI and Hussmann commented that these changes require engineering resources, validation testing, verification costs, establishment of new supply chains, and independent laboratory testing. AHRI and Hussmann noted that DOE's proposed changes to medium electric motors[113] and small, non-small electric motors standards (also referred to as "expanded scope electric motors")[114] also contribute to cumulative regulatory burden. AHRI and Hussmann commented that these motor regulations may require equipment changes to account for larger motors, additional testing, safety agency approval, backward compatibility for the replacement market, and a cost increase to go along with the higher efficiency motors. (AHRI, No. 72 at p. 16; Hussmann, No. 75 at p. 14)

AHRI commented that its members are weighing a range of decisions and design changes due to regulations requiring low-GWP refrigerants. AHRI commented that manufacturers do not consider the October 2023 EPA Technology Transitions Final Rule and DOE energy conservation standards rulemakings as independent of each other; AHRI commented that taken together, the EPA and DOE regulatory actions impose an unreasonable burden and are at high risk of resulting in requirements that are nearly impossible to meet in the required timeframes. AHRI commented that manufacturers are experiencing heavy backlog and extensive time to market because certification organizations and laboratories have limited resources. AHRI requested that DOE account

[113] In a direct final rule published on June 1, 2023 ("June 2023 Electric Motors Direct Final Rule"), DOE prescribed the energy conservation standards for electric motors manufactured on and after June 1, 2027. 88 FR 36066.

[114] In a proposed rule published on December 15, 2023 ("December 2023 ESEM NOPR"), DOE proposed energy conservation standards for expanded scope electric motors manufactured on and after January 1, 2029. 88 FR 87062.

for the fact that all commercial refrigeration equipment must meet UL-60335-2-89, which will replace current safety standards in 2024 and which will require more resources, time, and laboratory facilities. (AHRI, No. 72 at pp. 2–3 and No. 86 at p. 3)

Regarding cumulative regulatory burden, 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 analyzes and considers the impact on manufacturers of multiple product/equipment-specific Federal regulatory actions. DOE notes that regulations not yet finalized 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 lists 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.

Regarding EPA refrigerant regulations, as discussed in prior sections, DOE recognizes that redesigning walk-in refrigeration system designs to comply with the October 2023 EPA Technology Transitions Final Rule and DOE's amended energy conservation standards requires significant engineering resources and capital investment. DOE accounts for these impacts in its cumulative regulatory burden analysis. DOE analyzed the potential impacts of the December 2022 EPA Technology Transitions NOPR in its September 2023 NOPR. Based on the December 2022 EPA Technology Transitions NOPR, DOE modeled the WICF refrigeration system industry transitioning to low-GWP refrigerants prior to EPA's proposed January 1, 2025 compliance date.

However, EPA has since finalized refrigerant restrictions affecting walk-ins (*i.e.*, the October 2023 EPA Technology Transitions Final Rule). EPA finalized a January 1, 2026 compliance date for the refrigeration categories that apply to walk-in refrigeration systems (*i.e*., remote condensing units and cold storage warehouse systems).

DOE accounts for industry refrigerant transition expenses in its GRIM in the no-new-standards case and standards cases. Although refrigerant transition costs are independent of DOE adopting new and amended standards, DOE incorporates these expenses into its GRIM to better reflect the state of industry finances and annual cashflow. For the September 2023 NOPR, DOE relied on a range of sources, including feedback gathered during confidential manufacturer interviews, in response to the June 2022 Preliminary Analysis. In response to written comments to the September 2023 NOPR, DOE revised its refrigerant transition R&D estimates. *See* section V.B.2.e of this document for additional discussion of how DOE accounts for cumulative regulatory burden in its analysis.

Regarding State refrigerant regulations, those transition costs would be reflected in the refrigerant transition costs estimated in this final rule. DOE notes that since most State refrigerant regulations generally align with the October 2023 EPA Technology Transitions Final Rule GWP restrictions for walk-ins, DOE does not expect that individual State refrigerant regulations would significantly contribute to refrigerant transition costs beyond what was assessed for the October 2023 EPA Technology Transitions Final Rule. DOE notes that two States have established lower GWP limits for certain walk-in refrigeration systems as compared to the October 2023 EPA

Technology Transition Final Rule. Specifically, California and Washington prohibited refrigerants with a GWP of 150 or greater for new retail food refrigeration equipment and cold storage warehouses containing more than 50 lbs of refrigerant, which includes certain WICF refrigeration systems, as of January 1, 2022 in California[115] and as of January 1, 2025 in the State of Washington.[116] DOE developed cost adders for certain representative units, consistent with the March 2024 NODA, for this final rule. *See* subsection "Refrigerants Analyzed" of section IV.C.1.e of this document for additional information about WICF refrigeration systems designed to use refrigerants with a GWP of 150 or less. *See* section IV.F.2.a of this document for DOE's sensitivity analysis of sub-150 GWP refrigerants on consumers.

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 and its refrigerant transition R&D expenses 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.

Regarding potential PFAS/PFOA 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. Furthermore, DOE notes that the October 2023 EPA

---

[115] 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).
[116] 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).

Technology Transitions Final Rule finalized restrictions for WICF refrigeration systems using a GWP limit approach, which inherently permits the use of any substitutes consistent with the restrictions. DOE also 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.[117]

Regarding the June 2023 Electric Motors Direct Final Rule, DOE did not observe motors that would fall under the scope of the June 2023 Electric Motors Direct Final Rule in its testing and teardowns of WICF refrigeration systems conducted in support of this rulemaking. While it is possible that larger capacity dedicated condensing units or unit coolers incorporate a motor subject to the June 2023 Electric Motors Direct Final Rule, DOE does not have sufficient evidence to conclude that these in-scope motors are significantly used for WICF applications. Regarding the December 2023 ESEM NOPR, DOE acknowledges that some walk-in refrigeration systems may currently incorporate motors subject to standards proposed in the December 2023 ESEM NOPR. However, the compliance date analyzed in this final rule precedes the proposed ESEM standard compliance date (January 1, 2029) and, based on the design option pathway analyzed in the WICF engineering analysis, WICF refrigeration systems would likely require a motor that is outside the scope of the December 2023 ESEM NOPR (*e.g.*, an electronically commutated motor) to meet the efficiency levels adopted in this final rule. Furthermore, as DOE did not identify any walk-in manufacturers that also manufacture ESEMs, DOE

[117] U.S. Environmental Protection Agency, "Per- and Polyfluoroalkyl Substances (PFAS)." Available at: *www.epa.gov/pfas* (last accessed May 31, 2024).

did not include the December 2023 ESEM NOPR in its cumulative regulatory burden analysis.

e. Refrigerant Transition Costs

RSG noted that its analysis shows a significant increase in cost across most areas of operation and production to accommodate low-GWP refrigerants, including (but not limited to) production capital, system/end-product cost, laboratory testing, agency certification, engineering resources, and manufacturing operations and safety. RSG commented that DOE has assured that care will be taken to consider the financial impact on manufacturers and customers alike with such proposed regulation amendments. (RSG, No. 69 at p. 3) NRAC commented that the transition to low-GWP refrigerants, as required by EPA, would increase engineering efforts and laboratory testing by 40 to 50 percent. NRAC commented that certification costs will increase and additional components will be required for refrigerant mitigation; however, those costs are still uncertain and cannot currently be quantified. (NRAC, No. 73 at p. 3)

AHRI and Lennox commented that DOE's estimate of $14.5 million in R&D and $15.0 million in capital expenditures related to the transition to low-GWP refrigerants presented in the September 2023 NOPR seems reasonable if industry has facility modifications already complete and development in final stages as of the end of 2023, assuming transitions across the industry are primarily to A2L and A3 refrigerants. However, AHRI and Lennox commented that if these measures are not in place by the end of 2023, development expenses and laboratory capital expenses could be much higher since third-party testing expenses have likely increased by 30 to 40 percent since the manufacturer interviews were conducted. AHRI and Lennox asserted that if the transition is more heavily weighted to CO_2, then the overall cost could be approximately doubled for lab facilities, 50 percent more for manufacturing, and 50 percent more for laboratory testing. AHRI and Lennox provided a cost breakdown of R&D (engineering efforts 40 percent; lab testing hours 30 percent; third-party testing 20 percent; certification costs 10 percent) and capital investment (tooling 45 percent; new charging equipment 10 percent; lab upgrades 35 percent; personnel training 5 percent; leak detection systems 5 percent) for the refrigerant transition. (AHRI, No. 72 at pp. 14–15; Lennox, No. 70 at p. 10)

In response to the September 2023 NOPR, AHRI and Hussmann provided cost categories associated with transitioning walk-in refrigeration systems and production facilities to accommodate low-GWP refrigerants. This list included: (a) contracting with safety agencies to understand requirements; (b) testing, product changes, certification, and creation of new files for A2L using a new safety standard (*i.e.*, UL 60335-2-89); (c) acquiring necessary equipment associated with new safety-standard testing; (d) laboratory upgrades, such as new sensors, ventilation equipment, storage facilities, facilities to accommodate higher pressures, calorimeters, and load skids to work with A2L and CO_2 refrigerants; (f) new equipment such as vacuum pumps, reclaim equipment, and leak detectors as well as technician training to safely use flammable refrigerants; (g) building and insuring or contracting special buildings for required safety tests; (h) development, testing, and contracting with safety agencies to find, test, qualify, and certify items for a mitigation control system to sense for leaks, control safety aspects, and to implement mitigation actions; and (i) engineering efforts, including sizing and selecting all new components, updating all drawings and BOMs, creating all new items such as warning labels and installation instructions, and providing training to customers and technicians. (AHRI, No. 72 at pp. 15–16, Hussmann, No. 75 at p. 13–14)

In response to AHRI, Lennox, and Hussmann, DOE notes that it appreciates the level of detail provided regarding the costs and categories of expenses associated with transitioning to low-GWP refrigerants. In the September 2023 NOPR, DOE assumed that the transition to low-GWP refrigerants would require industry to invest approximately $14.5 million in R&D and $15.0 million in capital expenditures (*e.g.*, investments in new charging equipment, leak detection systems, *etc.*,) between 2023 (the September 2023 NOPR reference year) and 2025 (the proposed EPA compliance date for WICF refrigeration systems covered by this rulemaking). In response to stakeholder comments, DOE revised its R&D estimates to account for higher third-party laboratory testing costs. 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 walk-in refrigeration systems in the October 2023 EPA Technology Transitions Final Rule. As such, for this final rule, DOE models that the transition to low-GWP refrigerants would require industry to invest approximately $15.7 million in R&D and $12.4 million in capital expenditures from 2024 (the final rule reference year) and 2026 (the EPA compliance date for WICF refrigeration systems covered by this rulemaking). As with the September 2023 NOPR, DOE notes that its refrigerant transition estimates of $15.7 million in R&D and $12.4 million in capital expenditures reflect an estimate of *future* investments industry would incur to comply with Federal or State refrigerant regulations. Therefore, estimated investments made in 2023 or earlier are not reflected in the GRIM.

DOE acknowledges that manufacturers have already invested a significant amount of time and capital into transitioning walk-in refrigeration systems to low-GWP refrigerants.

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 greenhouse gases, 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 notice 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.[118]

[118] Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed July 12, 2021).

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 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 and the Inflation Reduction Act.[119]

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

[119] 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 May 1, 2024).

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.[120] The *AEO* incorporates implementation of CSAPR, including the update to the 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.[121] 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

[120] 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. 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).

[121] 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.

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 allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such case, 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 NO_X 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 products shipped in 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 September 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 interim 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, 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 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" that was presented as Supplementary Material to the RIA.[122] The 2023 SC-GHG estimates incorporate recent research addressing recommendations of the National Academies of Science, Engineering, and Medicine (National Academies), responses to public comments on an earlier sensitivity analysis using draft SC-GHG estimates included in EPA's December 2022 proposal in the oil and natural gas sector standards of performance rulemaking, and comments from a 2023 external peer review of the accompanying technical report.[123]

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

[122] *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)
[123] *www.epa.gov/environmental-economics/scghg*

facilitate sound decision-making" consistent with OMB Circular A-4 and applicable law.[124]

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.[125] 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 a July NODA for consumer gas-fired instantaneous water heaters, 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. 89 FR 59693, 59700. In DOE's final action in the consumer gas-fired instantaneous water heaters rulemaking, DOE will address any comments and make a final determination on whether to apply the updated 2023 SC-GHG estimates in that rulemaking. In this final rule, DOE is presenting estimates using both the updated 2023

---

[124] *https://www.whitehouse.gov/wp-content/uploads/2023/12/IWG-Memo-12.22.23.pdf* (last accessed July 3, 2024)

[125] Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide | The National Academies Press. (available at: *https://nap.nationalacademies.org/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of*) (last accessed July 3, 2024)

SC-GHG values and the interim 2021 interim SC-GHG estimates. While DOE did not present results using the updated 2023 SC-GHG values in the proposal, DOE believes that providing this information here, in addition to results calculated using the 2021 interim SC-GHG values, 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.

As DOE explained in the July NODA, it was the agency's preliminary assessment that the 2023 SC-GHG estimates represent a significant improvement because the 2023 SC-GHG estimates implement the key recommendations of the National Academies, and they incorporate the extensive scientific findings and methodological advances that have occurred since the last IWG substantive updates to the methodology in 2013, and the methodologically consistent updates to add estimates for methane and nitrous oxide in 2016.

The 2023 SC-GHG estimates have also been peer-reviewed. As indicated by their statements, the peer reviewers strongly supported the new methodology, calling it "a huge advance," "a real step change" and "an important improvement" in estimating the SC-GHG, and noting that it addressed the National Academies' and others' recommendations and "generally represents well the emerging consensus in the literature."

DOE also preliminarily determined that the most significant improvements in the 2023 SC-GHG estimates are consistent with the recommendations made by the National Academies. In its report, the National Academies' principal recommendation was to develop and use "a new framework that would strengthen the scientific basis, provide greater transparency, and improve characterization of the uncertainties of the estimates."[126] The IWG's estimates since 2010 have relied on averaging the values produced by three integrated assessment models, each of which generates a set of SC-GHG estimates based on the inputs and assumptions built into that particular model.[127] The National Academies recommended an entirely new approach that would "unbundle" this process and instead use a framework in which each step of the SC-GHG calculation is developed as one of four separate but integrated "modules": the socioeconomic module, the climate module, the damages module, and the discounting module. The report provided detailed recommendations on developing and using these modules, including how to address discounting, socioeconomic projections, climate modeling, and uncertainty.

In the July 2024 NODA, DOE preliminarily concluded that the 2023 SC-GHG estimates are consistent with the National Academies' (2017) recommendations and represent major scientific advancements over the IWG's approach. In addition, DOE supported the incorporation of more recent scientific findings and data throughout the

[126] Report Recommends New Framework for Estimating the Social Cost of Carbon | National Academies (available at: *https://www.nationalacademies.org/news/2017/01/report-recommends-new-framework-for-estimating-the-social-cost-of-carbon*) (last accessed July 3, 2023)
[127] *See https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf*, 6. (last accessed July 3, 2023)

development of each of the 2023 SC-GHG modules and the underlying components of those modules.

Thus, in accordance with the IWG memo, and having reviewed the 2023 SC-GHG methodologies and updates, DOE preliminarily determined that the updated 2023 SC-GHG estimates reflect the best available scientific and analytical evidence and methodologies, are accordingly the most appropriate for analytical use, and best facilitate sound decision-making by substantially improving the transparency of the estimates and representations of uncertainty inherent in such estimates. For this final rule, DOE used these updated 2023 SC-GHG values to monetize the climate benefits of the emissions reductions associated at each TSL for walk-in coolers and freezers. In future rulemakings, DOE will continue to evaluate the scientific literature and use our professional judgment to apply the SC-GHG estimates that are most appropriate to use at that time.

The September 2023 NOPR for walk-in coolers and freezers was developed and published prior to EPA's December 2023 final rule and accordingly used the 2021 interim SC-GHG estimates published by the IWG, rather than the updated 2023 SC-GHG estimates. As noted above, DOE preliminarily found in the July NODA that using the 2023 SC-GHG estimates provides a better-informed range of potential climate benefits associated with amended standards. However, for consistency with September 2023 NOPR, DOE also provides the SC-GHG associated with this rule based on the interim 2021interim SC-GHG estimates, in addition to the 2023 SC-GHG estimates, for the purposes of the summary results presented in sections I.C and V.B and V.C of this final rule.

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 interim 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 calculated using the older 2021 interim SC-GHG estimates, which were used in the September 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.

DOE's derivations of the SC-CO_2, SC-N_2O, and SC-CH_4 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 IV.K 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.57 in 5-year increments from 2020 to 2050.[128] The 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 products 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.57. Annual SC-CO_2 Values Based on 2023 SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton CO_2) [126]

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

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

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.58 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,[129] 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.

Table IV.58. Annual SC-CO_2 Values Based on 2021 Interim SC-GHG 2020–2050 (2020$ per Metric Ton CO_2) [127]

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 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-CO_2 value for that year for both sets of SC-CO_2 estimates. 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

[129] *See* EPA, *Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis*, Washington, D.C., December 2021. Available at *nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf* (last accessed Feb. 21, 2023).

values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SC-CO_2 values in each case.

b. Social Cost of Methane and Nitrous Oxide

The SC-CH_4 and SC-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.59 shows the updated sets of SC-CH_4 and SC-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.59. Annual SC-CH_4 and SC-N_2O Values Based on 2023 SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton)[126]

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	1,300	1,600	2,300	35,200	54,100	87,300
2025	1,600	2,000	2,700	40,000	60,300	95,200
2030	1,900	2,400	3,200	44,700	66,400	103,100
2035	2,300	2,800	3,700	49,600	72,600	111,100
2040	2,700	3,300	4,200	54,500	78,900	119,000
2045	3,100	3,800	4,700	60,100	85,900	127,900
2050	3,500	4,200	5,300	65,600	93,000	136,800

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.60 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.60 Annual SC-CH_4 and SC-N_2O Based on 2021 Interim SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton)[127]

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 both sets of SC-GHG. 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 the EPA's Benefits Mapping and Analysis Program.[130] 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).

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

[130] U.S. Environmental Protection Agency. "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-directly-emitted-pm25-pm25-precursors-and-ozone-precursors*.

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 chapters 13 and 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. 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 products 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 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.[131] 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.[132] There are many reasons for these differences, including wage differences and the fact that the utility sector is 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, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

---

[131] *See U.S. Bureau of Labor Statistics. Industry Output and Employment. Available at https://www.bls.gov/emp/data/industry-out-and-emp.htm (last accessed August 19, 2024).*

[132] *See* U.S. Department of Commerce–Bureau of Economic Analysis. Regional Input-Output Modeling System (RIMS II) User's Guide. Available at: *bea.gov/resources/methodologies/RIMSII-user-guide* (last accessed August 19, 2024).

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").[133] 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 it notes the 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 rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2033 for walk-in envelope components, and 2034 for walk-in refrigeration systems), 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 walk-ins. It addresses the TSLs

[133] Livingston, O. V., *et al*. 2015. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide*. Pacific Northwest National Laboratory. PNNL-24563.

examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for walk-ins, 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 products and 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 three TSLs for walk-ins. DOE developed TSLs that combine efficiency levels for each analyzed equipment class. These TSLs are discussed in section IV.E.1 of this document.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on walk-in consumers by looking at the effects that potential 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 products 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.*, product 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 product lifetime and a discount rate. Chapter 8 of the final rule TSD provides detailed information on the LCC and PBP analyses.

Table V.1 through Table V.48 show the LCC and PBP results for the TSLs considered for each equipment class. In the first of the pair of tables, the simple payback is measured relative to the baseline product. 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 products 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 a product 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. To aid the reader the LCC and PBP results for the amended standards have been *italicized*.

Display Doors

Table V.1 Average LCC and PBP Results for Medium-Temperature Display Doors (DW.M)

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	2,278	91	744	3,022	n/a	12.0
	1	2,278	90	735	3,013	n/a	12.0
	2	*2,278*	*89*	*725*	*3,003*	*n/a*	*12.0*
	3	2,278	80	651	2,929	n/a	12.0
1	Baseline	2,278	91	744	3,022	n/a	12.0
	1	2,278	90	735	3,013	n/a	12.0
	2	2,278	89	725	3,003	n/a	12.0
	3	2,278	80	651	2,929	n/a	12.0
2	Baseline	2,278	91	744	3,022	n/a	12.0
	1	2,278	90	735	3,013	n/a	12.0
	2	2,278	89	725	3,003	n/a	12.0
	3	2,278	80	651	2,929	n/a	12.0
3	Baseline	3,639	84	685	4,323	187.8	12.0
	1	3,639	83	677	4,316	191.4	12.0
	2	3,639	82	669	4,307	196.0	12.0
	3	3,639	74	604	4,243	236.9	12.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.2 Average LCC Savings Relative to the No-New-Standards Case for Medium-Temperature Display Doors (DW.M)

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	n/a	n/a
	1	n/a	n/a

	2	n/a	n/a
	3	n/a	n/a
2	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a
3	Baseline	100	-1,301
	1	100	-1,303
	2	100	-1,304
	3	100	-1,314

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.3 Average LCC and PBP Results for Low-Temperature Display Doors (DW.L)

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	2,461	314	2,581	5,042	n/a	12.1
	1	2,461	310	2,544	5,004	n/a	12.1
	2	*2,461*	*310*	*2,544*	*5,004*	*n/a*	*12.1*
	3	2,461	288	2,367	4,828	n/a	12.1
1	Baseline	2,461	314	2,581	5,042	n/a	12.1
	1	2,461	310	2,544	5,004	n/a	12.1
	2	2,461	310	2,544	5,004	n/a	12.1
	3	2,461	288	2,367	4,828	n/a	12.1
2	Baseline	2,461	314	2,581	5,042	n/a	12.1
	1	2,461	310	2,544	5,004	n/a	12.1
	2	2,461	310	2,544	5,004	n/a	12.1
	3	2,461	288	2,367	4,828	n/a	12.1
3	Baseline	3,819	277	2,278	6,098	36.8	12.1
	1	3,819	273	2,247	6,066	37.5	12.1
	2	3,819	273	2,247	6,066	37.5	12.1
	3	3,819	255	2,097	5,917	41.3	12.1

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.4 Average LCC Savings Relative to the No-New-Standards Case for Low-Temperature Display Doors (DW.L)

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a

2	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a
3	Baseline	100	-1,056
	1	100	-1,062
	2	100	-1,062
	3	100	-1,089

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Non-display Doors

Table V.5 Average LCC and PBP Results for Medium-Temperature Manual Non-Display Doors (NM.M)

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	2,638	105	627	3,266	n/a	8.0
	1	2,638	104	622	3,260	n/a	8.0
	2	2,638	103	615	3,253	n/a	8.0
	3	2,638	95	564	3,203	n/a	8.0
1	Baseline	2,719	63	378	3,098	1.9	8.0
	1	2,719	62	374	3,093	2.0	8.0
	2	*2,719*	*62*	*368*	*3,088*	*2.0*	*8.0*
	3	2,719	55	328	3,048	2.0	8.0
2	Baseline	2,796	44	261	3,057	2.6	8.0
	1	2,796	43	258	3,054	2.6	8.0
	2	2,796	42	255	3,050	2.6	8.0
	3	2,796	38	227	3,023	2.8	8.0
3	Baseline	3,078	40	238	3,316	6.7	8.0
	1	3,078	39	236	3,314	6.8	8.0
	2	3,078	39	232	3,311	6.9	8.0
	3	3,078	35	209	3,287	7.4	8.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.6 Average LCC Savings Relative to the No-New-Standards Case for Medium-Temperature Manual Non-Display Doors (NM.M)

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	6	275
	1	6	273

	2	*6*	*270*
	3	7	254
2	Baseline	10	324
	1	10	320
	2	11	315
	3	12	280
3	Baseline	54	9
	1	55	4
	2	55	-1
	3	60	-41

* The savings represent the average LCC for affected DOE adjusted the values to 2023$ using the implicit price deflator for GDP from the Bureau of Economic Analysis consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.7 Average LCC and PBP Results for Low-Temperature Manual Non-Display Doors (NM.L)

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	2,524	394	2,353	4,878	n/a	8.0
	1	2,524	389	2,327	4,852	n/a	8.0
	2	2,524	389	2,327	4,852	n/a	8.0
	3	2,524	369	2,205	4,729	n/a	8.0
1	Baseline	2,621	293	1,754	4,375	1.0	8.0
	1	2,621	290	1,733	4,353	1.0	8.0
	2	*2,621*	*290*	*1,732*	*4,353*	*1.0*	*8.0*
	3	2,621	273	1,631	4,252	1.0	8.0
2	Baseline	2,727	195	1,169	3,896	1.0	8.0
	1	2,727	193	1,154	3,882	1.0	8.0
	2	2,727	193	1,154	3,882	1.0	8.0
	3	2,727	181	1,084	3,811	1.1	8.0
3	Baseline	2,992	177	1,062	4,054	2.2	8.0
	1	2,992	175	1,049	4,041	2.2	8.0
	2	2,992	175	1,049	4,041	2.2	8.0
	3	2,992	165	989	3,980	2.3	8.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.8 Average LCC Savings Relative to the No-New-Standards Case for Low-Temperature Manual Non-Display Doors (NM.L)

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	2	690
	1	2	683
	2	*2*	*683*
	3	2	654

2	Baseline	2	1,198
	1	2	1,185
	2	2	1,185
	3	2	1,121
3	Baseline	7	1,035
	1	7	1,019
	2	7	1,019
	3	8	945

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.9 Average LCC and PBP Results for Medium-Temperature Motorized Non-Display Doors (NO.M)

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	6,904	199	1,189	8,092	n/a	8.0
	1	6,904	198	1,178	8,082	n/a	8.0
	2	6,904	195	1,165	8,069	n/a	8.0
	3	6,904	180	1,073	7,977	n/a	8.0
1	Baseline	7,032	112	670	7,702	1.5	8.0
	1	7,032	111	662	7,694	1.5	8.0
	2	*7,032*	*109*	*652*	*7,684*	*1.5*	*8.0*
	3	7,032	97	581	7,613	1.6	8.0
2	Baseline	7,147	76	456	7,603	2.0	8.0
	1	7,147	75	451	7,598	2.0	8.0
	2	7,147	74	445	7,592	2.0	8.0
	3	7,147	67	398	7,545	2.1	8.0
3	Baseline	7,490	67	400	7,890	4.4	8.0
	1	7,490	66	396	7,886	4.5	8.0
	2	7,490	65	390	7,881	4.5	8.0
	3	7,490	59	353	7,844	4.9	8.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.10 Average LCC Savings Relative to the No-New-Standards Case for Medium-Temperature Motorized Non-Display Doors (NO.M)

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	3	403
	1	3	400
	2	*3*	*397*
	3	3	375
2	Baseline	6	501
	1	6	496
	2	6	489
	3	7	443
3	Baseline	31	214
	1	32	208
	2	33	200
	3	37	144

* The savings represent the average LCC for affected consumers. The entry “n/a” means not applicable because there is no change in the standard at certain TSLs.

Table V.11 Average LCC and PBP Results for Low-Temperature Motorized Non-Display Doors (NO.L)

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	6,931	620	3,676	10,608	n/a	7.9
	1	6,931	613	3,635	10,567	n/a	7.9
	2	6,931	613	3,635	10,566	n/a	7.9
	3	6,931	580	3,440	10,371	n/a	7.9
1	Baseline	7,064	442	2,622	9,686	0.7	7.9
	1	7,064	436	2,589	9,653	0.8	7.9
	2	*7,064*	*436*	*2,589*	*9,653*	*0.8*	*7.9*
	3	7,064	410	2,431	9,495	0.8	7.9
2	Baseline	7,193	306	1,815	9,008	0.8	7.9
	1	7,193	302	1,791	8,984	0.8	7.9
	2	7,193	302	1,791	8,984	0.8	7.9
	3	7,193	283	1,679	8,872	0.9	7.9
3	Baseline	7,476	268	1,594	9,070	1.6	7.9
	1	7,476	265	1,575	9,050	1.6	7.9
	2	7,476	265	1,575	9,050	1.6	7.9
	3	7,476	249	1,482	8,958	1.7	7.9

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.12 Average LCC Savings Relative to the No-New-Standards Case for Low-Temperature Motorized Non-Display Doors (NO.L)

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	1	922
	1	1	914
	2	*1*	*914*
	3	1	876

2	Baseline	1	1,600
	1	1	1,583
	2	1	1,583
	3	1	1,500
3	Baseline	4	1,538
	1	4	1,516
	2	4	1,516
	3	5	1,413

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Panels

Table V.13 Average LCC and PBP Results for Medium-Temperature Structural Panels (PS.M) per ft^2

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	13.98	0.26	2.13	16.11	n/a	12.0
	1	13.98	0.26	2.09	16.07	n/a	12.0
	2	*13.98*	*0.25*	*2.04*	*16.03*	*n/a*	*12.0*
	3	13.98	0.21	1.69	15.67	n/a	12.0
1	Baseline	13.98	0.26	2.13	16.11	n/a	12.0
	1	13.98	0.26	2.09	16.07	n/a	12.0
	2	13.98	0.25	2.04	16.03	n/a	12.0
	3	13.98	0.21	1.69	15.67	n/a	12.0
2	Baseline	13.98	0.26	2.13	16.11	n/a	12.0
	1	13.98	0.26	2.09	16.07	n/a	12.0
	2	13.98	0.25	2.04	16.03	n/a	12.0
	3	13.98	0.21	1.69	15.67	n/a	12.0
3	Baseline	16.35	0.19	1.58	17.93	34.9	12.0
	1	16.35	0.19	1.55	17.90	35.6	12.0
	2	16.35	0.18	1.51	17.86	36.4	12.0
	3	16.35	0.15	1.25	17.60	44.0	12.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.14 Average LCC Savings Relative to the No-New-Standards Case for Medium-Temperature Structural Panels (PS.M) per ft^2

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	n/a	n/a
	1	n/a	n/a

	2	n/a	n/a
	3	n/a	n/a
2	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a
3	Baseline	100	-2.33
	1	100	-2.35
	2	100	-2.37
	3	100	-2.49

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table . Average LCC and PBP Results for Low-Temperature Structural Panels (PS.L) per ft²

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	14.40	0.92	7.57	21.97	n/a	12.0
	1	14.40	0.91	7.43	21.82	n/a	12.0
	2	*14.40*	*0.91*	*7.43*	*21.82*	*n/a*	*12.0*
	3	14.40	0.82	6.74	21.14	n/a	12.0
1	Baseline	14.40	0.92	7.57	21.97	n/a	12.0
	1	14.40	0.91	7.43	21.82	n/a	12.0
	2	14.40	0.91	7.43	21.82	n/a	12.0
	3	14.40	0.82	6.74	21.14	n/a	12.0
2	Baseline	14.40	0.92	7.57	21.97	n/a	12.0
	1	14.40	0.91	7.43	21.82	n/a	12.0
	2	14.40	0.91	7.43	21.82	n/a	12.0
	3	14.40	0.82	6.74	21.14	n/a	12.0
3	Baseline	16.27	0.72	5.91	22.17	9.2	12.0
	1	16.27	0.71	5.79	22.06	9.4	12.0
	2	16.27	0.71	5.79	22.06	9.4	12.0
	3	16.27	0.64	5.26	21.53	10.3	12.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table . Average LCC Savings Relative to the No-New-Standards Case for Low-Temperature Structural Panels (PS.L) per ft²

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings - Impacted Consumers (2023$)
1	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a

2	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a
3	Baseline	68	-0.20
	1	70	-0.24
	2	70	-0.24
	3	79	-0.45

* The savings represent the average LCC for affected consumers. The entry “n/a” means not applicable because there is no change in the standard at certain TSLs.

Table V.15 Average LCC and PBP Results for Low-Temperature Floor Panels (PF.L) per ft^2

TSL	Connected Refrigeration System TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
		Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	Baseline	14.30	0.69	5.69	19.99	n/a	12.0
	1	14.30	0.68	5.58	19.88	n/a	12.0
	2	*14.30*	*0.68*	*5.58*	*19.88*	*n/a*	*12.0*
	3	14.30	0.62	5.07	19.37	n/a	12.0
1	Baseline	14.30	0.69	5.69	19.99	n/a	12.0
	1	14.30	0.68	5.58	19.88	n/a	12.0
	2	14.30	0.68	5.58	19.88	n/a	12.0
	3	14.30	0.62	5.07	19.37	n/a	12.0
2	Baseline	14.30	0.69	5.69	19.99	n/a	12.0
	1	14.30	0.68	5.58	19.88	n/a	12.0
	2	14.30	0.68	5.58	19.88	n/a	12.0
	3	14.30	0.62	5.07	19.37	n/a	12.0
3	Baseline	16.17	0.51	4.18	20.36	10.2	12.0
	1	16.17	0.50	4.10	20.28	10.4	12.0
	2	16.17	0.50	4.10	20.28	10.4	12.0
	3	16.17	0.45	3.73	19.90	11.4	12.0

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.16 Average LCC Savings Relative to the No-New-Standards Case for Low-Temperature Floor Panels (PF.L) per ft^2

TSL	Connected Refrigeration System TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a

	3	n/a	n/a
2	Baseline	n/a	n/a
	1	n/a	n/a
	2	n/a	n/a
	3	n/a	n/a
3	Baseline	82	-0.49
	1	83	-0.52
	2	83	-0.52
	3	88	-0.70

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Dedicated Condensing Units

Table V.17 Average LCC and PBP Results for Dedicated Condensing Units, Low Temperature, Indoor (DC.L.I)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	7,283	2,990	18,377	25,660	n/a	8.5
1	7,404	2,928	18,009	25,414	2.0	8.5
2	*7,404*	*2,928*	*18,009*	*25,414*	*2.0*	*8.5*
3	10,545	2,800	17,356	27,901	20.3	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.18 Average LCC Savings Relative to the No-New-Standards Case for Dedicated Condensing Units, Low Temperature, Indoor (DC.L.I)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	3	381
2	*3*	*381*
3	99	-2,241

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.19 Average LCC and PBP Results for Dedicated Condensing Units, Low Temperature, Outdoor (DC.L.O)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1^{st} Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	25,081	4,566	28,313	53,395	n/a	8.4
1	25,391	4,495	27,892	53,282	4.4	8.4
2	*25,391*	*4,495*	*27,892*	*53,282*	*4.4*	*8.4*
3	36,330	3,991	25,317	61,647	24.2	8.4

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.20 Average LCC Savings Relative to the No-New-Standards Case for Dedicated Condensing Units, Low Temperature, Outdoor (DC.L.O)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	36	112
2	*36*	*112*
3	93	-8,252

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.21 Average LCC and PBP Results for Dedicated Condensing Units, Medium Temperature, Indoor (DC.M.I)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	4,066	1,395	8,544	12,609	n/a	8.5
1	4,225	1,345	8,242	12,468	3.2	8.5
2	*4,287*	*1,330*	*8,152*	*12,439*	*3.5*	*8.5*
3	5,673	1,240	7,662	13,335	11.4	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.22 Average LCC Savings Relative to the No-New-Standards Case for Dedicated Condensing Units, Medium Temperature, Indoor (DC.M.I)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	5	548
2	*6*	*660*
3	87	-726

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.23 Average LCC and PBP Results for Dedicated Condensing Units, Medium Temperature, Outdoor (DC.M.O)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	6,097	1,995	12,364	18,460	n/a	8.5
1	6,101	1,979	12,270	18,371	0.3	8.5
2	*6,196*	*1,929*	*11,966*	*18,162*	*1.5*	*8.5*
3	8,928	1,549	9,752	18,681	6.7	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.24 Average LCC Savings Relative to the No-New-Standards Case for Dedicated Condensing Units, Medium Temperature, Outdoor (DC.M.O)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	0	90
2	*3*	*298*
3	76	-220

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Single-Packaged Dedicated Systems

Table V.25 Average LCC and PBP Results for Single-packaged Dedicated Systems, High Temperature, Ducted, Indoor (SP.H.I.D)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	2,935	514	2,945	5,880	n/a	8.5
1	2,994	436	2,518	5,512	0.8	8.5
2	*2,994*	*436*	*2,518*	*5,512*	*0.8*	*8.5*
3	2,994	436	2,518	5,512	0.8	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.26 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, High Temperature, Ducted, Indoor (SP.H.I.D)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	0	368
2	*0*	*368*
3	0	368

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.27 Average LCC and PBP Results for Single-packaged Dedicated Systems, High Temperature, Ducted, Outdoor (SP.H.O.D)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	3,896	694	3,985	7,881	n/a	8.4
1	4,273	560	3,252	7,525	2.9	8.4
2	*4,320*	*558*	*3,245*	*7,565*	*3.2*	*8.4*
3	4,320	558	3,245	7,565	3.2	8.4

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.28 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, High Temperature, Ducted, Outdoor (SP.H.O.D)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	13	356
2	*24*	*316*
3	24	316

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.29 Average LCC and PBP Results for Single-packaged Dedicated Systems, High Temperature, Indoor (SP.H.I)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	2,836	300	1,768	4,604	n/a	8.5
1	2,850	271	1,607	4,457	0.5	8.5
2	*2,860*	*266*	*1,582*	*4,442*	*0.7*	*8.5*
3	2,860	266	1,582	4,442	0.7	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.30 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, High Temperature, Indoor (SP.H.I)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	1	147
2	*1*	*161*
3	1	161

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.31 Average LCC and PBP Results for Single-packaged Dedicated Systems, High Temperature, Outdoor (SP.H.O)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	3,887	421	2,465	6,352	n/a	8.4
1	4,022	376	2,222	6,244	3.1	8.4
2	*4,022*	*376*	*2,222*	*6,244*	*3.1*	*8.4*
3	4,249	370	2,195	6,444	7.5	8.4

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.32 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, High Temperature, Outdoor (SP.H.O)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	17	108
2	*17*	*108*
3	79	-92

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.33 Average LCC and PBP Results for Single-packaged Dedicated Systems, Low Temperature, Indoor (SP.L.I)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	3,850	861	4,991	8,841	n/a	8.5
1	4,000	783	4,556	8,556	2.0	8.5
2	*4,000*	*783*	*4,556*	*8,556*	*2.0*	*8.5*
3	5,324	755	4,455	9,779	16.1	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.34 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, Low Temperature, Indoor (SP.L.I)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	6	285
2	*6*	*285*
3	100	-937

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.35 Average LCC and PBP Results for Single-packaged Dedicated Systems, Low Temperature, Outdoor (SP.L.O)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	4,969	1,138	6,591	11,560	n/a	8.5
1	4,970	1,124	6,513	11,483	0.1	8.5
2	*4,972*	*1,120*	*6,487*	*11,458*	*0.2*	*8.5*
3	6,376	1,083	6,333	12,709	33.3	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.36 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, Low Temperature, Outdoor (SP.L.O)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	0	102
2	*0*	*101*
3	100	-1,150

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.37 Average LCC and PBP Results for Single-packaged Dedicated Systems, Medium Temperature, Indoor (SP.M.I)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	4,152	839	4,876	9,027	n/a	8.5
1	4,272	793	4,623	8,895	2.7	8.5
2	*4,272*	*793*	*4,623*	*8,895*	*2.7*	*8.5*
3	5,431	784	4,612	10,043	29.2	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.38 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, Medium Temperature, Indoor (SP.M.I)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	13	132
2	*13*	*132*
3	100	-1,016

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.39 Average LCC and PBP Results for Single-packaged Dedicated Systems, Medium Temperature, Outdoor (SP.M.O)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	4,884	785	4,590	9,475	n/a	8.5
1	5,020	748	4,387	9,406	3.8	8.5
2	*5,020*	*748*	*4,387*	*9,406*	*3.8*	*8.5*
3	6,279	744	4,407	10,686	47.4	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.40 Average LCC Savings Relative to the No-New-Standards Case for Single-packaged Dedicated Systems, Medium Temperature, Outdoor (SP.M.O)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	18	68
2	*18*	*68*
3	100	-1,212

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Unit Coolers

Table V.41Average LCC and PBP Results for Unit Coolers, High Temperature (UC.H)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	3,195	569	3,362	6,556	n/a	8.5
1	3,195	569	3,362	6,556	n/a	8.5
2	*3,195*	*569*	*3,362*	*6,556*	*n/a*	*8.5*
3	3,342	563	3,334	6,676	33.8	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.42 Average LCC Savings Relative to the No-New-Standards Case for Unit Coolers, High Temperature (UC.H)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	n/a	n/a
2	*n/a*	*n/a*
3	95	-120

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.43 Average LCC and PBP Results Unit Coolers, High Temperature, Ducted (UC.H.D)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	3,273	810	4,759	8,032	n/a	8.5
1	3,326	763	4,492	7,818	1.2	8.5
2	*3,326*	*763*	*4,492*	*7,818*	*1.2*	*8.5*
3	3,326	763	4,492	7,818	1.2	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.44 Average LCC Savings Relative to the No-New-Standards Case for Unit Coolers, High Temperature, Ducted (UC.H.D)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	2	214
2	*2*	*214*
3	2	214

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.45 Average LCC and PBP Results for Unit Coolers, Low Temperature (UC.L)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	3,445	5,287	31,707	35,152	n/a	8.5
1	3,671	5,076	30,455	34,126	1.1	8.5
2	*3,771*	*5,011*	*30,077*	*33,848*	*1.2*	*8.5*
3	3,771	5,011	30,077	33,848	1.2	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.46 Average LCC Savings Relative to the No-New-Standards Case for Unit Coolers, Low Temperature (UC.L)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	5	1,026
2	*8*	*1,304*
3	8	1,304

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.47 Average LCC and PBP Results Unit Coolers, Medium Temperature (UC.M)

TSL	Average Costs (2023$)				Simple Payback Period (*years*)	Average Lifetime (*years*)
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Life-Cycle Cost		
0	2,767	2,009	12,131	14,898	n/a	8.5
1	2,915	1,974	11,926	14,841	4.4	8.5
2	*2,976*	*1,963*	*11,863*	*14,840*	*4.7*	*8.5*
3	3,065	1,955	11,819	14,884	5.8	8.5

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.48 Average LCC Savings Relative to the No-New-Standards Case for Unit Coolers, Medium Temperature (UC.M)

TSL	% Consumers with Net Cost	Average Savings – Impacted Consumers (2023$)
1	38	65
2	*43*	*66*
3	52	15

* The savings represent the average LCC for affected consumers. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on high warm air-infiltration applications, and small businesses. Table V.51 through Table V.53 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the reduced consumer sample for all equipment classes and representative units. In most cases, the average LCC savings and PBP for small business and applications with high amount of warm-air infiltration at the considered trial standard levels are not substantially different from the average for all consumers. In those cases where the results differ, the selected subgroups tend to have greater benefits due to in the case of the small business subgroup: higher electricity costs; and in the case of the warm-air infiltration subgroup: increased hours of operation.

Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroups.

Table V.49 Comparison of LCC Savings and PBP for Consumer Subgroups for Walk-in Doors

Equipment Class	Reference			Small Businesses		
	TSL 1	**TSL 2**	**TSL 3**	**TSL 1**	**TSL 2**	**TSL 3**
Consumer Average LCC Savings – Impacted Consumers (2023$)						
Used in Conjunction with a Baseline Refrigeration System						
DW.L	n/a	n/a	-1,056	n/a	n/a	-994
DW.M	n/a	n/a	-1,301	n/a	n/a	-1,292
NM.L	690	1,198	1,035	834	1,462	1,322
NM.M	275	324	9	337	411	101
NO.L	922	1,600	1,538	1,104	1,934	1,919

NO.M	403	501	214	486	619	342
Used in Conjunction with a TSL 1 Refrigeration System						
DW.L	n/a	n/a	-1,062	n/a	n/a	-1,008
DW.M	n/a	n/a	-1,303	n/a	n/a	-1,294
NM.L	683	1,185	1,019	819	1,430	1,285
NM.M	273	320	4	334	406	95
NO.L	914	1,583	1,516	1,086	1,893	1,867
NO.M	400	496	208	482	612	333
Used in Conjunction with a TSL 2 Refrigeration System						
DW.L	n/a	n/a	-1,062	n/a	n/a	-1,008
DW.M	n/a	n/a	-1,304	n/a	n/a	-1,295
NM.L	683	1,185	1,019	819	1,430	1,285
NM.M	270	315	-1	332	402	90
NO.L	914	1,583	1,516	1,086	1,893	1,867
NO.M	397	489	200	480	607	327
Used in Conjunction with a TSL 3 Refrigeration System						
DW.L	n/a	n/a	-1,089	n/a	n/a	-1,039
DW.M	n/a	n/a	-1,314	n/a	n/a	-1,306
NM.L	654	1,121	945	785	1,355	1,199
NM.M	254	280	-41	313	362	45
NO.L	876	1,500	1,413	1,042	1,796	1,748
NO.M	375	443	144	455	553	263
% Consumers with Net Cost						
Used in Conjunction with a Baseline Refrigeration System						
DW.L	n/a	n/a	100	n/a	n/a	100
DW.M	n/a	n/a	100	n/a	n/a	100
NM.L	2	2	7	0	1	4
NM.M	6	10	54	3	7	39
NO.L	1	1	4	0	0	2
NO.M	3	6	31	2	4	19
Used in Conjunction with a TSL 1 Refrigeration System						
DW.L	n/a	n/a	100	n/a	n/a	100
DW.M	n/a	n/a	100	n/a	n/a	100
NM.L	2	2	7	0	1	4
NM.M	6	10	55	4	7	39
NO.L	1	1	4	0	0	2
NO.M	3	6	32	2	4	20
Used in Conjunction with a TSL 2 Refrigeration System						
DW.L	n/a	n/a	100	n/a	n/a	100

DW.M	n/a	n/a	100	n/a	n/a	100
NM.L	2	2	7	0	1	4
NM.M	6	11	55	4	7	39
NO.L	1	1	4	0	0	2
NO.M	3	6	33	2	4	20
Used in Conjunction with a TSL 3 Refrigeration System						
DW.L	n/a	n/a	100	n/a	n/a	100
DW.M	n/a	n/a	100	n/a	n/a	100
NM.L	2	2	8	0	1	4
NM.M	7	12	60	4	7	45
NO.L	1	1	5	0	0	3
NO.M	3	7	37	2	4	24
Simple Payback Period (years)						
Used in Conjunction with a Baseline Refrigeration System						
DW.L	n/a	n/a	36.8	n/a	n/a	28.3
DW.M	n/a	n/a	187.8	n/a	n/a	150.9
NM.L	1.0	1.0	2.2	0.8	0.8	1.7
NM.M	1.9	2.6	6.7	1.6	2.1	5.5
NO.L	0.7	0.8	1.6	0.6	0.7	1.2
NO.M	1.5	2.0	4.4	1.2	1.6	3.6
Used in Conjunction with a TSL 1 Refrigeration System						
DW.L	n/a	n/a	37.5	n/a	n/a	29.4
DW.M	n/a	n/a	191.4	n/a	n/a	154.1
NM.L	1.0	1.0	2.2	0.8	0.8	1.8
NM.M	2.0	2.6	6.8	1.6	2.1	5.6
NO.L	0.8	0.8	1.6	0.6	0.7	1.3
NO.M	1.5	2.0	4.5	1.2	1.6	3.6
Used in Conjunction with a TSL 2 Refrigeration System						
DW.L	n/a	n/a	37.5	n/a	n/a	29.4
DW.M	n/a	n/a	196.0	n/a	n/a	156.7
NM.L	1.0	1.0	2.2	0.8	0.8	1.8
NM.M	2.0	2.6	6.9	1.6	2.1	5.6
NO.L	0.8	0.8	1.6	0.6	0.7	1.3
NO.M	1.5	2.0	4.5	1.2	1.6	3.7
Used in Conjunction with a TSL 3 Refrigeration System						
DW.L	n/a	n/a	41.3	n/a	n/a	32.3
DW.M	n/a	n/a	236.9	n/a	n/a	188.4
NM.L	1.0	1.1	2.3	0.8	0.9	1.8
NM.M	2.0	2.8	7.4	1.7	2.3	6.0

NO.L	0.8	0.9	1.7	0.6	0.7	1.3
NO.M	1.6	2.1	4.9	1.3	1.7	3.9

Table V.50 Comparison of LCC Savings and PBP for Consumer Subgroups for Walk-in Panels

Equipment Class	Reference			Small Businesses		
	TSL 1	**TSL 2**	**TSL 3**	**TSL 1**	**TSL 2**	**TSL 3**
Consumer Average LCC Savings – Impacted Consumers (2023$)						
Used in Conjunction with a Baseline Refrigeration System						
PF.L	n/a	n/a	-0.49	n/a	n/a	-0.12
PS.L	n/a	n/a	-0.20	n/a	n/a	-0.06
PS.M	n/a	n/a	-2.33	n/a	n/a	-2.59
Used in Conjunction with a TSL 1 Refrigeration System						
PF.L	n/a	n/a	-0.52	n/a	n/a	-0.21
PS.L	n/a	n/a	-0.24	n/a	n/a	-0.14
PS.M	n/a	n/a	-2.35	n/a	n/a	-2.60
Used in Conjunction with a TSL 2 Refrigeration System						
PF.L	n/a	n/a	-0.52	n/a	n/a	-0.21
PS.L	n/a	n/a	-0.24	n/a	n/a	-0.03
PS.M	n/a	n/a	-2.37	n/a	n/a	-2.62
Used in Conjunction with a TSL 3 Refrigeration System						
PF.L	n/a	n/a	-0.70	n/a	n/a	-0.41
PS.L	n/a	n/a	-0.45	n/a	n/a	-0.32
PS.M	n/a	n/a	-2.49	n/a	n/a	-2.75
% Consumers with Net Cost						
Used in Conjunction with a Baseline Refrigeration System						
PF.L	n/a	n/a	82	n/a	n/a	63
PS.L	n/a	n/a	68	n/a	n/a	41
PS.M	n/a	n/a	100	n/a	n/a	100
Used in Conjunction with TSL 1 Refrigeration System						
PF.L	n/a	n/a	83	n/a	n/a	69
PS.L	n/a	n/a	70	n/a	n/a	48
PS.M	n/a	n/a	100	n/a	n/a	100
Used in Conjunction with a TSL 2 Refrigeration System						
PF.L	n/a	n/a	83	n/a	n/a	69
PS.L	n/a	n/a	70	n/a	n/a	48
PS.M	n/a	n/a	100	n/a	n/a	100
Used in Conjunction with a TSL 3 Refrigeration System						

PF.L	n/a	n/a	88	n/a	n/a	81
PS.L	n/a	n/a	79	n/a	n/a	63
PS.M	n/a	n/a	100	n/a	n/a	100
Simple Payback Period (years)						
Used in Conjunction with a Baseline Refrigeration System						
PF.L	n/a	n/a	10.2	n/a	n/a	7.9
PS.L	n/a	n/a	9.2	n/a	n/a	7.2
PS.M	n/a	n/a	34.9	n/a	n/a	30.4
Used in Conjunction with a TSL 1 Refrigeration System						
PF.L	n/a	n/a	10.4	n/a	n/a	8.2
PS.L	n/a	n/a	9.4	n/a	n/a	7.5
PS.M	n/a	n/a	35.6	n/a	n/a	31.0
Used in Conjunction with a TSL 2 Refrigeration System						
PF.L	n/a	n/a	10.4	n/a	n/a	8.2
PS.L	n/a	n/a	9.4	n/a	n/a	7.5
PS.M	n/a	n/a	36.4	n/a	n/a	31.5
Used in Conjunction with a TSL 3 Refrigeration System						
PF.L	n/a	n/a	11.4	n/a	n/a	9.0
PS.L	n/a	n/a	10.3	n/a	n/a	8.2
PS.M	n/a	n/a	44.0	n/a	n/a	37.9

Table V.51 Comparison of LCC Savings and PBP for Consumer Subgroups for Walk-in Refrigeration Systems

Equipment Class	Reference			Small Businesses			Warm Air		
	TSL 1	**TSL 2**	**TSL 3**	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 1**	**TSL 2**	**TSL 3**
Consumer Average LCC Savings – Impacted Consumers (2023$)									
DC.L.I	381	381	-2,241	393	393	-1,181	462	462	-2,114
DC.L.O	112	112	-8,252	163	163	-916	131	131	-7,942
DC.M.I	548	660	-726	516	516	-772	853	1,057	-491
DC.M.O	90	298	-220	88	198	-288	57	343	403
SP.H.I	147	161	161	147	161	161	188	208	208
SP.H.I.D	368	368	368	368	368	368	475	475	475
SP.H.O	108	108	-92	108	108	-92	123	123	-68
SP.H.O.D	356	316	316	356	316	316	496	458	458
SP.L.I	285	285	-937	285	285	-937	323	323	-880
SP.L.O	102	101	-1,150	102	101	-1,150	81	80	-1,148
SP.M.I	132	132	-1,016	132	132	-1,016	198	198	-937

SP.M.O	68	68	-1,212	68	68	-1,212	73	73	-1,201
UC.H	n/a	n/a	-120	n/a	n/a	-117	n/a	n/a	-113
UC.H.D	214	214	214	235	235	235	272	272	272
UC.L	1,026	1,304	1,304	1,505	1,934	1,934	1,140	1,451	1,451
UC.M	65	66	15	158	182	108	108	123	74
% Consumers with Net Cost									
DC.L.I	3	3	99	1	1	98	2	2	99
DC.L.O	36	36	93	36	36	89	36	36	91
DC.M.I	5	6	87	3	3	89	3	4	83
DC.M.O	0	3	76	0	1	76	0	2	64
SP.H.I	1	1	1	1	1	1	1	1	1
SP.H.I.D	0	0	0	0	0	0	0	0	0
SP.H.O	17	17	79	17	17	79	15	15	71
SP.H.O.D	13	24	24	13	24	24	8	18	18
SP.L.I	6	6	100	6	6	100	5	5	100
SP.L.O	0	0	100	0	0	100	0	0	100
SP.M.I	13	13	100	13	13	100	8	8	100
SP.M.O	18	18	100	18	18	100	18	18	100
UC.H	n/a	n/a	95	n/a	n/a	94	n/a	n/a	88
UC.H.D	2	2	2	2	2	2	1	1	1
UC.L	5	8	8	1	2	2	5	7	7
UC.M	38	43	52	19	22	34	33	37	46
Simple Payback Period (years)									
DC.L.I	2.0	2.0	20.3	1.1	1.1	15.7	1.7	1.7	18.0
DC.L.O	4.4	4.4	24.2	3.9	3.9	8.4	4.2	4.2	21.8
DC.M.I	3.2	3.5	11.4	3.3	3.3	12.3	2.6	2.7	8.9
DC.M.O	0.3	1.5	6.7	0.2	0.9	6.9	0.4	1.4	5.4
SP.H.I	0.5	0.7	0.7	0.5	0.7	0.7	0.4	0.6	0.6
SP.H.I.D	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.6	0.6
SP.H.O	3.1	3.1	7.5	3.1	3.1	7.5	2.9	2.9	6.9
SP.H.O.D	2.9	3.2	3.2	2.9	3.2	3.2	2.4	2.7	2.7
SP.L.I	2.0	2.0	16.1	2.0	2.0	16.1	1.8	1.8	14.5
SP.L.O	0.1	0.2	33.3	0.1	0.2	33.3	0.1	0.2	33.1
SP.M.I	2.7	2.7	29.2	2.7	2.7	29.2	2.1	2.1	22.2
SP.M.O	3.8	3.8	47.4	3.8	3.8	47.4	3.7	3.7	44.5
UC.H	n/a	n/a	33.8	n/a	n/a	29.4	n/a	n/a	26.2
UC.H.D	1.2	1.2	1.2	1.0	1.0	1.0	0.9	0.9	0.9
UC.L	1.1	1.2	1.2	0.8	0.8	0.8	1.0	1.1	1.1
UC.M	4.4	4.7	5.8	2.8	3.2	4.2	3.7	4.0	4.9

c. Rebuttable-Presumption Payback

As discussed in section IV.F of this document, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product 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 procedure for walk-in coolers and freezers. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V.52 through Table V.54 presents the rebuttable-presumption payback periods for the considered TSLs for walk-in coolers and freezers. 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. 6295(o)(2)(B)(i), which 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.52 Rebuttable-Presumption Payback Periods for Walk-in Doors

Equipment Class	TSL		
	1	2	3
Used in Conjunction with a Baseline Refrigeration System			
DW.L	n/a	n/a	36.8
DW.M	n/a	n/a	187.8
NM.L	1.0	1.0	2.2
NM.M	1.9	2.6	6.7
NO.L	0.7	0.8	1.6
NO.M	1.5	2.0	4.4
Used in Conjunction with a TSL 1 Refrigeration System			
DW.L	n/a	n/a	37.5
DW.M	n/a	n/a	191.4
NM.L	1.0	1.0	2.2
NM.M	2.0	2.6	6.8
NO.L	0.8	0.8	1.6
NO.M	1.5	2.0	4.5
Used in Conjunction with a TSL 2 Refrigeration System			
DW.L	n/a	n/a	37.5
DW.M	n/a	n/a	196.0
NM.L	1.0	1.0	2.2
NM.M	2.0	2.6	6.9
NO.L	0.8	0.8	1.6
NO.M	1.5	2.0	4.5
Used in Conjunction with a TSL 3 Refrigeration System			
DW.L	n/a	n/a	41.3
DW.M	n/a	n/a	236.9
NM.L	1.0	1.1	2.3
NM.M	2.0	2.8	7.4
NO.L	0.8	0.9	1.7
NO.M	1.6	2.1	4.9

Table V.53 Rebuttable-Presumption Payback Periods for Walk-in Panels

Equipment Class	TSL		
	1	2	3
Used in Conjunction with a Baseline Refrigeration System			
PF.L	n/a	n/a	10.2

PS.L	n/a	n/a	9.2
PS.M	n/a	n/a	34.9
Used in Conjunction with a TSL 1 Refrigeration System			
PF.L	n/a	n/a	10.4
PS.L	n/a	n/a	9.4
PS.M	n/a	n/a	35.6
Used in Conjunction with a TSL 2 Refrigeration System			
PF.L	n/a	n/a	10.4
PS.L	n/a	n/a	9.4
PS.M	n/a	n/a	36.4
Used in Conjunction with a TSL 3 Refrigeration System			
PF.L	n/a	n/a	11.4
PS.L	n/a	n/a	10.3
PS.M	n/a	n/a	44.0

Table V.54 Rebuttable-Presumption Payback Periods for Refrigeration Systems

Equipment Class	**TSL**		
	1	**2**	**3**
Dedicated Condensing Units			
DC.L.I	158.5	158.5	38.3
DC.L.O	7.5	7.5	54.3
DC.M.I	318.6	160.8	38.3
DC.M.O	0.2	5.4	35.3
Single-packaged Dedicated Systems			
SP.H.I	2.9	2.5	2.5
SP.H.I.D	1.6	1.6	1.6
SP.H.O	3.5	3.5	8.8
SP.H.OD	2.9	3.3	3.3
SP.L.I	4.9	4.9	24.9
SP.L.O	0.1	0.1	15.1
SP.M.I	5.7	5.7	28.7
SP.M.O	4.2	4.2	22.3
Unit Coolers			
UC.H	n/a	n/a	37.2
UC.H.I.D	1.2	1.2	1.2
UC.L	1.0	1.1	1.1
UC.M	5.2	5.7	6.8

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of walk-ins. 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. The following tables summarize the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of walk-ins, as well as the conversion costs that DOE estimates manufacturers of walk-ins would incur at each TSL.

The impacts of potential amended energy conservation standards were analyzed under two scenarios: (1) the preservation of gross margin percentage, and (2) the preservation of operating profit, as discussed in section IV.J.2.d of this document. The preservation of gross margin percentages applies a "gross margin percentage" of 31 percent for display doors, 33 percent for non-display doors, 24 percent for panels, and 26 percent for refrigeration systems, across all efficiency levels.[134] This scenario assumes that a manufacturer's per-unit dollar profit would increase as MPCs increase in the

[134] The gross margin percentages of 31 percent, 33 percent, 24 percent, and 26 percent are based on manufacturer markups of 1.45, 1.50, 1.32, and 1.35, respectively.

standards cases and often represents the upper bound to industry profitability under potential 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 typically results in the lower (or more severe) bound to impacts of potential amended standards on industry.

Each of the modeled scenarios results 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. For walk-in display doors, non-display doors, and panels, the analysis period is 2024–2057 (30 years after the modeled 2028 compliance year). For refrigeration systems, the analysis period is 2024–2058 (30 years after the modeled 2029 compliance year). 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 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 product designs into compliance with potential 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 standard. The conversion costs can have a significant impact on the short-term cash flow of the industry and generally result in lower free cash flow in the period between the publication of the final rule and the compliance date of potential amended standards. Conversion costs are independent of the manufacturer markup scenarios and are not presented as a range in this analysis.

Table V.55, Table V.56, Table V.57, and Table V.58 show the MIA results for each TSL for walk-in display door, non-display door, panel, and refrigeration system industries, respectively.

<u>Doors</u>

Display Doors

Table V.55 Manufacturer Impact Analysis Results for Walk-In Display Doors

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3
INPV	*2023$ Million*	218.7	218.7	218.7	148.5 to 287.7
Change in INPV*	*%*	-	-	-	(32.1) to 31.5
Free Cash Flow* (2027)	*2023$ Million*	17.0	17.0	17.0	3.7
Change in Free Cash Flow* (2027)	*%*	-	-	-	(78.4)
Product Conversion Costs	*2023$ Million*	-	-	-	32.2
Capital Conversion Costs	*2023$ Million*	-	-	-	5.2
Total Conversion Costs	*2023$ Million*	-	-	-	37.4

* Parentheses (-) negative values.

At TSL 1 and TSL 2, the standard for all walk-in display door equipment classes (DW.L, DW.M) are set to the baseline efficiency level (*i.e.*, EL 0). As a result, there are no changes to INPV, no changes in industry free cash flow, and no conversion costs.

At TSL 3, the standard represents the max-tech energy efficiency for all equipment classes. The change in INPV is expected to range from -32.1 percent to 31.5 percent. At this level, free cash flow is estimated to decrease by 78.4 percent compared to the no-new-standards case value of $17.0 million in the year 2027, the year before the standards year. DOE estimates that no display door shipments currently meet the max-tech efficiency levels.

DOE expects manufacturers of display doors would likely need to incorporate vacuum-insulated glass as a substitute for the prescriptive minimum design of double-pane or triple-pane insulated glass packs for medium-temperature doors (DW.M) and low-temperature doors (DW.L), respectively. For the 10 OEMs that manufacture walk-in display doors, implementing vacuum-insulated glass would require significant engineering resources and testing time to ensure adequate durability of their doors in all commercial settings. In interviews, manufacturers emphasized that there are currently a very limited number of suppliers of vacuum-insulated glass. Door manufacturers expressed concerns that the 3-year conversion period between the publication of the final rule and the compliance date of the amended energy conservation standard might be insufficient to design and test a full portfolio of vacuum-insulated doors that meet the max-tech efficiencies and maintain their internal metrics over the door lifetime. Of the 10 OEMs that manufacture walk-in display doors, five are small, domestic businesses. DOE estimates capital conversion costs of $5.2 million and product conversion costs of $32.2 million. Conversion costs total $37.4 million.

At TSL 3, the shipment-weighted average MPC for all display doors is expected to increase by 80.7 percent relative to the no-new-standards case shipment-weighted average MPC for all display doors in 2028. In the preservation of gross margin percentage scenario, the increase in cashflow from the higher MSP outweighs the $37.4 million in conversion costs, causing a significant positive change 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 2028, the analyzed compliance year. This reduction in the manufacturer markup and the $37.4 million in conversion costs incurred by manufacturers cause a significant negative change in INPV at TSL 3 under the preservation of operating profit scenario. *See* section IV.J.2.d of this document or chapter 12 of the final rule TSD for additional details about the manufacturer markup scenarios.

Non-Display Doors

Table V.56 Manufacturer Impact Analysis Results for Walk-In Non-Display Doors

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3
INPV	*2023$ Million*	508.4	506.4 to 511.9	475.6 to 495.3	415.8 to 475.3
Change in INPV*	*%*	-	(0.4) to 0.7	(6.5) to (2.6)	(18.2) to (6.5)
Free Cash Flow* (2027)	*2023$ Million*	40.3	39.8	24.8	(2.9)
Change in Free Cash Flow* (2027)	*%*		(1.2)	(38.4)	(107.2)
Product Conversion Costs	*2023$ Million*	-	1.4	5.8	23.8
Capital Conversion Costs	*2023$ Million*	-	0.0	30.0	77.9
Total Conversion Costs	*2023$ Million*	-	1.4	35.7	101.7

* Parentheses indicate (-) negative values.

At TSL 1, the standard represents EL 1 for all non-display door equipment classes. The change in INPV is expected to range from -0.4 percent to 0.7 percent. At this level, free cash flow is estimated to decrease by 1.2 percent compared to the no-new-standards case value of $40.3 million in the year 2027, the year before the standards year.

DOE expects that all non-display door equipment classes (*i.e.*, NM.L, NM.M, NO.L, NO.M) would likely require anti-sweat heater controls. Currently, approximately 32.0 percent of non-display-door shipments meet the TSL 1 efficiencies. DOE does not expect manufacturers would incur significant capital investments at this TSL as new equipment or tooling is likely not required. Product conversion costs may be necessary to update and test new non-display-door designs. DOE estimates total conversion costs of $1.4 million, all of which are product conversion costs.

At TSL 1, the shipment-weighted average MPC for non-display doors is expected to increase by 1.5 percent relative to the no-new-standards case shipment-weighted average MPC for non-display doors in 2028. In the preservation of gross margin percentage scenario, the minor increase in cash flow from the higher MSP slightly outweighs the $1.4 million in conversion costs, causing a slightly positive change 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 2028, the analyzed compliance year. This reduction in the manufacturer markup and the $1.4 million in conversion costs incurred by manufacturers cause a slightly negative change in INPV at TSL 1 under the preservation of operating profit scenario.

At TSL 2, the standard represents EL 3 for all non-display door equipment classes. The change in INPV is expected to range from -6.5 percent to -2.6 percent. At this level, free cash flow is estimated to decrease by 38.4 percent compared to the no-new-standards case value of $40.3 million in the year 2027, the year before the standards year.

At TSL 2, DOE expects that all non-display doors (*i.e.*, NM.L, NM.M, NO.L, NO.M) would likely require anti-sweat heater controls, improved framing systems, and reduced anti-sweat heat. Currently, approximately 14.2 percent of non-display-door shipments meet TSL 2 efficiencies. Capital conversion costs may be necessary to purchase additional foaming equipment to incorporate thermally-improved frame designs for all non-display doors. Product conversion costs may be necessary to update and test new non-display-door designs. DOE estimates capital conversion costs of $30.0 million and product conversion costs of $5.8 million. Conversion costs total $35.7 million.

At TSL 2, the shipment-weighted average MPC for non-display doors is expected to increase by 5.1 percent relative to the no-new-standards case shipment-weighted average MPC for non-display doors in 2028. In the preservation of gross margin percentage scenario, the increase in cash flow from the higher MSP is slightly outweighed by the $35.7 million in conversion costs, causing a slightly negative change 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 $35.7 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 2 under the preservation of operating profit scenario.

At TSL 3, the standard represents the max-tech efficiency levels for all equipment classes. The change in INPV is expected to range from -18.2 percent to -6.5 percent. At this level, free cash flow is estimated to decrease by 107.2 percent compared to the no-new-standards case value of $40.3 million in the year 2027, the year before the standards year.

The design options DOE analyzed at TSL 3 for non-display doors included anti-sweat heater controls, improved framing systems, reduced anti-sweat heat, and insulation thickness of at least 6 inches. DOE estimates that approximately 11.1 percent of non-display door shipments currently meet the max-tech efficiency levels. For the 51 OEMs that manufacture walk-in non-display doors, increasing insulation thickness from the assumed baseline thickness of 3.5 inches for medium-temperature (*i.e.*, NM.M, NO.M) and 4 inches for low-temperature (*i.e.*, NM.L, NO.L) non-display doors to 6 inches would likely require purchasing new foaming equipment, since most manufacturers are only able to manufacture non-display doors up to 5 inches thick. Additionally, non-display-door manufacturers were concerned about the flow of foam and the curing time of foam at max-tech. New foaming equipment to accommodate 6-inch non-display doors would require significant capital investment and is a key driver of capital conversion costs. Of the 51 non-display-door OEMs identified, 44 are small, domestic businesses. DOE estimates capital conversion costs of $77.9 million and product conversion costs of $23.8 million. Conversion costs total $101.7 million.

At TSL 3, the large conversion costs result in a free cash flow dropping below zero in the years before the standards year. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

At TSL 3, the shipment-weighted average MPC for all non-display doors is expected to increase by 15.5 percent relative to the no-new-standards case shipment-weighted average MPC for non-display doors in 2028. In the preservation of gross margin percentage scenario, the increase in cash flow from the higher MSP is outweighed by the $101.7 million in conversion costs, causing a negative change 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 2028, the analyzed compliance year. This reduction in the manufacturer markup and the $101.7 million in conversion costs incurred by manufacturers cause a large negative change in INPV at TSL 3 under the preservation of operating profit scenario.

Panels

Table V.57 Manufacturer Impact Analysis Results for Walk-In Panels

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3
INPV	*2023$ Million*	926.0	926.0	926.0	670.4 to 780.5
Change in INPV*	*%*	-	-	-	(27.6) to (15.7)
Free Cash Flow* (2027)	*2023$ Million*	82.9	82.9	82.9	(49.3)
Change in Free Cash Flow* (2027)	*%*	-	-	-	(159.5)
Product Conversion Costs	*2023$ Million*	-	-	-	78.8
Capital Conversion Costs	*2023$ Million*	-	-	-	234.0
Total Conversion Costs	*2023$ Million*	-	-	-	312.7

*Parentheses indicate (-) negative values.

At TSL 1 and TSL 2, the standard for all walk-in panel equipment classes is set to the baseline efficiency level (*i.e.*, EL 0). As a result, there are no changes to INPV, no changes in industry free cash flow, and no conversion costs.

At TSL 3, the standard represents the max-tech energy efficiency for all equipment classes. The change in INPV is expected to range from -27.6 percent to -15.7 percent. At this level, free cash flow is estimated to decrease by 159.5 percent compared to the no-new-standards case value of $82.9 million in the year 2027, the year before the standards year. Currently, approximately 8.1 percent of domestic panel shipments meet the efficiencies required at TSL 3.

The design options DOE analyzed at max-tech include increasing insulation thickness to 6 inches across all equipment classes. At this level, DOE assumes all manufacturers will need to purchase new foaming equipment. Increasing the insulation thickness for all panel equipment classes to 6 inches would require significant capital investment. Like non-display doors, most manufacturers are currently able to manufacture panels up to 5 inches thick. A standard level necessitating 6-inch panels would likely require new, costly foaming equipment for all manufacturers. Additionally, DOE estimates that every additional inch of foam increases panel cure times by roughly 10 minutes, which means that manufacturers would likely need to purchase additional equipment to maintain existing throughput. Some OEMs may need to invest in additional manufacturing space to accommodate the extra foaming stations. Of the 43 walk-in panel OEMs, 38 OEMs are small, domestic businesses. In interviews, manufacturers expressed concern about industry's ability to source the necessary foaming equipment to maintain existing production capacity within the 3-year compliance period due to the long lead times and limited number of foam fixture suppliers. DOE estimates capital conversion costs of $234.0 million and product conversion costs of $78.8 million. Conversion costs total $312.7 million.

At TSL 3, the large conversion costs result in a free cash flow dropping below zero in the years before the standards year. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

At TSL 3, the shipment-weighted average MPC for all panels is expected to increase by 16.4 percent relative to the no-new-standards case shipment-weighted average MPC for all panels in 2028. In the preservation of gross margin percentage scenario, the increase in cash flow from the higher MSP is outweighed by the $312.7 million in conversion costs, causing a negative change 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 2028, the analyzed compliance year. This reduction in the manufacturer markup and the $312.7 million in conversion costs incurred by manufacturers cause a large negative change in INPV at TSL 3 under the preservation of operating profit scenario.

Refrigeration Systems

Table V.58 Manufacturer Impact Analysis Results for Walk-In Refrigeration Systems

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3
INPV	*2023$ Million*	542.0	492.3 to 502.5	480.8 to 496.2	360.8 to 570.8
Change in INPV*	*%*	-	(9.2) to (7.3)	(11.3) to (8.4)	(33.4) to 5.3
Free Cash Flow (2028)*	*2023$ Million*	49.7	20.5	14.4	(8.4)
Change in Free Cash Flow (2028)*	*%*	-	(58.6)	(70.9)	(117.0)
Product Conversion Costs	*2023$ Million*	-	41.5	49.4	83.6
Capital Conversion Costs	*2023$ Million*	-	33.2	40.7	65.6
Total Conversion Costs	*2023$ Million*	-	74.6	90.1	149.1

* Parentheses indicate (-) negative values.

At TSL 1, the change in INPV is expected to range from -9.2 percent to -7.3 percent. At this level, free cash flow is estimated to decrease by 58.6 percent compared to the no-new-standards case value of $49.7 million in the year 2028, the year before the standards year. Currently, DOE has no evidence of significant shipments meeting efficiency levels above the baseline efficiency level (*i.e.*, EL 0).

DOE expects that at TSL 1, manufacturers would likely need to incorporate the following design options: for low- and medium-temperature indoor dedicated condensing system equipment classes[135] would generally require larger condenser coils; low- and medium-temperature outdoor dedicated condensing system equipment classes would generally require self-regulating crankcase heater controls with a temperature switch; low-temperature outdoor dedicated condensing systems would also generally require ambient subcooling circuits; some low- and medium-temperature single-packaged dedicated system equipment classes would require electronically commutated condenser fan motors; high-temperature outdoor single-packaged dedicated condensing systems would generally require self-regulating crankcase heater controls with a temperature switch and variable-speed condenser fans; and most high-temperature indoor single-packaged dedicated condensing systems would generally require up to 1.5 inches of thermal insulation and electronically commutated condenser fan motors. DOE expects that at TSL 1, most unit cooler equipment classes would incorporate improved evaporator coil designs. *See* section IV.E.1 of this document for the efficiency levels by representative unit for TSL 1. *See* chapter 12 of the final rule TSD for a table of analyzed design options above baseline for each considered representative capacity by TSL.

Capital conversion costs are driven by incorporating design options such as larger condenser coils, improved evaporator coils, and/or ambient subcooling circuits, which would likely necessitate new tooling for updated baseplate designs across some refrigeration system capacities and equipment classes. Implementing these design options would also require notable engineering resources and testing time as

[135] Dedicated condensing system equipment classes include dedicated condensing units, matched-pair refrigeration systems (consisting of a paired dedicated condensing unit and unit cooler) and single-packaged dedicated systems.

manufacturers redesign models. Manufacturers would also need to qualify, source, and test new high-efficiency components. DOE estimates capital conversion costs of $33.2 million and product conversion costs of $41.5 million. Conversion costs total $74.6 million.

At TSL 1, the shipment-weighted average MPC for all refrigeration systems is expected to increase by 2.7 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigeration systems in 2029. In the preservation of gross margin percentage scenario, the increase in cash flow from the higher MSP is outweighed by the $74.6 million in conversion costs, causing a negative change 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 the manufacturer markup and the $74.6 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 1 under the preservation of operating profit scenario.

At TSL 2, the change in INPV is expected to range from -11.3 percent to -8.4 percent. At this level, free cash flow is estimated to decrease by 70.9 percent compared to the no-new-standards case value of $49.7 million in the year 2028, the year before the standards year.

At TSL 2, DOE expects that manufacturers would likely incorporate similar design options as TSL 1. For most representative capacities analyzed, the efficiency levels and associated design options are the same at TSL 1 and TSL 2. However, at TSL 2 for DC.M.O, DOE expects manufacturers would likely need to incorporate electronically commutated condenser fan motors, in addition to the design options analyzed at TSL 1. DOE further expects that some DC.M.O units may need to incorporate improved compressors to meet the efficiency levels required. At TSL 2, more unit cooler equipment classes would need to incorporate the max-tech design options compared to TSL 1. *See* section IV.E.1 of this document for the efficiency levels by representative unit for TSL 2. *See* chapter 12 of the final rule TSD for a table of analyzed design options above baseline for each considered representative capacity by TSL.

DOE expects industry would incur more capital conversion costs at TSL 2 compared to TSL 1 as more unit cooler equipment classes would incorporate the max-tech design options (*i.e.*, would require evaporator coils 5 rows deep). DOE expects manufacturers would incur more product conversion costs compared to TSL 1 as they update and test more refrigeration system capacities across their portfolio. DOE estimates capital conversion costs of $40.7 million and product conversion costs of $49.4 million. Conversion costs total $90.1 million.

At TSL 2, the shipment-weighted average MPC for all refrigeration systems is expected to increase by 4.1 percent relative to the no-new-standards case shipment-weighted average MPC for all walk-in refrigeration systems in 2029. In the preservation of gross margin percentage scenario, the increase in cash flow from the higher MSP is outweighed by the $90.1 million in conversion costs, causing a negative change 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 2029, the analyzed compliance year. This reduction in the manufacturer markup and the $90.1 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 2 under the preservation of operating profit scenario.

At TSL 3, the standard represents the max-tech efficiency for all equipment classes. The change in INPV is expected to range from -33.4 percent to 5.3 percent. At this level, free cash flow is estimated to decrease by 117.0 percent compared to the no-new-standards case value of $49.7 million in the year 2028, the year before the standards year.

At TSL 3, all manufacturers would need to incorporate all analyzed design options to meet the efficiencies required. DOE expects that medium- and low-temperature dedicated condensing system equipment classes would require larger condenser coils, variable-capacity compressors, and electronically commutated variable-speed condenser fan motors. Additionally, low- and medium-temperature outdoor dedicated condensing system equipment classes would generally require self-regulating crankcase heater controls with a temperature switch and ambient subcooling circuits. DOE anticipates that low- and medium-temperature single-packaged dedicated system equipment classes would also require larger evaporator coils, variable-speed evaporator fans, and thermal insulation up to 4 inches in thickness. DOE expects that lower-capacity low- and medium-temperature single-packaged dedicated condensing units would require propane compressors. DOE expects that high-temperature dedicated condensing system equipment classes would require the same design options as medium- and low-temperature dedicated condensing systems, except for larger condensing coils and variable-capacity compressors. Additionally, DOE expects that high-temperature single-packaged dedicated condensing systems would require up to 1.5 inches of thermal insulation and would not require larger evaporator coils or variable-speed evaporator fans. Finally, DOE anticipates that low-, medium-, and high-temperature unit cooler equipment classes would require evaporator coils 5 rows deep at TSL 3. *See* section IV.E.1 of this document for the efficiency levels by representative unit for TSL 3. *See* chapter 12 of the final rule TSD for a table of analyzed design options above baseline for each considered representative capacity by TSL. Currently, DOE has no evidence of significant shipments meeting the max-tech levels. As such, DOE assumes that all manufacturers would need to redesign their refrigeration system models to incorporate a range of design options to meet TSL 3 efficiencies. Capital conversion costs are driven by incorporating design options such as larger condenser coils, improved evaporator coils, and/or ambient subcooling circuits, which would likely necessitate new tooling for updated baseplate designs across the full range of refrigeration system capacities and equipment classes. Implementing these design options would also require notable engineering resources and testing time as manufacturers redesign models and potentially increase the footprint of refrigeration systems to accommodate larger condensers and/or evaporators.

Manufacturers would also need to qualify, source, and test new high-efficiency components. For medium- and low-temperature dedicated condensing system equipment classes that would likely require variable-capacity compressors to meet the max-tech levels, manufacturers could face challenges sourcing variable-capacity compressors across their portfolio of capacity offerings, since the availability of variable-capacity compressors for walk-in applications is limited. At the time of this final rule publication, the few variable-capacity compressor product lines DOE identified are not advertised for the North American market. Additionally, the identified product lines may not have a sufficient range of available compressor capacities to replace compressors in all walk-in applications. DOE estimates capital conversion costs of $65.6 million and product conversion costs of $83.6 million. Conversion costs total $149.1 million.

At TSL 3, the shipment-weighted average MPC for all refrigeration systems is expected to increase by 54.4 percent relative to the no-new-standards case shipment-weighted average MPC for all refrigeration systems in 2029. In the preservation of gross margin percentage scenario, the increase in cash flow from the higher MSP outweighs the $149.1 million in conversion costs, causing a positive change 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 $149.1 million in conversion costs incurred by manufacturers cause a significant negative change in INPV at TSL 3 under the preservation of operating profit scenario.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the walk-in 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*,[136] BLS employee compensation data,[137] results of the engineering analysis, and manufacturer interviews.

Labor expenditures related to product manufacturing depend on the labor intensity of the product, 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 the *ASM* inputs: Production Workers' Annual Wages, Production Workers' Annual Hours, Production Workers for Pay Period, and Number of Employees. DOE also relied on the BLS

---

[136] U.S. Census Bureau. December 2022. (2021) *Annual Survey of Manufactures.* "Summary Statistics for Industry Groups and Industries." Available at *www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html* (last accessed March 8, 2024).
[137] U.S. Bureau of Labor Statistics. December 15, 2023. *Employer Costs for Employee Compensation*. Available at *www.bls.gov/news.release/archives/ecec_12152023.pdf* (last accessed March 8, 2024).

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 number of production employees is 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 interviews, equipment database analysis, and publicly available information. Consistent with the September 2023 NOPR, DOE estimates that approximately 90 percent of doors, 95 percent of panels, and 70 percent of refrigeration systems are manufactured domestically.

The domestic production employees estimate covers production line workers, including line supervisors, who are directly involved in fabricating and assembling products 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. 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 estimate covers domestic workers who are not directly involved in the production process, such as sales, engineering, human resources, and management. Using the amount 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.

In evaluating the impact of energy efficiency standards on employment, DOE performed separate analyses on all three walk-in component manufacturer industries: doors, panels, and refrigeration systems.

Using the GRIM, DOE estimates in the absence of amended energy conservation standards there would be 4,346 domestic production and non-production workers for walk-in doors and 7,858 domestic production and non-production workers for walk-in panels in 2028. For refrigeration systems, DOE estimates in the absence of amended energy conservation standards there would be 1,018 domestic production and non-production workers in 2029, using the GRIM. Table V.59, Table V.60, and Table V.61 show the range of the impacts of potential amended energy conservation standards on U.S. manufacturing employment in the door, panel, and refrigeration systems markets, respectively.

Table V.59 Direct Employment Impacts for Domestic Walk-In Door Manufacturers in 2028

	No-New-Standards Case	Trial Standard Levels		
		1	2	3
Direct Employment in 2028* (Production Workers + Non-Production Workers)	4,346	1,156 to 4,360	1,156 to 4,660	1,156 to 4,827
Potential Changes in Direct Employment in 2028*	-	(3,190) to 14	(3,190) to 314	(3,190) to 481

* DOE presents a range of potential employment impacts. Numbers in parentheses denote negative values.

Table V.60 Direct Employment Impacts for Domestic Walk-In Panel Manufacturers in 2028

	No-New-Standards Case	Trial Standard Levels		
		1	2	3
Direct Employment in 2028* (Production Workers + Non-Production Workers)	7,858	7,858	7,858	2,091 to 8,014
Potential Changes in Direct Employment in 2028*	-	-	-	(5,767) to 156

* DOE presents a range of potential employment impacts. Numbers in parentheses denote negative values.

Table V.61 Direct Employment Impacts for Domestic Walk-In Refrigeration System Manufacturers in 2029

	No-New-Standards Case	Trial Standard Levels		
		1	2	3
Direct Employment in 2029* (Production Workers + Non-Production Workers)	1,018	271 to 1,044	271 to 1,057	271 to 1,142
Potential Changes in Direct Employment in 2029*	-	(747) to 26	(747) to 39	(747) to 124

* DOE presents a range of potential employment impacts. Numbers in parentheses denote negative values.

The direct employment impacts shown in Table V.59 through Table V.61 represent the potential domestic employment changes that could result following the compliance date of amended energy conservation standards. The upper-bound estimate corresponds to the change in the number of domestic workers that would result from amended energy conservation standards if manufacturers continued to produce the same scope of covered equipment within the United States after compliance takes effect (DOE models a 2028 compliance year for walk-in display doors, non-display doors, and panels, and a 2029 compliance year for refrigeration systems). To establish a conservative lower bound, DOE assumes all manufacturers would shift production to foreign countries with lower costs of labor. For walk-in doors, DOE expects that the likelihood of manufacturers moving production locations due to the adopted TSL are low. For display doors, DOE is not adopting more stringent standards in this final rule. For non-display doors, DOE expects manufacturers would be able to meet the adopted level (*i.e.*, TSL 1 for non-display doors) with existing equipment. DOE's engineering analysis indicates that non-display door manufacturers could reach TSL 1 by incorporating anti-sweat heater controls, which does not require new equipment or significant capital investment. For walk-in panels, DOE is not adopting more stringent standards in this final rule. For walk-in refrigeration systems, some manufacturers currently produce at least a portion of their walk-in refrigeration systems in countries with lower labor costs. At the adopted level (*i.e.*, TSL 2 for refrigeration systems), DOE expects some manufacturers would need to invest in new equipment and tooling to incorporate larger or improved heat exchanger designs. If standards necessitate large expenditures to re-tool facilities, it is possible some manufacturers would reevaluate domestic production siting options. However, DOE notes that manufacturers of walk-in refrigeration systems did not express specific concerns about changes to domestic production employment in response to the September 2023 NOPR or the March 2024 NODA.

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

Doors

Display Doors

In interviews, display door manufacturers indicated that implementing vacuum-insulated glass across all equipment classes and configurations would require significant engineering resources and testing time to ensure adequate durability in all commercial settings. Manufacturers also emphasized that there are currently a very limited number of suppliers of vacuum-insulated glass for WICF applications. In interviews, manufacturers expressed concerns that the 3-year time period between the announcement of the final rule and the compliance date of the amended energy conservation standard might be insufficient to design and test a full portfolio of new doors. In this final rule, DOE is not adopting more stringent standards for walk-in display door equipment classes.

Non-Display Doors

The production of non-display doors is very similar to the production of panels and faces the same capacity challenges as panels, which is discussed in the following paragraphs. As indicated in the panel discussion, DOE does not anticipate capacity constraints at a standard that moves manufacturers to 5 inches of thickness. In this final rule, DOE is not adopting standard levels that would likely necessitate increasing insulation thickness of non-display doors. Therefore, DOE does not expect manufacturers will face long-term capacity constraints due to the standard levels detailed in this final rule.

<u>Panels</u>

Manufacturers indicated that design options that necessitate thicker panels could lead to longer production times for panels. In general, every additional inch of foam increases cure times by roughly 10 minutes. Based on information from manufacturer interviews and the engineering analysis, DOE understands that a number of manufacturers are able to produce panels above the baseline today and that a standard based on 5-inch panels is not likely to lead to equipment shortages in the industry. However, a standard that necessitates 6-inch panels for any of the panel equipment class would require manufacturers to add foaming equipment to maintain throughput due to longer curing times or to purchase all new tooling to enable production if the manufacturer's current equipment cannot accommodate 6-inch panels. In this final rule, DOE is not adopting more stringent standards for walk-in panel equipment classes.

Refrigeration Systems

Manufacturers raised concerns about technical resource constraints due to overlapping regulations. In confidential interviews and public comments in response to the September 2023 NOPR and March 2024 NODA, manufacturers asserted that due to the October 2023 EPA Technology Transitions Final Rule (compliance required for walk-ins starting January 1, 2026), they may face resource constraints should DOE maintain a 3-year compliance period and set more stringent standards that necessitate the redesign of the majority of models. These manufacturers stated that meeting the October 2023 EPA Technology Transitions Final Rule would take significant amounts of engineering resources, laboratory time, and investment.

Based on manufacturer feedback from confidential interviews and publicly available information, DOE expects the walk-in refrigeration system industry would need to invest approximately $28.1 million over a 2-year time period (2024–2025) to redesign models for low-GWP refrigerants and retrofit manufacturing facilities to accommodate flammable refrigerants in order to comply with EPA's refrigerant regulation. Should amended standards require significant product development or capital investment, the 3-year period between the announcement of the final rule and the compliance date of the amended energy conservation standard might be insufficient to complete the dual development needed to meet both EPA and DOE regulations.

As discussed in section III.A.2 of this document, DOE is extending the compliance lead-in period and requiring compliance with amended DOE standards for refrigeration systems on December 31, 2028 instead of 3-years after this final rule is published in the *Federal Register*, mitigating concerns about resource constraints. Additionally, as compared to the December 2022 EPA Technology Transitions NOPR, EPA provided an additional year to comply with its GWP restrictions for WICFs (January 1, 2026 instead of January 1, 2025).

d. Impacts on Subgroups of Manufacturers

Using average cost assumptions to develop industry cash flow estimates may not capture the differential impacts among subgroups of manufacturers. Small manufacturers, niche players, or manufacturers exhibiting a cost structure that differs substantially from the industry average could be affected disproportionately. DOE investigated small businesses as a manufacturer subgroup that could be disproportionally impacted by energy conservation standards and could merit additional analysis. DOE did not identify any other adversely impacted manufacturer subgroups for this rulemaking based on the results of the industry characterization.

DOE analyzes the impacts on small businesses in a separate analysis in section VI.B of this document as part of the Regulatory Flexibility Analysis. In summary, the Small Business Administration ("SBA") defines a "small business" as having 1,250 employees or less for NAICS 333415, "Air Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." For a discussion of the impacts on the small business manufacturer subgroup, see the Regulatory Flexibility Analysis in section VI.B of this document and 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 product/equipment-specific regulatory actions of other Federal agencies 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. 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 products. 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 the modeled 2028 compliance year for doors and panels and 3 years after the modeled 2029 compliance year for refrigeration systems (2025–2032).

The DOE energy conservation standards regulations potentially contributing to cumulative regulatory burden are presented in Table V.62. In addition to the proposed and adopted energy conservation standards rulemakings identified, DOE also considers refrigerant regulations, such as the October 2023 EPA Technology Transitions Final Rule, in its cumulative regulatory burden analysis. DOE discusses these refrigerant regulations in the subsection, "Refrigerant Regulations" included in this section.

Table V.62 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Walk-in Cooler and Freezer 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	3	2027	$15.9 (2022$)	0.6%
Room Air Conditioners 88 FR 34298 (May 26, 2023)	8	2	2026	$24.8 (2021$)	0.4%
Consumer Pool Heaters 88 FR 34624 (May 30, 2023)	20	1	2028	$48.4 (2021$)	1.5%
Microwave Ovens 88 FR 39912 (June 20, 2023)	18	2	2026	$46.1 (2021$)	0.7%
Consumer Boilers† 88 FR 55128 (August 14, 2023)	24	2	2030	$98.0 (2022$)	3.6%
Commercial Water Heating Equipment 88 FR 69686 (October 6, 2023)	15	1	2026	$42.7 (2022$)	5.3%
Commercial Refrigerators, Refrigerator-Freezers, and Freezers† 88 FR 70196 (October 10, 2023)	89	11	2028	$226.4 (2022$)	1.6%
Dehumidifiers† 88 FR 76510 (November 6, 2023)	20	1	2028	$6.9 (2022$)	0.4%
Consumer Furnaces 88 FR 87502 (December 18, 2023)	14	4	2028	$162.0 (2022$)	1.8%

Refrigerators, Refrigerator-Freezers, and Freezers 89 FR 3026 (January 17, 2024)	63	1	2029 and 2030‡	$830.3 (2022$)	1.3%
Consumer Conventional Cooking Products 89 FR 11548 (February 14, 2024)	35	1	2028	$66.7 (2022$)	0.3%
Consumer Water Heaters 89 FR 37778 (May 6, 2024)	16	1	2029	$239.8 (2022$)	1.9%
Miscellaneous Refrigeration Products 89 FR 38762 (May 7, 2024)	49	2	2029	$130.7 (2022$)	2.9%

* 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 walk-in doors, panels, or refrigeration systems 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 equipment class.

Refrigerant Regulations

The October 2023 EPA Technology Transitions Final Rule restricts the use of hydrofluorocarbons in specific sectors or subsectors, including use in walk-in refrigeration systems. Consistent with the September 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 requires time and investment to redesign walk-in refrigeration systems and upgrade production facilities to accommodate the additional structural and safety precautions required. As discussed in sections IV.C.1.e and IV.C.1.f of this document, DOE expects manufacturers will likely need to transition to an A2L or A3 refrigerant or CO_2 to comply with upcoming refrigerant regulations prior to the expected December 31, 2028[138] compliance date of any potential energy conservation standards. In this final rule, DOE maintained the refrigerants analyzed in the September 2023 NOPR analysis for dedicated condensing units, single-packaged dedicated condensing systems, and unit coolers. Consistent with the March 2024 NODA, DOE reviewed the EERs of R-454C compressors with capacities representative of walk-in refrigeration systems to assess the potential impact of State-level sub-150 GWP requirements. See the "Refrigerants Analyzed" subsections in sections IV.C.1.e and IV.C.1.f of this document for additional information about the refrigerants analyzed in the WICF refrigeration system engineering analysis.

DOE considers the cost associated with the refrigerant transition in its GRIM in the no-new-standards case and standards case because investments required to transition to low-GWP refrigerants in response to the October 2023 EPA Technology Transition Final Rule necessitates a level of investment beyond typical annual R&D and capital expenditures. DOE considers the expenses associated with the refrigerant transition as independent of DOE actions related to any new and amended energy conservation standards. In other words, manufacturers would need to comply with the October 2023 EPA Technology Transitions Final Rule regardless of whether or not DOE amended standards. For the September 2023 NOPR, DOE relied on manufacturer feedback in confidential interviews, a report prepared for EPA,[139] and written comments from AHRI

[138] Modeled as 2029 (the first full year of compliance) in this final rule.

[139] *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*.

in response to the June 2022 Preliminary Analysis to estimate the industry refrigerant transition costs. For this final rule, DOE refined its R&D estimate to reflect feedback from written comments in response to the September 2023 NOPR. DOE also DOE updated its refrigerant transition capital expenditure estimates from the September 2023 NOPR to 2023$ for this final rule. Furthermore, DOE adjusted the timeline of when manufacturers would need to make investments related to the refrigerant transition to align with the revised compliance dates for walk-in refrigeration systems in the October 2023 EPA Technology Transitions Final Rule.

Based on feedback, DOE assumed that the transition to low-GWP refrigerants would require industry to invest approximately $15.7 million in R&D and $12.4 million in capital expenditures (*e.g.*, investments in new charging equipment, leak detection systems, *etc.*) from 2024 (the final rule reference year) and 2026 (EPA compliance date). Consistent with the September 2023 NOPR, DOE notes that its refrigerant transition estimates of $15.7 million in R&D and $12.4 million capital expenditures reflect an estimate of *future* 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 WICF refrigeration systems to low-GWP refrigerants. However, as the GRIM developed for this rulemaking only analyzes future cashflows, 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 national energy savings 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 amended standards for walk-in coolers and freezers, 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 products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2028–2057 for envelope components, and 2029–2058 for refrigeration systems) Table V.63 through Table V.65 present DOE's projections of the national energy savings for each TSL considered for walk-in coolers and freezers. The savings were calculated using the approach described in section IV.H of this document.

Table V.63 Cumulative National Energy Savings for Walk-in Coolers and Freezer Doors; 30 Years of Shipments 2028–2057

Energy Savings	Connected Refrigeration System	Trial Standard Level for WICF Doors		
		1	2	3
Primary Energy Savings (Quads)	Baseline	0.562	0.975	1.190
	TSL 1	0.558	0.967	1.178
	TSL 2	0.557	0.964	1.172
	TSL 3	0.535	0.913	1.095
	Baseline	0.577	1.002	1.222
	TSL 1	0.574	0.993	1.210

FFC Energy Savings (Quads)	TSL 2	0.572	0.990	1.204
	TSL 3	0.550	0.938	1.124

Table V.64 Cumulative National Energy Savings for Walk-in Coolers and Freezer Panels; 30 Years of Shipments 2028–2057

Energy Savings	**Connected Refrigeration System**	**Trial Standard Level for WICF Panels**		
		1	**2**	**3**
Primary Energy Savings (Quads)	Baseline	n/a	n/a	0.584
	TSL 1	n/a	n/a	0.573
	TSL 2	n/a	n/a	0.567
	TSL 3	n/a	n/a	0.492
FFC Energy Savings (Quads)	Baseline	n/a	n/a	0.600
	TSL 1	n/a	n/a	0.589
	TSL 2	n/a	n/a	0.582
	TSL 3	n/a	n/a	0.506

Note: The entry “n/a” means not applicable because there is no change in the standard at certain TSLs

Table V.65 Cumulative National Energy Savings for Walk-in Coolers and Freezer Refrigeration Systems; 30 Years of Shipments 2029–2058

Energy Savings	**Trial Standard Level**		
	1	**2**	**3**
Primary Energy Savings (Quads)	0.66	1.00	3.30
FFC Energy Savings (Quads)	0.67	1.03	3.39

OMB Circular A-4[140] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of

[140] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. Available at *www.whitehouse.gov/omb/information-for-agencies/circulars* (last accessed May 31, 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.

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 product 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.[141] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to walk-ins. 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.66 through Table V.68. The impacts are counted over the lifetime of walk-ins purchased over the periods of 2028–2057 for envelope components, and 2029-2058 for refrigeration systems.

Table V.66 Cumulative National Energy Savings for Walk-in Coolers and Freezer Doors; 9 Years of Shipments (2028–2036)

Energy Savings	Connected Refrigeration System	Trial Standard Level for WICF Doors		
		1	2	3
Primary Energy Savings (Quads)	Baseline	0.151	0.261	0.318
	TSL 1	0.150	0.259	0.315
	TSL 2	0.149	0.258	0.313
	TSL 3	0.144	0.244	0.292

[141] 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(a); 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.

FFC Energy Savings (Quads)	Baseline	0.155	0.269	0.327
	TSL 1	0.154	0.266	0.324
	TSL 2	0.154	0.265	0.322
	TSL 3	0.148	0.251	0.301

Table V.67 Cumulative National Energy Savings for Walk-in Coolers and Freezer Panels; 9 Years of Shipments (2028–2036)

Energy Savings	Connected Refrigeration System	Trial Standard Level for WICF Panels		
		1	**2**	**3**
Primary Energy Savings (Quads)	Baseline	n/a	n/a	0.160
	TSL 1	n/a	n/a	0.157
	TSL 2	n/a	n/a	0.156
	TSL 3	n/a	n/a	0.135
FFC Energy Savings (Quads)	Baseline	n/a	n/a	0.165
	TSL 1	n/a	n/a	0.162
	TSL 2	n/a	n/a	0.160
	TSL 3	n/a	n/a	0.139

Note: The entry "n/a" means not applicable because there is no change in the standard at certain TSLs

Table V.68 Cumulative National Energy Savings for Walk-in Coolers and Freezer Refrigeration Systems; 9 Years of Shipments (2029–2037)

Energy Savings	Trial Standard Level		
	1	**2**	**3**
Primary Energy Savings (Quads)	0.180	0.276	0.909
FFC Energy Savings (Quads)	0.185	0.284	0.934

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 walk-ins.[142] In accordance with OMB Circular A-4, DOE calculated NPV using both a 7-percent and a 3-percent real discount

[142] See section IV.H.3 of this document for the more detailed discussion on the NPV of consumer costs and benefits.

rate. Table V.69 through Table V.71 shows the consumer NPV results with impacts counted over the lifetime of products purchased during the periods of 2028–2057 for envelope components, and 2029-2058 for refrigeration systems.

Table V.69 Cumulative Net Present Value of Consumer Benefits for Walk-in Coolers and Freezer Doors; 30 Years of Shipments 2028–2057 (*billion 2023$*)

Discount Rate	Connected Refrigeration System	Trial Standard Level for WICF Doors		
		1	2	3
3 percent	Baseline	2.10	3.49	-5.83
	TSL 1	2.09	3.45	-5.89
	TSL 2	2.08	3.44	-5.92
	TSL 3	1.98	3.20	-6.28
7 percent	Baseline	0.95	1.55	-3.65
	TSL 1	0.94	1.54	-3.68
	TSL 2	0.93	1.53	-3.69
	TSL 3	0.89	1.42	-3.86

Table V.70 Cumulative Net Present Value of Consumer Benefits Walk-in Coolers and Freezer Panels; 30 Years of Shipments 2028–2057 (*billion 2023$*)

Discount Rate	Connected Refrigeration System	Trial Standard Level for WICF Panels		
		1	2	3
3 percent	Baseline	n/a	n/a	-3.80
	TSL 1	n/a	n/a	-3.85
	TSL 2	n/a	n/a	-3.88
	TSL 3	n/a	n/a	-4.22
7 percent	Baseline	n/a	n/a	-2.38
	TSL 1	n/a	n/a	-2.40
	TSL 2	n/a	n/a	-2.41
	TSL 3	n/a	n/a	-2.57

Note: The entry “n/a” means not applicable because there is no change in the standard at certain TSLs

Table V.71 Cumulative Net Present Value of Consumer Benefits for Walk-in Coolers and Freezer Refrigeration Systems; 30 Years of Shipments 2029–2057 (*billion 2023$*)

Discount Rate	Trial Standard Level		
	1	2	3
3 percent	1.76	2.66	-8.07
7 percent	0.71	1.07	-4.92

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.72 through Table V.74. The impacts are counted over the lifetime of products purchased during the periods of 2028–2036 for envelope components, and 2029-2037 for refrigeration systems. 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.72 Cumulative Net Present Value of Consumer Benefits for Walk-in Coolers and Freezer Doors; 9 Years of Shipments 2028–2036 (*billion 2023$*)

Discount Rate	Connected Refrigeration System	Trial Standard Level for WICF Doors		
		1	2	3
3 percent	Baseline	0.76	1.27	-2.09
	TSL 1	0.76	1.25	-2.11
	TSL 2	0.75	1.25	-2.12
	TSL 3	0.72	1.16	-2.25
7 percent	Baseline	0.46	0.76	-1.78
	TSL 1	0.46	0.75	-1.80

	TSL 2	0.46	0.75	-1.80
	TSL 3	0.43	0.69	-1.89

Table V.73 Cumulative Net Present Value of Consumer Benefits for Walk-in Coolers and Freezer Panels; 9 Years of Shipments 2028–2036 (*billion 2023$*)

Discount Rate	Connected Refrigeration System	Trial Standard Level for WICF Panels		
		1	2	3
3 percent	Baseline	n/a	n/a	-1.40
	TSL 1	n/a	n/a	-1.42
	TSL 2	n/a	n/a	-1.43
	TSL 3	n/a	n/a	-1.56
7 percent	Baseline	n/a	n/a	-1.18
	TSL 1	n/a	n/a	-1.19
	TSL 2	n/a	n/a	-1.20
	TSL 3	n/a	n/a	-1.28

Note: The entry “n/a” means not applicable because there is no change in the standard at certain TSLs

Table V.74 Cumulative Net Present Value of Consumer Benefits for Walk-in Coolers and Freezer Refrigeration Systems; 9 Years of Shipments 2029–2037 (*billion 2023$*)

Discount Rate	Trial Standard Level		
	1	2	3
3 percent	0.657	0.995	-2.898
7 percent	0.354	0.535	-2.418

The previous results reflect the use of a default trend to estimate the change in price for walk-ins over the analysis period (see section IV.H of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the final rule TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the low-price-decline case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

DOE estimates that amended energy conservation standards for walk-ins will reduce energy expenditures for consumers of those products, 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 (2028 through 2032 for envelope components and 2029 through 2033 for refrigeration systems), 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 Products

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 walk-ins under consideration in this rulemaking. In performing the engineering analysis, DOE considers design options that would not lessen the utility or performance of the individual classes of equipment. (42 U.S.C. 6295(o)(2)(B)(i)(IV) and 42 U.S.C. 6316(a)) As presented in the screening analysis (chapter 4 of the final rule TSD), DOE eliminates from consideration any design options that reduce the utility of the equipment. Further, DOE is aware that manufacturers currently offer units with expected performance that meets or exceeds the adopted standards for some equipment classes.

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 NOPR and the TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for walk-ins 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 in 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 walk-ins is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and GHGs. Table V.75 through Table V.77 provide DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.L. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

Table V.75 Cumulative Emissions Reduction for Walk-in Cooler and Freezer Doors Shipped in 2028–2057

	Connected Refrigeration System	Trial Standard Level for WICF Doors		
		1	2	3
Electric Power Sector Emissions				

CO_2 (million metric tons)	Baseline	9.55	16.57	20.18
	TSL 1	9.49	16.43	19.97
	TSL 2	9.46	16.37	19.87
	TSL 3	9.10	15.52	18.56
CH_4 (thousand tons)	Baseline	0.71	1.24	1.50
	TSL 1	0.71	1.23	1.49
	TSL 2	0.71	1.22	1.48
	TSL 3	0.68	1.16	1.38
N_2O (thousand tons)	Baseline	0.10	0.17	0.21
	TSL 1	0.10	0.17	0.21
	TSL 2	0.10	0.17	0.21
	TSL 3	0.09	0.16	0.19
SO_2 (thousand tons)	Baseline	3.16	5.49	6.69
	TSL 1	3.15	5.44	6.62
	TSL 2	3.14	5.43	6.59
	TSL 3	3.02	5.14	6.15
NO_X (thousand tons)	Baseline	4.57	7.93	9.64
	TSL 1	4.54	7.86	9.54
	TSL 2	4.53	7.84	9.49
	TSL 3	4.36	7.43	8.87
Hg (tons)	Baseline	0.02	0.04	0.05
	TSL 1	0.02	0.04	0.05
	TSL 2	0.02	0.04	0.05
	TSL 3	0.02	0.04	0.04
Upstream Emissions				
CO_2 (million metric tons)	Baseline	0.96	1.67	2.04
	TSL 1	0.96	1.65	2.01
	TSL 2	0.95	1.65	2.00
	TSL 3	0.92	1.56	1.87
CH_4 (thousand tons)	Baseline	87.29	151.50	184.79
	TSL 1	86.75	150.21	182.87
	TSL 2	86.52	149.70	181.99
	TSL 3	83.18	141.91	169.98
N_2O (thousand tons)	Baseline	0.00	0.01	0.01
	TSL 1	0.00	0.01	0.01
	TSL 2	0.00	0.01	0.01
	TSL 3	0.00	0.01	0.01
SO_2 (thousand tons)	Baseline	0.06	0.10	0.12
	TSL 1	0.06	0.10	0.12

	TSL 2	0.06	0.10	0.12
	TSL 3	0.06	0.10	0.11
NO_X (thousand tons)	Baseline	14.97	25.98	31.69
	TSL 1	14.88	25.76	31.36
	TSL 2	14.84	25.68	31.21
	TSL 3	14.27	24.34	29.15
Hg (tons)	Baseline	0.00	0.00	0.00
	TSL 1	0.00	0.00	0.00
	TSL 2	0.00	0.00	0.00
	TSL 3	0.00	0.00	0.00
Total FFC Emissions				
CO_2 (million metric tons)	Baseline	10.51	18.24	22.21
	TSL 1	10.44	18.08	21.98
	TSL 2	10.42	18.02	21.88
	TSL 3	10.01	17.08	20.44
CH_4 (thousand tons)	Baseline	88.00	152.73	186.29
	TSL 1	87.46	151.44	184.36
	TSL 2	87.23	150.92	183.47
	TSL 3	83.86	143.07	171.36
N_2O (thousand tons)	Baseline	0.10	0.18	0.22
	TSL 1	0.10	0.18	0.22
	TSL 2	0.10	0.18	0.21
	TSL 3	0.10	0.17	0.20
SO_2 (thousand tons)	Baseline	3.22	5.59	6.81
	TSL 1	3.20	5.55	6.74
	TSL 2	3.20	5.53	6.71
	TSL 3	3.07	5.24	6.27
NO_X (thousand tons)	Baseline	19.54	33.91	41.33
	TSL 1	19.42	33.62	40.90
	TSL 2	19.37	33.51	40.71
	TSL 3	18.62	31.77	38.02
Hg (tons)	Baseline	0.02	0.04	0.05
	TSL 1	0.02	0.04	0.05
	TSL 2	0.02	0.04	0.05
	TSL 3	0.02	0.04	0.04

Note: Negative values refer to an increase in emissions.

Table V.76 Cumulative Emissions Reduction for Walk-in Cooler and Freezer Panels Shipped in 2028–2057

	Connected Refrigeration System	Trial Standard Level for WICF Panels		
		1	2	3
Electric Power Sector Emissions				
CO_2 (million metric tons)	Baseline	n/a	n/a	9.79
	TSL 1	n/a	n/a	9.61
	TSL 2	n/a	n/a	9.49
	TSL 3	n/a	n/a	8.25
CH_4 (thousand tons)	Baseline	n/a	n/a	0.72
	TSL 1	n/a	n/a	0.71
	TSL 2	n/a	n/a	0.70
	TSL 3	n/a	n/a	0.61
N_2O (thousand tons)	Baseline	n/a	n/a	0.10
	TSL 1	n/a	n/a	0.10
	TSL 2	n/a	n/a	0.10
	TSL 3	n/a	n/a	0.08
SO_2 (thousand tons)	Baseline	n/a	n/a	3.24
	TSL 1	n/a	n/a	3.17
	TSL 2	n/a	n/a	3.14
	TSL 3	n/a	n/a	2.73
NO_X (thousand tons)	Baseline	n/a	n/a	4.62
	TSL 1	n/a	n/a	4.53
	TSL 2	n/a	n/a	4.48
	TSL 3	n/a	n/a	3.89
Hg (tons)	Baseline	n/a	n/a	0.02
	TSL 1	n/a	n/a	0.02
	TSL 2	n/a	n/a	0.02
	TSL 3	n/a	n/a	0.02
Upstream Emissions				
CO_2 (million metric tons)	Baseline	n/a	n/a	1.00
	TSL 1	n/a	n/a	0.98
	TSL 2	n/a	n/a	0.97
	TSL 3	n/a	n/a	0.84
CH_4 (thousand tons)	Baseline	n/a	n/a	90.47
	TSL 1	n/a	n/a	88.77
	TSL 2	n/a	n/a	87.74
	TSL 3	n/a	n/a	76.22
N_2O (thousand tons)	Baseline	n/a	n/a	0.00

	TSL 1	n/a	n/a	0.00
	TSL 2	n/a	n/a	0.00
	TSL 3	n/a	n/a	0.00
SO_2 (thousand tons)	Baseline	n/a	n/a	0.06
	TSL 1	n/a	n/a	0.06
	TSL 2	n/a	n/a	0.06
	TSL 3	n/a	n/a	0.05
NO_X (thousand tons)	Baseline	n/a	n/a	15.51
	TSL 1	n/a	n/a	15.22
	TSL 2	n/a	n/a	15.04
	TSL 3	n/a	n/a	13.07
Hg (tons)	Baseline	n/a	n/a	0.00
	TSL 1	n/a	n/a	0.00
	TSL 2	n/a	n/a	0.00
	TSL 3	n/a	n/a	0.00
Total FFC Emissions				
CO_2 (million metric tons)	Baseline	n/a	n/a	10.79
	TSL 1	n/a	n/a	10.58
	TSL 2	n/a	n/a	10.46
	TSL 3	n/a	n/a	9.09
CH_4 (thousand tons)	Baseline	n/a	n/a	91.20
	TSL 1	n/a	n/a	89.48
	TSL 2	n/a	n/a	88.44
	TSL 3	n/a	n/a	76.83
N_2O (thousand tons)	Baseline	n/a	n/a	0.11
	TSL 1	n/a	n/a	0.10
	TSL 2	n/a	n/a	0.10
	TSL 3	n/a	n/a	0.09
SO_2 (thousand tons)	Baseline	n/a	n/a	3.30
	TSL 1	n/a	n/a	3.23
	TSL 2	n/a	n/a	3.20
	TSL 3	n/a	n/a	2.78
NO_X (thousand tons)	Baseline	n/a	n/a	20.13
	TSL 1	n/a	n/a	19.75
	TSL 2	n/a	n/a	19.53
	TSL 3	n/a	n/a	16.96
Hg (tons)	Baseline	n/a	n/a	0.02
	TSL 1	n/a	n/a	0.02
	TSL 2	n/a	n/a	0.02

	TSL 3	n/a	n/a	0.02

Note: Negative values refer to an increase in emissions, and the entry “n/a” means not applicable because there is no change in the standard at certain TSLs.

Table V.77 Cumulative Emissions Reduction for Walk-in Cooler and Freezer Refrigeration Systems Shipped in 2029–2058

	Trial Standard Level		
	1	**2**	**3**
Electric Power Sector Emissions			
CO_2 (million metric tons)	10.93	16.70	54.95
CH_4 (thousand tons)	0.81	1.23	4.06
N_2O (thousand tons)	0.11	0.17	0.56
SO_2 (thousand tons)	3.61	5.51	18.15
NO_X (thousand tons)	5.15	7.87	25.88
Hg (tons)	0.02	0.04	0.13
Upstream Emissions			
CO_2 (million metric tons)	1.11	1.70	5.60
CH_4 (thousand tons)	101.28	154.72	509.22
N_2O (thousand tons)	0.00	0.01	0.02
SO_2 (thousand tons)	0.07	0.10	0.34
NO_X (thousand tons)	17.37	26.53	87.31
Hg (tons)	0.00	0.00	0.00
Total FFC Emissions			
CO_2 (million metric tons)	12.04	18.40	60.55
CH_4 (thousand tons)	102.09	155.95	513.28
N_2O (thousand tons)	0.12	0.18	0.59
SO_2 (thousand tons)	3.68	5.62	18.49
NO_X (thousand tons)	22.51	34.39	113.20
Hg (tons)	0.03	0.04	0.13

As part of the analysis for this rule, DOE estimated monetized climate benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for walk-in coolers and freezers. Section IV.L of this document discusses the two separate sets of SC-CO_2 estimates that DOE used.

Table V.78 through Table V.83 present the value of CO_2 emissions reduction 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.78 Present Value of CO_2 Emissions Reduction for Walk-in Doors Shipped in 2028–2057 (2023 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CO_2 Case		
		Near-term Ramsey Discount Rate		
		2.5%	2.0%	1.5%
		billion 2023$		
1	Baseline	1.34	2.27	4.01
	TSL 1	1.33	2.25	3.99
	TSL 2	1.32	2.25	3.98
	TSL 3	1.27	2.16	3.83
2	Baseline	2.32	3.93	6.97
	TSL 1	2.30	3.90	6.91
	TSL 2	2.29	3.88	6.88
	TSL 3	2.17	3.68	6.52
3	Baseline	2.82	4.78	8.48
	TSL 1	2.79	4.73	8.39
	TSL 2	2.77	4.71	8.35
	TSL 3	2.59	4.40	7.80

Table V.79 Present Value of CO_2 Emissions Reduction for Walk-in Panels Shipped in 2028–2057 (2023 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CO_2 Case		
		Near-term Ramsey Discount Rate		
		2.5%	2.0%	1.5%
		billion 2023$		
1	Baseline	n/a	n/a	n/a

	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
3	Baseline	1.35	2.30	4.09
	TSL 1	1.32	2.25	4.01
	TSL 2	1.31	2.23	3.96
	TSL 3	1.14	1.94	3.44

Note: the entry “n/a” means not applicable because there is no change in the standard at certain TSLs.

Table V.80 Present Value of CO_2 Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058 (2023 estimates of SC-GHG)

TSL	SC-CO_2 Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	1.50	2.56	4.56
2	2.30	3.91	6.96
3	7.56	12.88	22.92

Table V.81 Present Value of CO_2 Emissions Reduction for Walk-in Doors Shipped in 2028–2057 (2021 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CO_2 Case			
		Discount Rate and Statistics			
		5%	3%	2.5%	3%
		Average	Average	Average	95th percentile
		billion 2023$			
1	Baseline	0.12	0.50	0.77	1.51
	TSL 1	0.12	0.49	0.77	1.50
	TSL 2	0.12	0.49	0.76	1.50
	TSL 3	0.11	0.47	0.73	1.44
2	Baseline	0.21	0.86	1.34	2.62
	TSL 1	0.21	0.85	1.33	2.60

	TSL 2	0.20	0.85	1.32	2.59
	TSL 3	0.19	0.81	1.25	2.45
3	Baseline	0.25	1.05	1.62	3.18
	TSL 1	0.25	1.04	1.61	3.15
	TSL 2	0.25	1.03	1.60	3.13
	TSL 3	0.23	0.96	1.49	2.92

Table V.82 Present Value of CO_2 Emissions Reduction for Walk-in Panels Shipped in 2028–2057 (2021 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CO_2 Case			
		Discount Rate and Statistics			
		5%	3%	2.5%	3%
		Average	Average	Average	95th percentile
		billion 2023$			
1	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
3	Baseline	0.12	0.50	0.77	1.50
	TSL 1	0.12	0.49	0.76	1.48
	TSL 2	0.11	0.48	0.75	1.46
	TSL 3	0.10	0.42	0.65	1.27

Note: the entry “n/a” means not applicable because there is no change in the standard at certain TSLs.

Table V.83 Present Value of CO_2 Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058 (2021 estimates of SC-GHG)

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	billion 2023$			
1	0.13	0.55	0.86	1.67
2	0.20	0.84	1.31	2.56
3	0.65	2.77	4.32	8.42

As discussed in section IV.L.2, 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 walk-ins Table V.84 through Table V.89 present the value of the CH_4 emissions reduction at each TSL, and Table V.90 through Table V.95 present the value of the N_2O emissions reduction at each TSL. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

Table V.84 Present Value of Methane Emissions Reduction for Walk-in Doors Shipped in 2028–2057 (2023 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CH_4 Case		
		Near-term Ramsey Discount Rate		
		2.5%	2.0%	1.5%
		billion 2023$		
1	Baseline	0.17	0.23	0.32
	TSL 1	0.17	0.22	0.32
	TSL 2	0.17	0.22	0.32
	TSL 3	0.16	0.22	0.30
2	Baseline	0.29	0.39	0.55
	TSL 1	0.29	0.39	0.55
	TSL 2	0.29	0.39	0.55
	TSL 3	0.27	0.37	0.52

3	Baseline	0.35	0.48	0.68
	TSL 1	0.35	0.47	0.67
	TSL 2	0.35	0.47	0.67
	TSL 3	0.33	0.44	0.62

Table V.85 Present Value of Methane Emissions Reduction for Walk-in Panels Shipped in 2028–2057 (2023 estimates of SC-GHG)

TSL	**Connected Refrigeration System**	**SC-CH_4 Case**		
		Near-term Ramsey Discount Rate		
		2.5%	**2.0%**	**1.5%**
		billion 2023$		
1	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
3	Baseline	0.17	0.24	0.33
	TSL 1	0.17	0.23	0.33
	TSL 2	0.17	0.23	0.32
	TSL 3	0.15	0.20	0.28

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.86 Present Value of Methane Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058 (2023 estimates of SC-GHG)

TSL	**SC-CH_4 Case**		
	Near-term Ramsey Discount Rate		
	2.5%	**2.0%**	**1.5%**
	billion 2023$		
1	0.19	0.26	0.37
2	0.30	0.40	0.57
3	0.98	1.33	1.88

Table V.87 Present Value of Methane Emissions Reduction for Walk-in Doors Shipped in 2028–2057 (2021 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CH_4 Case			
		Discount Rate and Statistics			
		5%	3%	2.5%	3%
		Average	Average	Average	95th percentile
		billion 2023$			
1	Baseline	0.05	0.13	0.18	0.35
	TSL 1	0.05	0.13	0.18	0.35
	TSL 2	0.05	0.13	0.18	0.34
	TSL 3	0.04	0.13	0.17	0.33
2	Baseline	0.08	0.23	0.32	0.60
	TSL 1	0.08	0.23	0.31	0.60
	TSL 2	0.08	0.23	0.31	0.60
	TSL 3	0.07	0.21	0.30	0.57
3	Baseline	0.10	0.28	0.39	0.73
	TSL 1	0.09	0.27	0.38	0.73
	TSL 2	0.09	0.27	0.38	0.72
	TSL 3	0.09	0.26	0.35	0.68

Table V.88 Present Value of Methane Emissions Reduction for Walk-in Panels Shipped in 2028–2057 (2021 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-CH_4 Case			
		Discount Rate and Statistics			
		5%	3%	2.5%	3%
		Average	Average	Average	95th percentile
		billion 2023$			
1	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
3	Baseline	0.05	0.13	0.19	0.35
	TSL 1	0.04	0.13	0.18	0.35

	TSL 2	0.04	0.13	0.18	0.34
	TSL 3	0.04	0.11	0.16	0.30

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.89 Present Value of Methane Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058 (2021 estimates of SC-GHG)

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	**3%**	**2.5%**	**3%**
	Average	**Average**	**Average**	**95th percentile**
	billion 2023$			
1	0.05	0.15	0.21	0.40
2	0.08	0.23	0.32	0.60
3	0.25	0.75	1.05	1.99

Table V.90 Present Value of Nitrous Oxide Emissions Reduction for Walk-in Doors Shipped in 2028–2057 (2023 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-N_2O Case		
		Near-term Ramsey Discount Rate		
		2.5%	**2.0%**	**1.5%**
		billion 2023$		
1	Baseline	0.004	0.006	0.010
	TSL 1	0.004	0.006	0.010
	TSL 2	0.004	0.006	0.010
	TSL 3	0.004	0.006	0.010
2	Baseline	0.007	0.011	0.017
	TSL 1	0.007	0.010	0.017
	TSL 2	0.007	0.010	0.017
	TSL 3	0.006	0.010	0.016
3	Baseline	0.008	0.013	0.021
	TSL 1	0.008	0.013	0.021
	TSL 2	0.008	0.013	0.021
	TSL 3	0.007	0.012	0.020

Table V.91 Present Value of Nitrous Oxide Emissions Reduction for Walk-in Panels Shipped in 2028–2057 (2023 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-N_2O Case		
		Near-term Ramsey Discount Rate		
		2.5%	2.0%	1.5%
		billion 2023$		
1	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
3	Baseline	0.004	0.006	0.010
	TSL 1	0.004	0.006	0.010
	TSL 2	0.004	0.006	0.010
	TSL 3	0.003	0.005	0.009

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.92 Present Value of Nitrous Oxide Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058 (2023 estimates of SC-GHG)

TSL	SC-N_2O Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	0.00	0.01	0.01
2	0.01	0.01	0.02
3	0.02	0.03	0.06

Table V.93 Present Value of Nitrous Oxide Emissions Reduction for Walk-in Doors Shipped in 2028–2057 (2021 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-N_2O Case			
		Discount Rate and Statistics			
		5%	3%	2.5%	3%
		Average	Average	Average	95th percentile
		billion 2023$			

1	Baseline	0.000	0.002	0.003	0.005
	TSL 1	0.000	0.002	0.003	0.005
	TSL 2	0.000	0.002	0.003	0.005
	TSL 3	0.000	0.002	0.003	0.004
2	Baseline	0.001	0.003	0.005	0.008
	TSL 1	0.001	0.003	0.005	0.008
	TSL 2	0.001	0.003	0.005	0.008
	TSL 3	0.001	0.003	0.004	0.007
3	Baseline	0.001	0.004	0.006	0.010
	TSL 1	0.001	0.004	0.006	0.010
	TSL 2	0.001	0.004	0.006	0.010
	TSL 3	0.001	0.003	0.005	0.009

Table V.94 Present Value of Nitrous Oxide Emissions Reduction for Walk-in Panels Shipped in 2028–2057 (2021 estimates of SC-GHG)

TSL	Connected Refrigeration System	SC-N_2O Case			
		Discount Rate and Statistics			
		5%	3%	2.5%	3%
		Average	Average	Average	95th percentile
		billion 2023$			
1	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
3	Baseline	0.000	0.002	0.003	0.005
	TSL 1	0.000	0.002	0.003	0.005
	TSL 2	0.000	0.002	0.003	0.004
	TSL 3	0.000	0.001	0.002	0.004

Note: the entry “n/a” means not applicable because there is no change in the standard at certain TSLs.

Table V.95 Present Value of Nitrous Oxide Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058 (2021 estimates of SC-GHG)

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	**3%**	**2.5%**	**3%**
	Average	**Average**	**Average**	**95th percentile**
	billion 2023$			
1	0.00	0.00	0.00	0.01
2	0.00	0.00	0.00	0.01
3	0.00	0.01	0.01	0.03

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 continue 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 walk-ins. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.96 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.97 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.96 Present Value of NO_X Emissions Reduction for Walk-in Doors Shipped in 2028–2057

TSL	Connected Refrigeration System	7% Discount Rate	3% Discount Rate
		million 2023$	
1	Baseline	1,011.6	430.2
	TSL 1	1,005.3	427.5
	TSL 2	1,002.6	426.4
	TSL 3	964.0	409.9
2	Baseline	1,754.8	745.7
	TSL 1	1,739.9	739.4
	TSL 2	1,733.9	736.9
	TSL 3	1,643.6	698.5
3	Baseline	2,128.4	899.2
	TSL 1	2,106.5	890.0
	TSL 2	2,096.4	885.7
	TSL 3	1,958.8	827.9

Table V.97 Present Value of SO_2 Emissions Reduction for Walk-in Doors Shipped in 2028–2057

TSL	Connected Refrigeration System	7% Discount Rate	3% Discount Rate
		million 2023$	
1	Baseline	233.2	100.8
	TSL 1	231.7	100.2
	TSL 2	231.1	99.9
	TSL 3	222.2	96.1
2	Baseline	404.4	174.8
	TSL 1	401.0	173.3
	TSL 2	399.6	172.7

	TSL 3	378.8	163.7
3	Baseline	490.2	210.6
	TSL 1	485.2	208.4
	TSL 2	482.9	207.5
	TSL 3	451.2	193.9

Table V.98 Present Value of NO_X Emissions Reduction for Walk-in Panels Shipped in 2028–2057

TSL	Connected Refrigeration System	7% Discount Rate	3% Discount Rate
		million 2023$	
1	Baseline	n/a	n/a
	TSL 1	n/a	n/a
	TSL 2	n/a	n/a
	TSL 3	n/a	n/a
2	Baseline	n/a	n/a
	TSL 1	n/a	n/a
	TSL 2	n/a	n/a
	TSL 3	n/a	n/a
3	Baseline	1,005.1	407.8
	TSL 1	986.2	400.1
	TSL 2	974.7	395.4
	TSL 3	846.7	343.5

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.99 Present Value of SO_2 Emissions Reduction for Walk-in Panels Shipped in 2028–2057

TSL	Connected Refrigeration System	7% Discount Rate	3% Discount Rate
		million 2023$	
1	Baseline	n/a	n/a
	TSL 1	n/a	n/a
	TSL 2	n/a	n/a

	TSL 3	n/a	n/a
2	Baseline	n/a	n/a
	TSL 1	n/a	n/a
	TSL 2	n/a	n/a
	TSL 3	n/a	n/a
3	Baseline	230.4	94.9
	TSL 1	226.1	93.2
	TSL 2	223.5	92.1
	TSL 3	194.1	80.0

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.100 Present Value of NO_X Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058

TSL	7% Discount Rate	3% Discount Rate
	million 2023$	
1	1,118.1	446.9
2	1,709.1	683.6
3	5,623.9	2,248.9

Table V.101 Present Value of SO_2 Emissions Reduction for Walk-in Refrigeration Systems Shipped in 2029–2058

TSL	3% Discount Rate	7% Discount Rate
	million 2023$	
1	255.8	103.7
2	391.0	158.7
3	1,286.6	521.9

Not all the public health and environmental benefits from the reduction of GHGs, 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 of Energy, 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)) No other factors were considered in this analysis.

8. Summary of Economic Impacts

Table V.102 through Table V.107 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 walk-in envelope components shipped in 2028–2057, and walk-in refrigeration systems shipped in 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 walk-in envelope components shipped in 2028–2057, and walk-in refrigeration systems shipped in 2029-2058.

Table V.102 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for Walk-in Doors (2023 SC-GHG estimates)

TSL	Connected Refrigeration System	2.5% Near-term Ramsey DR	2.0% Near-term Ramsey DR	1.5% Near-term Ramsey DR
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
1	Baseline	4.85	5.84	7.69
	TSL 1	4.82	5.80	7.64
	TSL 2	4.81	5.79	7.62
	TSL 3	4.60	5.54	7.30
2	Baseline	8.27	9.99	13.19
	TSL 1	8.19	9.89	13.07
	TSL 2	8.16	9.86	13.02
	TSL 3	7.67	9.28	12.28
3	Baseline	-0.03	2.06	5.96
	TSL 1	-0.15	1.92	5.78
	TSL 2	-0.21	1.86	5.70
	TSL 3	-0.94	0.98	4.57
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
1	Baseline	2.98	3.97	5.82
	TSL 1	2.96	3.95	5.78
	TSL 2	2.95	3.94	5.77
	TSL 3	2.83	3.77	5.53
2	Baseline	5.09	6.81	10.01
	TSL 1	5.04	6.75	9.92
	TSL 2	5.02	6.72	9.89
	TSL 3	4.73	6.34	9.34
3	Baseline	0.64	2.73	6.63
	TSL 1	0.56	2.64	6.50
	TSL 2	0.53	2.59	6.44
	TSL 3	0.09	2.01	5.60

Table V.103 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for Walk-in Doors (2021 Interim SC-GHG estimates)

TSL	Connected Refrigeration System	5% Average SC-GHG case	3% Average SC-GHG case	2.5% Average SC-GHG case	2.5% Average SC-GHG case
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)					
1	Baseline	3.51	3.98	4.30	5.21
	TSL 1	3.49	3.95	4.27	5.17
	TSL 2	3.48	3.94	4.26	5.16
	TSL 3	3.32	3.76	4.07	4.94
2	Baseline	5.94	6.75	7.31	8.88
	TSL 1	5.88	6.68	7.24	8.80
	TSL 2	5.86	6.65	7.21	8.76
	TSL 3	5.49	6.25	6.78	8.25
3	Baseline	-2.87	-1.89	-1.20	0.71
	TSL 1	-2.95	-1.98	-1.30	0.58
	TSL 2	-2.99	-2.03	-1.35	0.53
	TSL 3	-3.55	-2.65	-2.02	-0.26
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)					
1	Baseline	1.64	2.11	2.43	3.34
	TSL 1	1.63	2.09	2.42	3.32
	TSL 2	1.62	2.09	2.41	3.31
	TSL 3	1.55	1.99	2.30	3.17
2	Baseline	2.76	3.57	4.13	5.71
	TSL 1	2.73	3.53	4.09	5.65
	TSL 2	2.72	3.52	4.08	5.63
	TSL 3	2.55	3.30	3.83	5.30
3	Baseline	-2.20	-1.22	-0.53	1.38
	TSL 1	-2.24	-1.27	-0.59	1.30
	TSL 2	-2.26	-1.29	-0.61	1.26
	TSL 3	-2.52	-1.62	-0.99	0.77

Table V.104 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for Walk-in Panels (2023 SC-GHG estimates)

TSL	Connected Refrigeration System	2.5% Near-term Ramsey DR	2.0% Near-term Ramsey DR	1.5% Near-term Ramsey DR
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
1	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
3	Baseline	-1.04	-0.03	1.87
	TSL 1	-1.14	-0.15	1.71
	TSL 2	-1.20	-0.22	1.61
	TSL 3	-1.89	-1.04	0.55
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)				
1	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a
3	Baseline	-0.35	0.67	2.56
	TSL 1	-0.41	0.59	2.44
	TSL 2	-0.45	0.54	2.37
	TSL 3	-0.86	0.00	1.59

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.105 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for Walk-in Panels (2021 Interim SC-GHG estimates)

TSL	Connected Refrigeration System	5% Average SC-GHG case	3% Average SC-GHG case	2.5% Average SC-GHG case	2.5% Average SC-GHG case
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)					
1	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
3	Baseline	-2.40	-1.93	-1.60	-0.70
	TSL 1	-2.48	-2.02	-1.70	-0.81
	TSL 2	-2.53	-2.07	-1.75	-0.88
	TSL 3	-3.04	-2.65	-2.37	-1.61
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)					
1	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
2	Baseline	n/a	n/a	n/a	n/a
	TSL 1	n/a	n/a	n/a	n/a
	TSL 2	n/a	n/a	n/a	n/a
	TSL 3	n/a	n/a	n/a	n/a
3	Baseline	-1.71	-1.24	-0.91	-0.01
	TSL 1	-1.75	-1.29	-0.96	-0.08
	TSL 2	-1.77	-1.31	-0.99	-0.12
	TSL 3	-2.00	-1.61	-1.33	-0.57

Note: the entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

Table V.106 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for Walk-in Refrigeration Systems (2023 SC-GHG estimates)

Category	TSL 1	TSL 2	TSL 3
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)			
2.5% Near-term Ramsey DR	4.84	7.36	7.40
2.0% Near-term Ramsey DR	5.97	9.09	13.08
1.5% Near-term Ramsey DR	8.08	12.31	23.70
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)			
2.5% Near-term Ramsey DR	2.96	4.51	6.41
2.0% Near-term Ramsey DR	4.09	6.24	12.09
1.5% Near-term Ramsey DR	6.20	9.47	22.71

Table V.107 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits for Walk-in Refrigeration Systems (2021 Interim SC-GHG estimates)

Category	TSL 1	TSL 2	TSL 3
Using 3% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)			
5% Average SC-GHG case	3.32	5.04	-0.25
3% Average SC-GHG case	3.84	5.83	2.38
2.5% Average SC-GHG case	4.21	6.40	4.23
2.5% Average SC-GHG case	5.21	7.93	9.28
Using 7% Discount Rate for Consumer NPV and Health Benefits (billion 2023$)			
5% Average SC-GHG case	1.44	2.19	-1.24
3% Average SC-GHG case	1.96	2.99	1.39
2.5% Average SC-GHG case	2.33	3.55	3.24
3% 95th percentile SC-GHG case	3.33	5.08	8.28

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(a); 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(a); 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(a); 42 U.S.C. 6295(o)(3)(B))

For this final rule, DOE considered the impacts of new and amended standards for walk-ins 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.

1. Benefits and Burdens of TSLs Considered for Walk-In Cooler and Walk-In Freezer Standards

a. Refrigeration Systems

The efficiency levels contained in each TSL are shown in Table V.108 and described in section IV.E.1 of this document. Table V.109 and Table V.110 summarize the quantitative impacts estimated for each TSL for walk-in refrigeration systems. The national impacts are measured over the lifetime of walk-ins purchased in 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 estimated benefits from reductions in GHG emissions, including the estimates published by EPA in December 2023 or the Interim Estimates presented by the Interagency Working Group in 2021.

Table V.108 Walk-in Refrigeration System Efficiency Levels by Trial Standard Level

Type	Equipment Class	Capacity (kBtu/h)	TSL 1	TSL 2	TSL 3
Dedicated Condensing Systems	DC.L.I	3	1	1	2
	DC.L.I	9	0	0	1
	DC.L.I	25	2	2	3
	DC.L.I	54	1	1	2
	DC.L.O	3	2	2	3
	DC.L.O	9	4	4	5
	DC.L.O	25	7	7	8
	DC.L.O	54	4	4	5
	DC.L.O	75	2	2	4
	DC.M.I	9	0	0	1
	DC.M.I	25	2	2	3

Type	Equipment Class	Capacity (kBtu/h)	TSL 1	TSL 2	TSL 3
	DC.M.I	54	2	3	4
	DC.M.I	75	2	2	3
	DC.M.O	9	2	3	8
	DC.M.O	25	2	3	8
	DC.M.O	54	2	4	9
	DC.M.O	75	2	3	8
	DC.M.O	124	2	4	9
Single-Packaged Dedicated Condensing Systems	SP.H.I	2	1	2	2
	SP.H.I	7	2	2	2
	SP.H.I.D	2	2	2	2
	SP.H.I.D	7	2	2	2
	SP.H.O	2	5	5	6
	SP.H.O	7	5	5	6
	SP.H.O.D	2	5	6	6
	SP.H.O.D	7	6	6	6
	SP.L.I	2	4	4	7
	SP.L.I	6	1	1	2
	SP.L.O	2	0	2	4
	SP.L.O	6	1	2	4
	SP.M.I	2	3	3	5
	SP.M.I	9	1	1	3
	SP.M.O	2	8	8	9
	SP.M.O	9	3	3	5
Unit Coolers	UC.H	9	0	0	1
	UC.H	25	0	0	1
	UC.H.D	9	1	1	1
	UC.H.D	25	1	1	1
	UC.L	3	1	2	2
	UC.L	9	2	2	2
	UC.L	25	1	2	2
	UC.L	54	2	2	2
	UC.L	75	1	2	2
	UC.M	3	2	2	2
	UC.M	9	1	2	2
	UC.M	25	2	2	2
	UC.M	54	1	2	2
	UC.M	75	0	0	2

Table V.109 Summary of Analytical Results for Walk-in Refrigeration System TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3
Cumulative FFC National Energy Savings			
Quads	0.67	1.03	3.39
Cumulative FFC Emissions Reduction			
CO_2 (*million metric tons*)	12.04	18.40	60.55
CH_4 (*thousand tons*)	102.09	155.95	513.28
N_2O (*thousand tons*)	0.12	0.18	0.59
SO_2 (*thousand tons*)	3.68	5.62	18.49
NO_X (*thousand tons*)	22.51	34.39	113.20
Hg (*tons*)	0.03	0.04	0.13
Present Value of Benefits and Costs (*3% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	2.54	3.87	7.28
Climate Benefits* (2023 SC-GHG estimate)	2.83	4.33	14.24
Climate Benefits* (2021 interim SC-GHG estimate)	0.70	1.07	3.54
Health Benefits**	1.37	2.10	6.91
Total Benefits† (2023 SC-GHG estimate)	6.75	10.29	28.43
Total Benefits† (2021 interim SC-GHG estimate)	4.62	7.04	17.72
Consumer Incremental Product Costs‡	0.78	1.21	15.34
Consumer Net Benefits	1.76	2.66	-8.07
Total Net Benefits (2023 SC-GHG estimate)	5.97	9.09	13.08
Total Net Benefits (2021 interim SC-GHG estimate)	3.84	5.83	2.38
Present Value of Benefits and Costs (*7% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	1.13	1.71	3.24
Climate Benefits* (2023 SC-GHG estimate)	2.83	4.33	14.24
Climate Benefits* (2021 interim SC-GHG estimate)	0.70	1.07	3.54
Health Benefits**	0.55	0.84	2.77
Total Benefits† (2023 SC-GHG estimate)	4.51	6.88	20.25
Total Benefits† (2021 interim SC-GHG estimate)	2.38	3.63	9.54
Consumer Incremental Product Costs‡	0.42	0.64	8.16
Consumer Net Benefits	0.71	1.07	-4.92
Total Net Benefits (2023 SC-GHG estimate)	4.09	6.24	12.09
Total Net Benefits (2021 interim SC-GHG estimate)	1.96	2.99	1.39

Note: This table presents the costs and benefits associated with walk-in refrigeration systems shipped in 2029−2058. These results include benefits to consumers which accrue after 2058 from the products shipped in 2029−2058.
Parentheses indicate negative (-) values. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.

* Climate benefits are calculated using 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 another interim set of estimates published in 2021 by the Interagency Working Group on the SC-GHG (IWG) (“2021 Interim SC-GHG”) which were used in the NOPR.) These estimates represent the global SC-GHG. 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. The health benefits are presented at real discount rates of 3 and 7 percent. Table 5 of the EPA’s Estimating the Benefit per Ton of Reducing $PM_{2.5}$ 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 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 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.
† 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 a 2 percent near-term Ramsey discount rate for the 2023 estimate and the average SC-GHG with a 3-percent discount rate for the 2021 interim SC-GHG estimate.
‡ Costs include incremental equipment costs as well as installation costs.

Table V.110 Summary of Analytical Results for Walk-in Coolers and Freezers Refrigeration System TSLs: Manufacturer and Consumer Impacts

Category	TSL 1*	TSL 2*	TSL 3*
Manufacturer Impacts			
Industry NPV (*million 2023$*) (No-new-standards case INPV = 542.0)	492.3 to 502.5	480.8 to 496.2	360.8 to 570.8
Industry NPV *(% change)*	(9.2) to (7.3)	(11.3) to (8.4)	(33.4) to 5.3
Consumer Average LCC Savings (2023$)			
DC.L.I	381	381	(2,241)
DC.L.O	112	112	(8,252)
DC.M.I	548	660	(726)
DC.M.O	90	298	(220)
SP.H.I	147	161	161
SP.H.I.D	368	368	368
SP.H.O	108	108	(92)
SP.H.O.D	356	316	316
SP.L.I	285	285	(937)
SP.L.O	102	101	(1,150)
SP.M.I	132	132	(1,016)
SP.M.O	68	68	(1,212)

Category	TSL 1*	TSL 2*	TSL 3*
UC.H	0	0	(120)
UC.H.D	214	214	214
UC.L	1,026	1,304	1,304
UC.M	65	66	15
Shipment-Weighted Average*	256	370	(861)
Consumer Simple PBP (years)			
DC.L.I	2.0	2.0	20.3
DC.L.O	4.4	4.4	24.2
DC.M.I	3.2	3.5	11.4
DC.M.O	0.3	1.5	6.7
SP.H.I	0.5	0.7	0.7
SP.H.I.D	0.8	0.8	0.8
SP.H.O	3.1	3.1	7.5
SP.H.O.D	2.9	3.2	3.2
SP.L.I	2.0	2.0	16.1
SP.L.O	0.1	0.2	33.3
SP.M.I	2.7	2.7	29.2
SP.M.O	3.8	3.8	47.4
UC.H	0.0	0.0	33.8
UC.H.D	1.2	1.2	1.2
UC.L	1.1	1.2	1.2
UC.M	4.4	4.7	5.8
Shipment-Weighted Average*	2.4	3.0	8.6
Percent of Consumers that Experience a Net Cost (%)			
DC.L.I	3	3	99
DC.L.O	36	36	93
DC.M.I	5	6	87
DC.M.O	0	3	76
SP.H.I	1	1	1
SP.H.I.D	0	0	0
SP.H.O	17	17	79
SP.H.O.D	13	24	24
SP.L.I	6	6	100
SP.L.O	0	0	100
SP.M.I	13	13	100
SP.M.O	18	18	100
UC.H	0	0	95
UC.H.D	2	2	2
UC.L	5	8	8
UC.M	38	43	52
Shipment-Weighted Average*	16	19	64

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 2024.

For walk-in refrigeration systems, DOE first considered TSL 3, which represents the max-tech efficiency levels. At this level, DOE expects that medium- and low-temperature dedicated condensing system equipment classes[143] would require larger condenser coils, variable capacity compressors, and electronically commutated variable-speed condenser fan motors. Additionally, low- and medium-temperature outdoor dedicated condensing system equipment classes would generally require self-regulating crankcase heater controls with a temperature switch, and ambient subcooling circuits. DOE anticipates that low- and medium-temperature single-packaged dedicated system equipment classes would also require larger evaporator coils, variable speed evaporator fans, and thermal insulation up to 4 inches in thickness. DOE expects that lower-capacity low- and medium-temperature single-packaged dedicated condensing units would require propane compressors. DOE expects that high-temperature dedicated condensing system equipment classes would require the same design options as medium- and low-temperature dedicated condensing systems except for larger condensing coils and variable capacity compressors.[144] Additionally, DOE expects that high-temperature single-packaged dedicated condensing systems would require up to 1.5 inches of thermal insulation and would not require larger evaporator coils or variable speed evaporator

[143] Dedicated condensing system equipment classes include dedicated condensing units, matched-pair refrigeration systems (consisting of a paired dedicated condensing unit and unit cooler) and single-packaged dedicated systems.

[144] As discussed in section 5.7 of the final rule TSD, DOE did not consider larger condensing coils or variable capacity compressors for high-temperature dedicated condensing systems.

fans.[145] Finally, DOE anticipates that low-, medium-, and high-temperature unit cooler equipment classes would require evaporator coils 5 rows deep at TSL 3.

TSL 3 would save an estimated 3.39 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be -$4.92 billion using a discount rate of 7 percent, and -$8.07 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 60.55 million Mt of CO_2, 18.49 thousand tons of SO_2, 113.20 thousand tons of NO_X, 0.13 tons of Hg, 513.28 thousand tons of CH_4, and 0.59 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 3 is $14.24 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $3.54 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $2.77 billion using a 7-percent discount rate and $6.91 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 $12.09 billion (using the 2023 SC-GHG estimates) or $1.39 billion (using the 2021 interim SC-GHG estimates). Using a 3-

[145] As discussed in section 5.7 of the final rule TSD, DOE did not consider larger evaporator coils or off cycle variable speed evaporator fans for high-temperature single-packaged dedicated condensing systems and only considered improved thermal insulation up to 1.5 inches.

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 total NPV at TSL 3 is $13.08 billion (using the 2023 SC-GHG estimates) or $2.38 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, the average LCC impact ranges from a savings of -$8,252 for low-temperature, outdoor, dedicated condensing units (DC.L.O), to $1,304 for low-temperature unit coolers (UC.L). The simple payback period ranges from 0.7 years for high-temperature, indoor, single-packaged dedicated systems (SP.H.I) to 47.4 years for medium-temperature, outdoor, single-packaged dedicated systems (SP.M.O). The fraction of consumers experiencing a net LCC cost ranges from 0.4 percent for high-temperature, ducted, indoor, single-packaged dedicated systems (SP.H.I.D) to 100.0 percent for low-temperature and medium-temperature indoor and outdoor single-packaged dedicated systems.

At TSL 3, the projected change in INPV ranges from a decrease of $181.1 million to an increase of $28.9 million, which corresponds to a decrease of 33.4 percent and an increase of 5.3 percent, respectively. DOE estimates that industry must invest $149.1 million to redesign walk-in refrigeration systems and purchase new tooling to accommodate changes to the condensers and/or evaporators for most analyzed capacities and equipment classes.

Currently, DOE has no evidence of significant shipments meeting the max-tech levels. As such, all manufacturers would need to redesign their walk-in refrigeration system models to incorporate a range of design options to meet TSL 3 efficiencies. Capital conversion costs are driven by incorporating design options such as larger condenser coils, improved evaporator coils, and/or ambient subcooling circuits, which would likely necessitate new tooling for updated baseplate designs across the full range of refrigeration system capacities and equipment classes. DOE expects manufacturers may need to increase the size of the cabinet to incorporate larger condenser coils or additional rows since there might not be sufficient room to increase the size of the heat exchanger within existing case dimensions. Some manufacturers may need to purchase new equipment to maintain current production levels. Implementing these design options would also require notable engineering resources and testing time, as manufacturers redesign models and potentially increase the footprint of refrigeration systems to accommodate larger condensers and/or evaporators.

Manufacturers would also need to qualify, source, and test new high-efficiency components. For medium- and low-temperature dedicated condensing system equipment classes that would likely require variable capacity compressors to meet the max-tech levels, manufacturers could face challenges sourcing variable capacity compressors across their portfolio of capacity offerings since the availability of variable capacity compressors for walk-in applications is limited. At the time of this final rule publication, the few variable capacity compressor product lines DOE identified appear to be primarily advertised for markets outside of North America. Additionally, the identified product lines may not have a sufficient range of available compressor capacities to replace compressors in all walk-in applications.

The Secretary concludes that at TSL 3 for walk-in refrigeration systems, the benefits of energy savings, emissions reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on many consumers in the form of negative NPV of consumer benefits, and the impacts on manufacturers, including the large conversion costs, and profit margin impacts that could result in a large reduction in INPV. Most consumers of low- and medium-temperature dedicated condensing system and single-packaged dedicated system consumers (ranging from 0.4 to 100.0 percent) would experience a net cost and the average LCC savings would be negative. At this level, there is risk of greater reduction in INPV at max-tech if manufacturers maintain their operating profit in the presence of amended efficiency standards on account of having higher costs but similar profits. Most manufacturers would need to dedicate significant capital and engineering resources to incorporate all analyzed design options across their entire range of equipment classes and capacity offerings. Furthermore, manufacturers may face challenges sourcing variable capacity compressors given the limited availability of variable capacity compressor product lines designed for walk-in applications. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

DOE then considered TSL 2 for walk-in refrigeration systems. DOE expects that for medium- and low-temperature dedicated condensing systems, TSL 2 would not necessitate the use of variable capacity compressors. DOE expects that at TSL 2, all dedicated condensing system equipment classes would generally require electronically commutated condenser fan motors; all outdoor dedicated condensing system equipment would generally require self-regulating crankcase heater controls with a temperature switch; additionally, low-temperature outdoor dedicated condensing system equipment classes would generally require variable-speed condenser fan motors and all but the highest capacity units would generally require ambient subcooling circuits; some medium-temperature outdoor dedicated condensing unit equipment classes would require improved single-speed compressors; low-temperature and indoor medium-temperature dedicated condensing unit equipment classes would generally require larger condenser coils; low- and medium-temperature single-packaged dedicated system equipment classes would generally require larger evaporator coils and variable speed evaporator fans; lower-capacity medium-temperature single-packaged dedicated condensing systems would generally require propane compressors; higher capacity indoor low-temperature single-packaged dedicated system equipment classes would generally require thermal insulation up to 4 inches in thickness; outdoor medium-temperature single-packaged dedicated system equipment classes would generally require variable speed condenser fans; lower capacity outdoor medium-temperature single-packaged dedicated system equipment classes would generally require thermal insulation up to 4 inches in thickness and ambient subcooling circuits; high-temperature indoor, and outdoor ducted, dedicated condensing system equipment classes would generally incorporate max-tech design options; finally high-temperature outdoor non-ducted dedicated condensing system equipment classes would generally require thermal insulation up to 1.5 inches in thickness, and variable speed condenser fans.

DOE expects that at TSL 2 all unit cooler equipment classes would incorporate the max-tech design options, except for high-temperature non-ducted unit coolers, which would generally require evaporator coils 4 rows deep, and highest-capacity medium-temperature unit coolers, which would generally only require 3-row deep evaporator coils.

TSL 2 would save an estimated 1.03 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $1.07 billion using a discount rate of 7 percent, and $2.66 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 18.40 million Mt of CO_2, 5.62 thousand tons of SO_2, 34.39 thousand tons of NO_X, 0.04 tons of Hg, 155.95 thousand tons of CH_4, and 0.18 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 2 is $4.33 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $1.07 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 2 is $0.84 billion using a 7-percent discount rate and $2.10 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 2 is \$6.24 billion (using the 2023 SC-GHG estimates) or \$2.99 billion (using the 2021interim SC-GHG estimates). Using a 3-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 total NPV at TSL 2 is \$9.09 billion (using the 2023 SC-GHG estimates) or \$5.83 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 standard level is economically justified.

At TSL 2, the average LCC impact ranges from a savings of \$66 for medium-temperature unit coolers (UC.M) to \$1,304 for low-temperature unit coolers (UC.L).[146] The simple payback period ranges from 0.2 years for low-temperature, outdoor, single-packaged dedicated systems (SP.L.O) to 4.7 years for medium-temperature unit coolers (UC.M). The fraction of consumers experiencing a net LCC cost ranges from 0 percent for low-temperature, outdoor, single-packaged dedicated systems (SP.L.O) and high-temperature, indoor, ducted single-packaged dedicated systems (SP.H.I.D) to 42.8 percent for medium temperature unit coolers (UC.M).

[146] For this summary statement of consumer impacts DOE did not include high-temperature unit coolers as DOE is not amending standards for this equipment at this time.

At TSL 2, the projected change in INPV ranges from a decrease of $61.2 million to a decrease of $45.7 million, which corresponds to decreases of 11.3 percent and 8.4 percent, respectively. DOE estimates that industry must invest $90.1 million to redesign walk-in refrigeration systems and purchase some new tooling to accommodate changes to the condensers and/or evaporators for select capacities and equipment classes. At this level, DOE expects manufacturers could reach the TSL 2 efficiencies without implementing all the max-tech design options. Specifically, compared to max-tech, only some analyzed dedicated condensing system representative units would have to incorporate larger condenser coils or ambient subcooling, reducing the expected capital and product conversion costs at this level (*i.e.*, all DC.M.O representative units would not require larger condensers or ambient subcooling, which accounts for approximately 50 percent of industry dedicated refrigeration system unit shipments). Additionally, at this level, DOE does not expect manufacturers would need to implement variable capacity compressors, further reducing industry product conversion costs as compared to TSL 3.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that a standard set at TSL 2 for refrigeration systems would be economically justified. At this TSL, the average LCC savings for all refrigeration equipment is positive. The consumers of medium-temperature unit coolers will be most affected with 43 percent of consumers experiencing a net cost, the consumers of the remaining equipment are estimated to experience a net cost between 1 and 36 percent of the time. 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 2, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 19 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 2 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included – representing $4.33 billion in climate benefits (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $1.07 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimate), and $2.10 billion (using a 3-percent discount rate) or $0.84 billion (using a 7-percent discount rate) in health benefits – the rationale becomes stronger still.

Therefore, based on the previous considerations, DOE adopts energy conservation standards for walk-in refrigeration systems at TSL 2. The amended energy conservation standards for walk-in refrigeration systems, which are expressed as AWEF2, are shown in Table V.111.

Table V.111 Amended Energy Conservation Standards for Walk-in Refrigeration Systems

Equipment Class	Net Capacity (q_{net})*	Minimum AWEF2* Btu/W-h
Dedicated Condensing System - High-Temperature, Indoor, Non-Ducted	< 7,000 Btu/h	$7.55 \times 10^{-4} \times q_{net} + 2.37$
	≥ 7,000 Btu/h	7.66
Dedicated Condensing System – High-Temperature, Outdoor, Non-Ducted	< 7,000 Btu/h	$1.02 \times 10^{-3} \times q_{net} + 2.40$
	≥ 7,000 Btu/h	9.55
Dedicated Condensing System - High-Temperature, Indoor, Ducted	< 7,000 Btu/h	$2.46 \times 10^{-4} \times q_{net} + 1.55$
	≥ 7,000 Btu/h	3.27
Dedicated Condensing System - High-Temperature, Outdoor, Ducted	< 7,000 Btu/h	$3.60 \times 10^{-4} \times q_{net} + 1.88$
	≥ 7,000 Btu/h	4.39
Dedicated Condensing System other than Single-Packaged - Medium-Temperature, Indoor	< 8,000 Btu/h	5.61
	≥ 8,000 Btu/h and < 25,000 Btu/h	$3.35 \times 10^{-5} \times q_{net} + 5.34$
	≥ 25,000 Btu/h	6.18
Dedicated Condensing System other than Single-Packaged - Medium-Temperature, Outdoor	< 25,000 Btu/h	$1.61 \times 10^{-5} \times q_{net} + 7.26$
	≥ 25,000 Btu/h and < 54,000 Btu/h	$7.59 \times 10^{-6} \times q_{net} + 7.47$
	≥ 54,000 Btu/h	7.88
Dedicated Condensing System other than Single-Packaged - Low-Temperature, Indoor	< 9,000 Btu/h	$4.64 \times 10^{-5} \times q_{net} + 2.18$
	≥ 9,000 Btu/h and < 25,000 Btu/h	$2.52 \times 10^{-5} \times q_{net} + 2.37$
	≥ 25,000 Btu/h and < 54,000 Btu/h	$1.45 \times 10^{-6} \times q_{net} + 2.96$
	≥ 54,000 Btu/h	3.04
Dedicated Condensing System other than Single-Packaged - Low-Temperature, Outdoor	< 9,000 Btu/h	$9.93 \times 10^{-5} \times q_{net} + 2.62$
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.14 \times 10^{-5} \times q_{net} + 3.23$
	≥ 25,000 Btu/h and < 75,000 Btu/h	$4.72 \times 10^{-6} \times q_{net} + 3.90$
	≥ 75,000 Btu/h	4.25
Single-Packaged Dedicated Condensing System - Medium-Temperature, Indoor	< 9,000 Btu/h	$1.00 \times 10^{-4} \times q_{net} + 4.91$
	≥ 9,000 Btu/h	5.81
Single-Packaged Dedicated Condensing System - Medium-Temperature, Outdoor	< 9,000 Btu/h	$3.07 \times 10^{-4} \times q_{net} + 4.73$
	≥ 9,000 Btu/h	7.49
Single-Packaged Dedicated Condensing System - Low-Temperature, Indoor	< 6,000 Btu/h	$8.00 \times 10^{-5} \times q_{net} + 1.80$
	≥ 6,000 Btu/h	2.28
Single-Packaged Dedicated Condensing System - Low-Temperature, Outdoor	< 6,000 Btu/h	$1.39 \times 10^{-4} \times q_{net} + 1.95$
	≥ 6,000 Btu/h	2.78
Unit Cooler - High-Temperature Non-Ducted	< 9,000 Btu/h	10.33
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.83 \times 10^{-4} \times q_{net} + 6.89$
	≥ 25,000 Btu/h	16.45
Unit Cooler - High-Temperature Ducted	< 9,000 Btu/h	6.64
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.70 \times 10^{-4} \times q_{net} + 3.31$
	≥ 25,000 Btu/h	12.57
Unit Cooler - Medium-Temperature	< 54,000 Btu/h	9.65
	≥ 54,000 Btu/h and < 75,000 Btu/h	$-3.10 \times 10^{-5} \times q_{net} + 11.32$
	≥ 75,000 Btu/h	9.00
Unit Cooler - Low-Temperature	All	4.57

* Where q_{net} is net capacity as determined in accordance with § 431.304 and certified in accordance with 10 CFR part 429.

b. Doors

Table V.113, Table V.114, Table V.116, and Table V.117 summarize the quantitative impacts estimated for each TSL for walk-in display doors and non-display doors. National impacts for walk-in doors are measured over the lifetime of walk-ins purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2028–2057). 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 estimated benefits from reductions in GHG emissions, including the estimates published by EPA in December 2023 or the Interim Estimates presented by the Interagency Working Group in 2021. The efficiency levels contained in each TSL are described in section IV.E.1 of this document and shown in Table V.112 and Table V.115 for display doors and non-display doors, respectively.

Display Doors

Walk-in display door efficiency levels contained in each TSL are shown in Table V.112 and described in section IV.E.1 of this document and summarize the quantitative impacts estimated for each TSL for walk-in display doors.

Table V.112 Walk-in Display Doors Efficiency Level Mapping by Trial Standard Level

Equipment Class	TSL 1	TSL 2	TSL 3
Low Temperature (DW.L)	0	0	2
Medium Temperature (DW.M)	0	0	2

Table V.113 Summary of Analytical Results for Walk-in Display Door TSLs: National Impacts (Evaluated when used in conjunction with a TSL 2 Refrigeration System)

Category	TSL 1	TSL 2	TSL 3
Cumulative FFC National Energy Savings			
Quads	n/a	n/a	0.13
Cumulative FFC Emissions Reduction			
CO_2 (*million metric tons*)	n/a	n/a	2.41
CH_4 (*thousand tons*)	n/a	n/a	20.38
N_2O (*thousand tons*)	n/a	n/a	0.02
SO_2 (*thousand tons*)	n/a	n/a	0.73
NO_X (*thousand tons*)	n/a	n/a	4.49
Hg (*tons*)	n/a	n/a	0.01
Present Value of Benefits and Costs (*3% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	n/a	n/a	0.58
Climate Benefits* (2023 SC-GHG estimate)	n/a	n/a	0.57
Climate Benefits* (2021 interim SC-GHG estimate)	n/a	n/a	0.14
Health Benefits**	n/a	n/a	0.27
Total Benefits† (2023 SC-GHG estimate)	n/a	n/a	1.42
Total Benefits† (2021 interim SC-GHG estimate)	n/a	n/a	1.00
Consumer Incremental Product Costs‡	n/a	n/a	8.50
Consumer Net Benefits	n/a	n/a	-7.91
Total Net Benefits (2023 SC-GHG estimate)	n/a	n/a	-7.07
Total Net Benefits (2021 interim SC-GHG estimate)	n/a	n/a	-7.50
Present Value of Benefits and Costs (*7% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	n/a	n/a	0.26
Climate Benefits* (2023 SC-GHG estimate)	n/a	n/a	0.57
Climate Benefits* (2021 interim SC-GHG estimate)	n/a	n/a	0.14
Health Benefits**	n/a	n/a	0.11
Total Benefits† (2023 SC-GHG estimate)	n/a	n/a	0.94
Total Benefits† (2021 interim SC-GHG estimate)	n/a	n/a	0.51

Consumer Incremental Product Costs‡	n/a	n/a	4.66
Consumer Net Benefits	n/a	n/a	-4.40
Total Net Benefits (2023 SC-GHG estimate)	n/a	n/a	-3.72
Total Net Benefits (2021 interim SC-GHG estimate)	n/a	n/a	-4.15

Note: This table presents the costs and benefits associated with walk-in display doors shipped in 2028−2057. These results include benefits to consumers which accrue after 2057 from the equipment shipped in 2028−2057.
Parentheses indicate negative (-) values. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.
* Climate benefits are calculated using different estimates of the global SC-GHG. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (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 $PM_{2.5}$ 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 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 a 2 percent near-term Ramsey discount rate for the 2023 estimate and the average SC-GHG with a 3-percent discount rate for the 2021 interim SC-GHG estimate.
‡ Costs include incremental equipment costs as well as installation costs

Table V.114 Summary of Analytical Results for Walk-In Display Doors TSLs: Manufacturer and Consumer Impacts (Evaluated when used in conjunction with a TSL 2 Refrigeration System)

Category	TSL 1*	TSL 2*	TSL 3*
Manufacturer Impacts			
Industry NPV (*million 2023*$) (No-new-standards case INPV = 218.7)	218.7	218.7	148.5 to 287.7
Industry NPV *(% change)*	n/a	n/a	(32.1) to 31.5
Consumer Average LCC Savings (2023$)			
DW.L	n/a	n/a	(1,062)
DW.M	n/a	n/a	(1,304)
Shipment-Weighted Average*	n/a	n/a	(1,276)
Consumer Simple PBP (years)			

DW.L	n/a	n/a	37.5
DW.M	n/a	n/a	196.0
Shipment-Weighted Average*	n/a	n/a	177.7
Percent of Consumers that Experience a Net Cost			
DW.L	n/a	n/a	100
DW.M	n/a	n/a	100
Shipment-Weighted Average*	n/a	n/a	100

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 2024.

For walk-in display doors, DOE first considered TSL 3, which represents the max-tech efficiency levels. At TSL 3, DOE expects display doors would require the use of vacuum-insulated glass as a substitute for the prescriptive minimum design of double-pane or triple-pane insulated glass packs for medium-temperature doors and low-temperature doors, respectively. TSL 3 would save an estimated 0.13 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be -$4.40 billion using a discount rate of 7 percent, and -$7.91 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 2.41 million Mt of CO_2, 0.73 thousand tons of SO_2, 4.49 thousand tons of NO_X, 0.01 tons of Hg, 20.38 thousand tons of CH_4, and 0.02 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 3 is 1.42 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $1.00 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.11 billion using a 7-percent discount rate and $0.27 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 -$3.72 billion (using the 2023 SC-GHG estimates) or -$4.15 billion (using the 2021 interim SC-GHG estimates). Using a 3-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 total NPV at TSL 3 is -$7.07 billion (using the 2023 SC-GHG estimates) or -$7.50 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 standard level is economically justified.

At TSL 3, when used in conjunction with a TSL 2 refrigeration system, the average LCC impact ranges from a savings of -$1,304 for medium-temperature display doors (DW.M), to -$1,062 for low-temperature display doors (DW.L). The simple payback period ranges from 37.5 years for low-temperature display doors (DW.L) to 196.0 years for medium-temperature display doors (DW.M). The fraction of consumers experiencing a net LCC cost is 100.0 percent for all equipment classes.

At TSL 3 for walk-in display doors, the projected change in INPV ranges from a decrease of $70.2 million to an increase of $69.0 million, which corresponds to a decrease of 32.1 percent and an increase of 31.5 percent, respectively. DOE estimates industry would invest $37.4 million to redesign walk-in display doors to incorporate vacuum-insulated glass.

DOE estimates that there are no walk-in display door shipments that currently meet the max-tech efficiency levels. For the 10 OEMs that manufacture walk-in display doors, implementing vacuum-insulated glass would require significant engineering resources and testing time to ensure adequate durability of their doors in all commercial settings. In interviews, manufacturers emphasized that there are currently a very limited number of suppliers of vacuum-insulated glass. Door manufacturers expressed concerns that the 3-year conversion period between the publication of the final rule and the compliance date of the amended energy conservation standard might be insufficient to design and test a full portfolio of vacuum-insulated doors that meet the max-tech efficiencies and maintain their internal metrics over the door lifetime.

The Secretary concludes that at TSL 3 for all walk-in display doors, the benefits of energy savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden in the form of negative NPV of consumer benefits, and the impacts on manufacturers, including the large conversion costs and profit margin impacts that could result in a large reduction in INPV. No manufacturers currently offer equipment that meet the efficiency levels required at TSL 3. Walk-in display door manufacturers raised concern about their ability to incorporate vacuum insulated glass across all their offerings, while also maintaining important display door performance characteristics, within three years. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

As discussed in section IV.E.1 of this document, DOE did not incorporate the other analyzed efficiency levels above baseline into TSL 2 or TSL 1 since the other analyzed efficiency levels do not yield positive consumer benefits for either of the display door equipment classes (*see* appendix 8C of the final rule TSD). Absent positive consumer benefits, it is unlikely DOE will determine that there is a sufficient economic basis to support amended standard levels. Here, DOE has determined there is no combination of energy efficiency improvements for display-doors that is economically justified. Therefore, based on the previous considerations, the Secretary is not amending energy conservation standards for walk-in display doors at this time.

Non-Display Doors

Walk-in non-display door efficiency levels contained in each TSL are shown in Table V.115 and described in section IV.E.1 of this document. Table V.116 and Table V.117 summarize the quantitative impacts estimated for each TSL for walk-in non-display doors.

Table V.115 Walk-in Non-Display Door Efficiency Level Mapping by Trial Standard Level

Equipment Class	TSL 1	TSL 2	TSL 3
Non-Motorized Low Temperature (NM.L)	1	3	5
Non-Motorized Medium Temperature (NM.M)	1	3	6
Motorized Low Temperature (NO.L)	1	3	5
Motorized Medium Temperature (NO.M)	1	3	6

Table V.116 Summary of Analytical Results for Walk-in Non-display Doors TSLs: National Impacts (Evaluated when used in conjunction with a TSL 2 Refrigeration System)

Category	TSL 1	TSL 2	TSL 3
Cumulative FFC National Energy Savings			
Quads	0.57	0.99	1.07
Cumulative FFC Emissions Reduction			
CO_2 (*million metric tons*)	10.42	18.02	19.47
CH_4 (*thousand tons*)	87.23	150.92	163.09
N_2O (*thousand tons*)	0.10	0.18	0.19
SO_2 (*thousand tons*)	3.20	5.53	5.97
NO_X (*thousand tons*)	19.37	33.51	36.21
Hg (*tons*)	0.02	0.04	0.04
Present Value of Benefits and Costs (*3% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	2.65	4.59	4.96
Climate Benefits* (2023 SC-GHG estimate)	2.48	4.28	4.63
Climate Benefits* (2021 interim SC-GHG estimate)	0.62	1.08	1.17
Health Benefits**	1.23	2.13	2.31
Total Benefits† (2023 SC-GHG estimate)	6.36	11.00	11.89
Total Benefits† (2021 interim SC-GHG estimate)	4.51	7.80	8.43
Consumer Incremental Product Costs‡	0.57	1.15	2.96
Consumer Net Benefits	2.08	3.44	2.00
Total Net Benefits (2023 SC-GHG estimate)	5.79	9.86	8.93
Total Net Benefits (2021 interim SC-GHG estimate)	3.94	6.65	5.47
Present Value of Benefits and Costs (*7% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	1.25	2.16	2.33
Climate Benefits* (2023 SC-GHG estimate)	2.48	4.28	4.63
Climate Benefits* (2021 interim SC-GHG estimate)	0.62	1.08	1.17
Health Benefits**	0.53	0.91	0.98

Total Benefits† (2023 SC-GHG estimate)	4.25	7.35	7.95
Total Benefits† (2021 interim SC-GHG estimate)	2.40	4.15	4.48
Consumer Incremental Product Costs‡	0.32	0.63	1.63
Consumer Net Benefits	0.93	1.53	0.71
Total Net Benefits (2023 SC-GHG estimate)	3.94	6.72	6.32
Total Net Benefits (2021 interim SC-GHG estimate)	2.09	3.52	2.86

Note: This table presents the costs and benefits associated with walk-in non-display doors shipped in 2028−2057. These results include benefits to consumers which accrue after 2057 from the equipment shipped in 2028−2057.

* Climate benefits are calculated using different estimates of the global SC-GHG. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (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 $PM_{2.5}$ 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 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 a 2 percent near-term Ramsey discount rate for the 2023 estimate and the average SC-GHG with a 3-percent discount rate for the 2021 interim SC-GHG estimate.

‡ Costs include incremental equipment costs as well as installation costs.

Table V.117 Summary of Analytical Results for Walk-in Non-display Doors TSLs: Manufacturer and Consumer Impacts (Evaluated when used in conjunction with a TSL 2 Refrigeration System)

Category	TSL 1*	TSL 2*	TSL 3*
Manufacturer Impacts			
Industry NPV (*million 2023*$) (No-new-standards case INPV = 508.4)	506.4 to 511.9	475.6 to 495.3	415.8 to 475.3
Industry NPV ***(% change)***	(0.4) to 0.7	(6.5) to (2.6)	(18.2) to (6.5)
Consumer Average LCC Savings (2023$)			
NM.L	683	1,185	1,019
NM.M	270	315	(1)
NO.L	914	1,583	1,516
NO.M	397	489	200

Shipment-Weighted Average*	415	616	352
Consumer Simple PBP (years)			
NM.L	1.0	1.0	2.2
NM.M	2.0	2.6	6.9
NO.L	0.8	0.8	1.6
NO.M	1.5	2.0	4.5
Shipment-Weighted Average*	1.6	2.1	5.2
Percent of Consumers that Experience a Net Cost			
NM.L	2	2	7
NM.M	6	11	55
NO.L	1	1	4
NO.M	3	6	33
Shipment-Weighted Average*	4	8	38

Parentheses indicate negative (-) values.
* Weighted by shares of each equipment class in total projected shipments in 2024.

For walk-in non-display doors, DOE first considered TSL 3, which represents the max-tech efficiency levels. At TSL 3, DOE expects manufacturers would likely need to incorporate the following additional design options: anti-sweat heater controls, improved framing systems filled with polyurethane foam instead of wood, reduced anti-sweat heat, and insulation thickness of 6 inches.

For walk-in non-display doors, TSL 3 would save an estimated 1.07 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.71 billion using a discount rate of 7 percent, and $2.00 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 19.47 million Mt of CO_2, 5.97 thousand tons of SO_2, 36.21 thousand tons of NO_X, 0.04 tons of Hg, 163.09 thousand tons of CH_4, and 0.19 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emission at TSL 3 is $4.63 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or 1.17 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.98 billion using a 7-percent discount rate and $2.31 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 $6.32 billion (using the 2023 SC-GHG estimates) or 6.32 billion (using the 2021 interim SC-GHG estimates). Using a 3-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 total NPV at TSL 3 is $8.93 billion year (using the 2023 SC-GHG estimates) or $5.47 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 standard level is economically justified.

At TSL 3, when used in conjunction with a TSL 2 refrigeration system, the average LCC impact ranges from a savings of -$1 for manual, medium-temperature non-display doors (NM.M), to $1,516 for motorized low-temperature non-display doors (NO.L). The simple payback period ranges from 1.6 years for motorized low-temperature non-display doors (NO.L) to 6.9 years for manual, medium-temperature non-display doors (NM.M). The fraction of consumers experiencing a net LCC cost ranges from 4 percent for motorized low-temperature non-display doors (NO.L) to 55 percent for manual, medium-temperature non-display doors (NM.M).

At TSL 3, the projected change in INPV ranges from a decrease of $92.6 million to a decrease of $33.1 million, which corresponds to decreases of 18.2 percent and 6.5 percent, respectively. DOE estimates industry would invest $101.7 million to purchase new foaming equipment and tooling to implement thermally-improved frame designs and increase insulation thickness to 6 inches for all walk-in non-display doors.

DOE estimates that approximately 11.1 percent of walk-in non-display door shipments currently meet the max-tech efficiency levels. For the 51 OEMs that manufacture walk-in non-display doors, increasing insulation thickness from the assumed baseline thickness of 3.5 inches for medium-temperature and 4 inches for low-temperature non-display doors to 6 inches would likely require purchasing new foaming equipment since most manufacturers are only able to manufacture non-display doors up to 5 inches thick. Additionally, non-display door manufacturers were concerned about the flow of foam and the curing time of foam at max-tech. At TSL 3, DOE expects that manufacturers would also incorporate thermally-improved frame designs. New foaming equipment to accommodate thermally-improved frame designs and 6-inch non-display doors would require significant capital investment and is a key driver of capital conversion costs. In addition to the impacts that investments in new foaming equipment may have for non-display door manufacturers overall, it would also disproportionately impact small businesses since nearly all non-display door manufacturers (44 of the 51 OEMs identified) are small businesses and nearly half of the small businesses identified have an estimated annual revenue of less than $6 million.

Furthermore, of the 51 walk-in non-display door OEMs, 40 OEMs also produce walk-in panels. Most of these OEMs use the same panel foaming systems to produce non-display doors that they use to produce panels; however, panel shipments dwarf shipments of non-display doors. Because the same product lines are used, these OEMs offer non-display doors in the same range of thickness as panels. It is typical to align the thickness of non-display doors and panels to avoid a situation where the walk-in door protrudes from the surrounding panel enclosure. Were the thickness of non-display doors and panels to be different in an installation, consumers may need to prematurely replace the surrounding panels to accommodate a thicker non-display door. Thus, a standard that would likely necessitate 6-inch-thick non-display doors may inadvertently force consumers to purchase some or all panels of the walk-in that are 6-inches thick so that the thickness of the entire walk-in is the same or that there is appropriate structural transition between the door and panels of differing thicknesses. As discussed in section V.C.1.c of this document, panels of 6-inch thickness do not have positive consumer benefits.

At levels that DOE expects would likely necessitate thermally-improved frame designs (*i.e.*, TSL 2 and TSL 3), some manufacturers expressed concerns about potential impacts to equipment performance, including maintaining adequate structural durability. Currently, a variety of framing systems exist on the market. Many non-display doors incorporate wood or other high-strength material framing systems, while others incorporate thermally-improved framing systems filled with polyurethane foam. Such thermally-improved frame designs may have reduced structural rigidity compared to traditional (*e.g.*, wood) framing systems. While the presence of this design feature in the walk-in market does indicate its suitability in a range of current applications without any detrimental impact on product performance or lifetime, DOE recognizes that there may be remaining uncertainty regarding the structural suitability of the best thermally-insulating frame systems available on the market in certain applications. Given these concerns, and lacking structural performance data at this time that could be used to quantify such differences, DOE cannot be certain whether the differences in non-display door framing systems currently in the market are due to manufacturer design preferences or specific durability requirements (*e.g.*, large sliding doors manufactured separately from the walk-in in which they are installed may warrant a frame with greater structural durability than doors manufactured together with the surrounding panels as a complete system). If the latter, establishing standards that DOE expects would necessitate thermally-improved frame designs could result in the need for earlier replacement of certain non-display doors due to their potentially reduced structural rigidity in such applications. If the structural integrity of a non-display door with thermally improved frame designs were to be compromised this would require earlier replacement than would have otherwise been expected. As discussed previously in the sensitivity analysis in section IV.F.7 of this document, the cost associated with more frequent replacements would far outweigh the operating cost savings over the lifetime of the equipment, reducing the economic justification at TSL 2 and TSL 3.[147]

For these reasons, DOE cannot be certain that the thermally-improved framing system associated with TSL 2 and TSL 3 efficiencies would not negatively impact the durability of walk-in non-display doors, and, consequently, these impacts may jeopardize the economic benefits that would be achieved at these efficiency levels. DOE emphasizes that its findings in this regard are based on the data available at this time. Additional data that could become available, as well as future advances in walk-in non-display door technologies and design strategies, could alleviate any such concerns or uncertainties regarding equipment performance and could lead DOE to reach a different conclusion in a future rulemaking.

The Secretary concludes that at TSL 3 for walk-in non-display doors, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the potential for negative impacts to the durability of non-display doors, which may jeopardize the economic benefits that would be achieved at these efficiency levels, and the impacts on manufacturers, including the conversion costs and profit margin impacts

[147] In installations where the lifetime of the non-display door is reduced as compared to the no-new-standards case, the consumer would bear additional replacement costs that would outweigh the savings in operating costs when considering the same service lifetime as a non-display door without the thermally improved frame design. This can be seen in Table IV.50 where the consumer LCC savings is negative for all non-display doors at TSL 2 or TSL 3.

that could result in a reduction in INPV, and the limited number of manufacturers currently offering equipment meeting the efficiency levels required at this TSL, including many small businesses of non-display doors. Manufacturers of non-display doors would need to incorporate thermally-improved frame designs and increase insulation thickness to 6 inches across all equipment classes, necessitating large capital investments. Nearly all the non-display door OEMs identified are small, domestic businesses. Lastly, to purchase walk-in doors at TSL 3, consumers may also be required to purchase some or all panels of their walk-ins at a level that is not economically justified for the thickness of the door and panel to be uniform. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

DOE then considered TSL 2 for walk-in non-display doors, which represents EL 3 for all non-display doors. At TSL 2, DOE expects that manufacturers would likely need to incorporate anti-sweat heater controls, improved framing systems, and reduced anti-sweat heat into all non-display door designs.

TSL 2 would save an estimated 0.99 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $1.53 billion using a discount rate of 7 percent, and $3.44 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 18.02 million Mt of CO_2, 5.53 thousand tons of SO_2, 33.51 thousand tons of NO_X, 0.04 tons of Hg, 150.92 thousand tons of CH_4, and 0.18 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 2 is $4.28 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $1.08 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 2 is $0.91 billion using a 7-percent discount rate and $2.13 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 2 is $6.72 billion (using the 2023 SC-GHG estimates) or $3.52 billion (using the 2021 interim SC-GHG estimates). Using a 3-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 total NPV at TSL 2 is $9.86 billion (using the 2023 SC-GHG estimates) or $6.65 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 standard level is economically justified.

At TSL 2, when used in conjunction with a TSL 2 refrigeration system, the average LCC impact ranges from a savings of $315 for manual, medium-temperature non-display doors (NM.M), to $1,583 for motorized, low-temperature non-display doors (NO.L). The simple payback period ranges from 0.8 years for motorized, low-temperature non-display doors (NO.L) to 2.6 years for manual, medium-temperature non-display doors (NM.M). The fraction of consumers experiencing a net LCC cost ranges from 0.8 percent for motorized, low-temperature non-display doors (NO.L) to 2.6 percent for manual, medium-temperature non-display doors (NM.M).

At TSL 2, the projected change in INPV ranges from a decrease of $32.8 million to a decrease of $13.1 million, which corresponds to decreases of 6.5 percent and 2.6 percent, respectively. DOE estimates that industry must invest $35.7 million to comply with standards for non-display doors set at TSL 2. DOE estimates that approximately 14.2 percent of non-display door shipments currently meet TSL 2 efficiencies. DOE does not expect manufacturers would need to increase insulation thickness to meet the efficiency levels required by TSL 2, however, DOE expects manufacturers may need to purchase new foaming equipment to incorporate thermally-improved frame designs. As previously discussed, investments in new foaming equipment would disproportionately impact small businesses since nearly all non-display door manufacturers are small businesses and nearly half of the small businesses identified have an estimated annual revenue of less than $6 million.

As discussed previously, manufacturer concerns surrounding the potential impacts to equipment performance, including maintaining adequate structural durability, applies to the efficiency levels required at TSL 2. Although many non-display doors incorporate wood or other high-strength material framing systems, other non-display doors incorporate thermally-improved framing systems filled with polyurethane foam. Such thermally-improved frame designs may have reduced structural rigidity compared to traditional (*e.g.*, wood) framing systems. Based on the data currently available, DOE cannot be certain whether the differences in non-display door framing systems currently in the market are due to manufacturer design preferences or specific durability requirements. If the structural integrity of a non-display door with thermally improved frame designs were to be compromised, necessitating earlier replacement than would have otherwise been expected, the cost associated with more frequent replacements would far outweigh the operating cost savings over the lifetime of the equipment, reducing the economic justification at TSL 2. For these reasons, DOE cannot be certain that the thermally-improved framing system associated with TSL 2 efficiencies would not negatively impact the durability of walk-in non-display doors, and, consequently, these impacts may jeopardize the economic benefits that would be achieved at these efficiency levels. DOE emphasizes that its findings in this regard are based on the data available at this time. Additional data that could become available, as well as future advances in walk-in non-display door technologies and design strategies, could alleviate any such concerns or uncertainties regarding equipment performance and could lead DOE to reach a different conclusion in a future rulemaking.

The Secretary concludes that at TSL 2 for walk-in non-display doors, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the potential for negative impacts to the performance of non-display doors in certain applications, which may jeopardize the economic benefits that would be achieved at TSL 2, and the impacts on manufacturers. Nearly all the non-display door OEMs identified are small, domestic businesses. Manufacturers of non-display doors would need to incorporate thermally-improved frame designs across all equipment classes, which could necessitate large capital investments relative to the annual revenue of many small businesses. Consequently, the Secretary has concluded that TSL 2 is not economically justified.

DOE then considered TSL 1 for walk-in non-display doors, which represents EL 1 for all non-display doors. At TSL 1, DOE expects that manufacturers would likely need to incorporate anti-sweat heater controls into all non-display door designs.

The cumulative emissions reductions at TSL 1 are 10.42 million Mt of CO_2, 3.20 thousand tons of SO_2, 19.37 thousand tons of NO_X, 0.02 tons of Hg, 87.23 thousand tons of CH_4, and 0.10 thousand tons of N_2O The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 1 is $2.48 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $0.62 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 1 is $0.53 billion using a 7-percent discount rate and $1.23 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 1 is $3.94 billion (using the 2023 SC-GHG estimates) or $2.09 billion (using the 2021 interim SC-GHG estimates). Using a 3-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 total NPV at TSL 1 is $5.79 billion (using the 2023 SC-GHG estimates) or $3.94 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 standard level is economically justified.

At TSL 1, when used in conjunction with a TSL 2 refrigeration system, the average LCC impact ranges from a savings of $270 for manual, medium-temperature non-display doors (NM.M), to $914 for motorized, low-temperature non-display doors (NO.L). The simple payback period ranges from 0.8 years for motorized, low-temperature non-display doors (NO.L) to 2.0 years for manual, medium-temperature non-display doors (NM.M). The fraction of consumers experiencing a net LCC cost ranges from 1 percent for motorized, low-temperature non-display doors (NO.L) to 6 percent for manual, medium-temperature non-display doors (NM.M).

At TSL 1, the projected change in INPV ranges from a decrease of $2.0 million to an increase of $3.5 million, which corresponds to a decrease of 0.4 percent and an increase of 0.7 percent, respectively. DOE estimates that industry must invest $1.4 million to comply with standards for non-display doors set at TSL 1. DOE estimates that approximately 32.0 percent of non-display door shipments currently meet TSL 1 efficiencies. At this level, DOE expects manufacturers would likely need to update non-display door models to incorporate anti-sweat heater controls. DOE does not expect manufacturers would need to incorporate thermally-improved frame designs or increase insulation thickness to meet the efficiency levels required by TSL 1.

At TSL 1, DOE's analysis indicates that manufacturers could reach the required efficiencies without incorporating thermally-improved frame designs. Manufacturers did not express any specific concerns regarding non-display door performance (*i.e.*, structural durability) at TSL 1. Based on the information available, DOE concludes that no lessening of equipment performance or reduction of expected lifetime would occur at TSL 1.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that a standard set at TSL 1 for walk-in non-display doors would be economically justified. At this TSL, the average LCC savings for all non-display door consumers are positive, and the greatest fraction of consumers to experience net cost is estimated at 6 percent for medium-temperature, manual non-display doors. At TSL 1, 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 1, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 466 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 1 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included – representing $2.48 billion in climate benefits (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $0.62 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates), and \$1.23 billion (using a 3-percent discount rate) or \$0.53 billion (using a 7-percent discount rate) in health benefits – the rationale becomes stronger still.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for walk-in non-display doors at TSL 1. The amended energy conservation standards for walk-in non-display doors, which are expressed as kWh/year, are shown in Table V.118.

Table V.118 Amended Energy Conservation Standards for Walk-in Non-display Doors

Equipment Class	**Maximum Daily Energy Consumption*** ***kWh/day***
Non-Display Door, Manual, Medium-Temperature	$0.02 \times A_{nd} + 0.58 + 0.33 \times a + 0.07 \times b + 0.24 \times c + e$
Non-Display Door, Manual, Low-Temperature	$0.10 \times A_{nd} + 2.63 + 0.40 \times a + 0.09 \times b + 0.30 \times c + 0.85 \times d + f$
Non-Display Door, Motorized, Medium-Temperature	$0.02 \times A_{nd} + 0.77 + 0.33 \times a + 0.07 \times b + 0.24 \times c + e$
Non-Display Door, Motorized, Low-Temperature	$0.09 \times A_{nd} + 2.88 + 0.40 \times a + 0.09 \times b + 0.30 \times c + 0.85 \times d + f$

A_{nd} represents the surface area of the non-display door in square feet.
a = 1 for a door with lighting and = 0 for a door without lighting.
b = 1 for a door with a digital temperature display without alarms and = 0 for a door without a digital display without alarms.
c = 1 for a door with a digital temperature display with alarms and = 0 for a door without a digital temperature display with alarms.
d = 1 for a door with a heated pressure relief vent and = 0 for a door without a heated pressure relief vent.
e = 0.06 x A_{window} + 0.10, with a maximum value of 0.25, for a door with a heated viewport window, and = 0 for a door without a heated viewport window.
f = 0.54 x A_{window} + 0.23, with a maximum value of 1.50, for a door with a heated viewport window, and = 0 for a door without a heated viewport window.
A_{window} represents the surface area of the viewing window in square feet.

c. Panels

The efficiency levels contained in each TSL are shown in Table V.119 and described in section IV.E.1 of this document. Table V.120 and Table V.121 summarize the quantitative impacts estimated for each TSL for walk-in panels. The national impacts are measured over the lifetime of walk-ins purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2028–2057). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results.

Table V.119 Walk-in Panel Efficiency Level Mapping by Trial Standard Level

Equipment Class	TSL 1	TSL 2	TSL 3
Floor Low Temperature (PF.L)	0	0	3
Structural Low Temperature (PS.L)	0	0	2
Structural Medium Temperature (PS.M)	0	0	3

Table V.120 Summary of Analytical Results for Walk-in Panel TSLs: National Impacts (Evaluated when used in conjunction with a TSL 2 Refrigeration System)

Category	TSL 1	TSL 2	TSL 3
Cumulative FFC National Energy Savings			
Quads	n/a	n/a	0.58
Cumulative FFC Emissions Reduction			
CO_2 (*million metric tons*)	n/a	n/a	10.46
CH_4 (*thousand tons*)	n/a	n/a	88.44
N_2O (*thousand tons*)	n/a	n/a	0.10
SO_2 (*thousand tons*)	n/a	n/a	3.20
NO_X (*thousand tons*)	n/a	n/a	19.53
Hg (*tons*)	n/a	n/a	0.02
Present Value of Benefits and Costs (*3% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	n/a	n/a	2.58
Climate Benefits* (2023 SC-GHG estimate)	n/a	n/a	2.46
Climate Benefits* (2021 interim SC-GHG estimate)	n/a	n/a	0.61
Health Benefits**	n/a	n/a	1.20
Total Benefits† (2023 SC-GHG estimate)	n/a	n/a	6.25
Total Benefits† (2021 interim SC-GHG estimate)	n/a	n/a	4.39
Consumer Incremental Product Costs‡	n/a	n/a	6.47
Consumer Net Benefits	n/a	n/a	-3.88
Total Net Benefits (2023 SC-GHG estimate)	n/a	n/a	-0.22
Total Net Benefits (2021 interim SC-GHG estimate)	n/a	n/a	-2.07
Present Value of Benefits and Costs (*7% discount rate, billion 2023$*)			
Consumer Operating Cost Savings	n/a	n/a	1.16
Climate Benefits* (2023 SC-GHG estimate)	n/a	n/a	2.46
Climate Benefits* (2021 interim SC-GHG estimate)	n/a	n/a	0.61
Health Benefits**	n/a	n/a	0.49
Total Benefits† (2023 SC-GHG estimate)	n/a	n/a	4.11
Total Benefits† (2021 interim SC-GHG estimate)	n/a	n/a	2.26
Consumer Incremental Product Costs‡	n/a	n/a	3.57
Consumer Net Benefits	n/a	n/a	-2.41
Total Net Benefits (2023 SC-GHG estimate)	n/a	n/a	0.54
Total Net Benefits (2021 interim SC-GHG estimate)	n/a	n/a	-1.31

Note: This table presents the costs and benefits associated with walk-in panels shipped in 2028−2057. These results include benefits to consumers which accrue after 2057 from the equipment shipped in 2028−2057.
* Climate benefits are calculated using different estimates of the global SC-GHG. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (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 $PM_{2.5}$ 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 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 a 2 percent near-term Ramsey discount rate for the 2023 estimate and the average SC-GHG with a 3-percent discount rate for the 2021 interim SC-GHG estimate.
‡ Costs include incremental equipment costs as well as installation costs.

Table V.121 Summary of Analytical Results for Walk-In Panel TSLs: Manufacturer and Consumer Impacts (Evaluated when used in conjunction with a TSL 2 Refrigeration System)

Category	TSL 1*	TSL 2*	TSL 3*
Manufacturer Impacts			
Industry NPV (*million 2023*$) (No-new-standards case INPV = 926.0)	926.0	926.0	670.4 to 780.5
Industry NPV ***(% change*)**	n/a	n/a	(27.6) to (15.7)
Consumer Average LCC Savings per ft^2 (2023$)			
PF.L	n/a	n/a	(0.52)
PS.L	n/a	n/a	(0.24)
PS.M	n/a	n/a	(2.37)
Shipment-Weighted Average*	n/a	n/a	(1.83)
Consumer Simple PBP (years)			
PF.L	n/a	n/a	10.4
PS.L	n/a	n/a	9.4
PS.M	n/a	n/a	36.4
Shipment-Weighted Average*	n/a	n/a	29.5
Percent of Consumers that Experience a Net Cost (%)			

Category	TSL 1*	TSL 2*	TSL 3*
PF.L	n/a	n/a	83
PS.L	n/a	n/a	70
PS.M	n/a	n/a	100
Shipment-Weighted Average*	n/a	n/a	93

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 2024.

For walk-in panels, DOE first considered TSL 3, which represents the max-tech efficiency levels. At this level, DOE expects that manufacturers would likely need to increase insulation thickness to 6 inches for all panel equipment classes.

TSL 3 would save an estimated 0.58 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be -$2.41 billion using a discount rate of 7 percent, and -$3.88 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 10.46 million Mt of CO_2, 3.20 thousand tons of SO_2, 19.53 thousand tons of NO_X, 0.02 tons of Hg, 88.44 thousand tons of CH_4, and 0.10 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 3 is $2.46 billion (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC-GHG estimates) or $0.61 billion (associated with the average SC-GHG at a 3-percent discount rate using the 2021 interim SC-GHG estimates). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.49 billion using a 7-percent discount rate and $1.20 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 \$0.54 billion (using the 2023 SC-GHG estimates) or -\$1.31 billion (using the 2021 interim SC-GHG estimates). Using a 3-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 total NPV at TSL 3 is \$0.54 billion (using the 2023 SC-GHG estimates) or -\$1.31 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 standard level is economically justified.

At TSL 3, when used in conjunction with a TSL 2 refrigeration system, the average per square foot LCC impact ranges from a savings of -\$2.37 for medium-temperature structural panels (PS.M), to -\$0.24 for low-temperature structural panels (PS.L). The simple payback period ranges from 9.4 years for low-temperature structural panels (PS.L) to 36.4 years payback period for medium-temperature structural panels (PS.M). The fraction of consumers experiencing a net LCC cost ranges from 70 percent for low-temperature structural panels (PS.L) to 100 percent for medium-temperature structural panels (PS.M).

At TSL 3, the projected change in INPV ranges from a decrease of \$255.5 million to a decrease of \$145.5 million, which corresponds to decreases of 27.6 percent and 15.7

percent, respectively. DOE estimates that industry must invest $312.7 million to update panel designs and purchase new foaming equipment and tooling to increase insulation thickness to 6 inches across all panel models.

DOE estimates that 8.1 percent of walk-in panel shipments currently meet the max-tech levels. Increasing the insulation thickness for all panel equipment classes to 6 inches would require significant capital investment. Like walk-in non-display doors, most manufacturers are currently able to manufacture walk-in panels up to 5 inches thick. A standard level necessitating 6-inch panels would likely require new, costly foaming equipment for all manufacturers. Additionally, DOE estimates that every additional inch of foam increases panel cure times by roughly 10 minutes, which means that manufacturers would likely need to purchase additional equipment to maintain existing throughput. Some OEMs may need to invest in additional manufacturing space to accommodate the extra foaming stations. Of the 43 walk-in panel OEMs, 38 OEMs are small, domestic businesses. In interviews, manufacturers expressed concern about industry's ability to source the necessary foaming equipment to maintain existing production capacity within the 3-year compliance period due to the long lead times and limited number of foam fixture suppliers.

The Secretary concludes that at TSL 3 for walk-in panels, the benefits of energy savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden, in the form of negative NPV, on many consumers, and the impacts on manufacturers, including the large conversion costs, profit margin impacts that could result in a large reduction in INPV, and the small number of manufacturers currently offering equipment meeting the efficiency levels required at this TSL, including most small businesses. A majority of panel consumers would experience a net cost ranging from 83 percent for low-temperature, structural panels to 100 percent for medium-temperature, structural panels and the average LCC savings would be negative. The potential reduction in INPV could be as high as 27.6 percent. The drop in industry value and reduction in free cash flow after the compliance year is driven by a range of factors, but most notably the changes are driven by conversion cost investments manufacturers must make to redesign and produce more efficient walk-in panels. Most manufacturers would need to dedicate significant resources to purchase all new foaming equipment. Due to the longer curing times, some manufacturers may need to both replace existing foaming equipment and purchase additional foaming equipment to maintain current production capacity. Furthermore, most panel manufacturers are small, domestic manufacturers. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

As discussed in section IV.E.1 of this document, DOE did not incorporate the other analyzed efficiency levels above baseline into TSL 2 or TSL 1 since the other analyzed efficiency levels do not yield positive consumer benefits for any of the panel equipment classes (*see* appendix 8C of the final rule TSD). Absent positive consumer benefits, it is unlikely DOE will determine that there is a sufficient economic basis to support amended standard levels. Here, DOE has determined there is no combination of energy efficiency improvements for display-doors that is economically justified. Therefore, based on the previous considerations, the Secretary is not amending energy conservation standards for walk-in panels at this time.

d. Combined Benefits of Amended Standards

For the final rule efficiency levels for refrigeration systems, shown in Table V.111; and non-display doors, shown in Table V.118 the combined quantitative impacts estimates are shown in Table V.122. The national impacts are measured over the lifetime of walk-ins purchased in the 30-year period that begins in the anticipated year of compliance with amended standards, which is 2028–2057 for non-display doors, and 2029-2058 for refrigeration systems. The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results.

Table V.122 Summary of Monetized Benefits and Costs of Adopted Energy Conservation Standards for Non-Display Doors at TSL 1 Shipped During the Period 2028–2057 and for Refrigeration Systems at TSL 2 Shipped During the Period 2029–2058

	Billion $2023
3% discount rate	
Consumer Operating Cost Savings	6.52
Climate Benefits* (2023 SC-GHG estimates)	6.80
Climate Benefits* (2021 interim SC-GHG estimates)	1.70
Health Benefits**	3.33
Total Benefits† (2023 SC-GHG estimates)	16.66
Total Benefits† (2021 interim SC-GHG estimates)	11.55
Consumer Incremental Product Costs‡	1.78
Total Net Benefits† (2023 SC-GHG estimates)	14.88
Total Net Benefits† (2021 interim SC-GHG estimates)	9.77
Change in Producer Cashflow (INPV)‡‡	(0.06) – (0.04)
7% discount rate	
Consumer Operating Cost Savings	2.96
Climate Benefits* (2023 SC-GHG estimates)	6.80
Climate Benefits* (2021 interim SC-GHG estimates)	1.70
Health Benefits**	1.37
Total Benefits† (2023 SC-GHG estimates)	11.14
Total Benefits† (2021 interim SC-GHG estimates)	6.03
Consumer Incremental Product Costs‡	0.96
Total Net Benefits† (2023 SC-GHG estimates)	10.18

	Billion $2023
Total Net Benefits† (2021 interim SC-GHG estimates)	5.07
Change in Producer Cashflow (INPV)‡‡	(0.06) – (0.04)

Note: These results include consumer, climate, and health benefits that accrue after 2057 and 2058 from the walk-in non-display doors and refrigeration systems shipped during the periods 2028−2057 and 2029-2058, respectively.
* Climate benefits are calculated using different estimates of the social cost of carbon ($SC\text{-}CO_2$), methane ($SC\text{-}CH_4$), and nitrous oxide ($SC\text{-}N_2O$). 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 estimate and the average SC-GHG with 3-percent discount rate for the 2021 interim SC-GHG estimate.
‡ Costs include incremental product costs as well as installation costs
‡ Costs include incremental equipment costs as well as installation costs.
‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 9.4 percent for doors, 10.5 percent for panels, and 10.2 percent for refrigeration systems that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-ins, the change in INPV ranges from -$63 million to -$42 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 (2023 SC-GHG estimates) for this final rule, the net benefits would range from $14.82 billion to $14.84 billion at 3-percent discount rate and would range from $10.12 billion to $10.14 billion at 7-percent discount rate.

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 products that meet the adopted standards (consisting primarily of operating cost savings from using less energy), minus increases in product purchase costs; and (2) the annualized monetary value of the climate and health benefits.

a. Non-display Doors

Table V.123 presents the total estimated monetized benefits and costs associated with the adopted standard for walk-in non-display doors, expressed in terms of annualized values. The results under the primary estimate 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 $31.2 million per year in increased equipment costs, while the estimated annual benefits are $123.4 million in reduced equipment operating costs, $117.3 million in climate benefits (using the 2023 SC-GHG estimates) or $34.8 million in climate benefits (using the 2021 interim SC-GHG estimates), and $52.0 million in health benefits. In this case, the net benefit would amount to $261.5 million per year (using the 2023 SC-GHG estimates) or $179.0 million per year (using the 2021 interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_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 is $32.0 million per year in increased equipment costs, while the estimated annual benefits are $147.9 million in reduced operating costs, $117.3 million in climate benefits (using the 2023 SC-GHG estimates) or $34.8 million in climate benefits (using the 2021 interim SC-GHG estimates), and $68.8 million in health benefits. In this case, the net benefit would amount to $302.0 million per year (using the 2023 SC-GHG estimates) or $219.5 million per year (using the 2021 interim SC-GHG estimates).

Table V.123 Annualized Benefits and Costs of Adopted Standards for Non-Display Doors at TSL 1 Shipped During the Period 2028 – 2057

	Million 2023$/year		
	Primary Estimate	**Low-Net-Benefits Estimate**	**High-Net-Benefits Estimate**
3% discount rate			
Consumer Operating Cost Savings	147.9	145.0	158.5
Climate Benefits* (2023 SC-GHG estimates)	117.3	116.6	119.8
Climate Benefits* (2021 interim SC-GHG estimates)	34.8	34.6	35.6
Health Benefits**	68.8	68.4	70.2
Total Benefits† (2023 SC-GHG estimates)	334.0	330.0	348.6
Total Benefits† (2021 interim SC-GHG estimates)	251.5	248.0	264.3
Consumer Incremental Product Costs‡	32.0	36.6	31.9
Net Monetized Benefits (2023 SC-GHG estimates)	302.0	293.4	316.7
Net Monetized Benefits (2021 interim SC-GHG estimates)	219.5	211.4	232.4
Change in Producer Cashflow (INPV)‡‡	(0.2) – 0.3	(0.2) – 0.3	(0.2) – 0.3
7% discount rate			
Consumer Operating Cost Savings	123.4	121.3	132.2
Climate Benefits* (2023 SC-GHG estimates)	117.3	116.6	119.8
Climate Benefits* (2021 interim SC-GHG estimates)	34.8	34.6	35.6
Health Benefits**	52.0	51.6	53.0
Total Benefits† (2023 SC-GHG estimates)	292.7	289.5	305.0
Total Benefits† (2021 interim SC-GHG estimates)	210.2	207.6	220.8
Consumer Incremental Product Costs‡	31.2	34.9	31.2
Net Monetized Benefits (2023 SC-GHG estimates)	261.5	254.7	273.8
Net Monetized Benefits (2021 interim SC-GHG estimates)	179.0	172.7	189.6
Change in Producer Cashflow (INPV)‡‡	(0.2) – 0.3	(0.2) – 0.3	(0.2) – 0.3

Note: These results include consumer, climate, and health benefits that accrue after 2057 from the products shipped during the period 2028–2057 for doors and panels. 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 constant prices rate in the Primary Estimate, a declining rate in the High Net Benefits Estimate, and a inclining rate in the Low Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.2 and IV.H.3 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. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (*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 as well as installation costs.

‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 9.4 percent for doors that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-in doors, the annualized change in INPV ranges from -\$0.2 million to \$0.3 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 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 (2023 SC-GHG estimates) for this final rule, the annualized net benefits would range from \$301.8 million to \$302.3 million at 3-percent discount rate and would range from \$261.3 million to \$261.8 million at 7-percent discount rate.

b. Refrigeration Systems

Table V.124 presents the total estimated monetized benefits and costs associated with the adopted standard for walk-in refrigeration systems, expressed in terms of annualized values. The results under the primary estimate 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 $67.9 million per year in increased equipment costs, while the estimated annual benefits are $180.9 million in reduced equipment operating costs, $209.2 million in climate benefits (using the 2023 SC-GHG estimates) or $61.7 million in climate benefits (using the 2021 interim SC-GHG estimates), and $89.0 million in health benefits. In this case, the net benefit would amount to $411.2 million per year (using the 2023 SC-GHG estimates) or $263.7 million per year (using the 2021 interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO_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 is $61.7 million per year in increased equipment costs, while the estimated annual benefits are $222.0 million in reduced operating costs, $209.2 million in climate benefits (using the 2023 SC-GHG estimates) or $61.7 million in climate benefits (using the 2021 interim SC-GHG estimates), and $165 million in health benefits. In this case, the net benefit would amount to $482.5 million per year (using the 2023 SC-GHG estimates) or $335.1 million per year (using the 2021 interim SC-GHG estimates).

Table V.124 Annualized Benefits and Costs of Adopted Standards for Refrigeration Systems at TSL 2 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	222.0	211.1	238.0
Climate Benefits* (2023 SC-GHG estimates)	209.2	205.8	215.4
Climate Benefits* (2021 interim SC-GHG estimates)	61.7	60.7	63.5
Health Benefits**	120.6	118.6	124.1
Total Benefits† (2023 SC-GHG estimates)	551.7	535.6	577.4
Total Benefits† (2021 interim SC-GHG estimates)	404.3	390.4	425.5
Consumer Incremental Product Costs‡	69.2	91.4	66.7
Net Monetized Benefits (2023 SC-GHG estimates)	482.5	444.1	510.7
Net Monetized Benefits (2021 interim SC-GHG estimates)	335.1	299.0	358.8
Change in Producer Cashflow (INPV)‡‡	(6.5) – (4.8)	(6.5) – (4.8)	(6.5) – (4.8)
7% discount rate			
Consumer Operating Cost Savings	180.9	172.3	193.8
Climate Benefits* (2023 SC-GHG estimates)	209.2	205.8	215.4
Climate Benefits* (2021 interim SC-GHG estimates)	61.7	60.7	63.5
Health Benefits**	89.0	87.5	91.4
Total Benefits† (2023 SC-GHG estimates)	479.1	465.5	500.6
Total Benefits† (2021 interim SC-GHG estimates)	331.6	320.4	348.7
Consumer Incremental Product Costs‡	67.9	85.8	65.8
Net Monetized Benefits (2023 SC-GHG estimates)	411.2	379.7	434.7
Net Monetized Benefits (2021 interim SC-GHG estimates)	263.7	234.6	282.8
Change in Producer Cashflow (INPV)‡‡	(6.5) – (4.8)	(6.5) – (4.8)	(6.5) – (4.8)

Note: These results include consumer, climate, and health benefits that accrue after 2058 from the products shipped during the period 2029-2058 for refrigeration systems. 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 constant prices rate in the Primary Estimate, a declining rate in the High Net Benefits Estimate, and an inclining rate in the Low Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.2 and IV.H.3 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. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (*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 as well as installation costs.

‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 10.2 percent for refrigeration systems that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-in refrigeration systems, the annualized change in INPV ranges from -\$6.5 million to -\$4.8 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 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 (2023 SC-GHG estimates) for this final rule, the annualized net benefits would range from \$476.0 million to \$477.7 million at 3-percent discount rate and would range from \$404.7 million to \$406.4 million at 7-percent discount rate.

c. Amended Standards

Table V.125 presents the total estimated monetized benefits and costs associated with the adopted standard for walk-in non-display doors (TSL 1) and refrigeration systems (TSL 2), expressed 2023$ in terms of annualized values. The results under the primary estimate 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 $99.1 million per year in increased equipment costs, while the estimated annual benefits are $304.4 million in reduced equipment operating costs, $326.5 million in climate benefits (using the 2023 SC-GHG estimates) or $96.5 million in climate benefits (using the 2021 estimates of the SC-GHG), and $136 million in health benefits. In this case, the net benefit would amount to $672.7 million per year (using the 2023 SC-GHG estimates) or $442.7 million per year (using the 2021 estimates of the SC-GHG).

Using a 3-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 is $101.2 million per year in increased equipment costs, while the estimated annual benefits are $369.8 million in reduced operating costs, $326.5 million in climate benefits (using the 2023 SC-GHG estimates) or $96.5 million in climate benefits (using the 2021 estimates of the SC-GHG), and \$189.4 million in health benefits. In this case, the net benefit would amount to \$784.5 million per year (using the 2023 SC-GHG estimates) or \$554.5 million per year (using the 2021 estimates of the SC-GHG).

Table V.125 Annualized Benefits and Costs of Adopted Standards for Non-Display Doors at TSL 1 Shipped During the Period 2028 – 2057; and for Refrigeration Systems at TSL 2 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	369.8	356.2	396.5
Climate Benefits* (2023 SC-GHG estimates)	326.5	322.4	335.2
Climate Benefits* (2021 SC-GHG estimates)	96.5	95.3	99.1
Health Benefits**	189.4	187.0	194.3
Total Benefits† (2023 SC-GHG estimates)	885.7	865.5	926.0
Total Benefits† (2021 SC-GHG estimates)	655.7	638.4	689.8
Consumer Incremental Product Costs‡	101.2	128.0	98.6
Net Monetized Benefits (2023 SC-GHG estimates)	784.5	737.5	827.3
Net Monetized Benefits (2021 SC-GHG estimates)	554.5	510.4	591.2
Change in Producer Cashflow (INPV)‡‡	(6.7) - (4.5)	(6.7) - (4.5)	(6.7) - (4.5)
7% discount rate			
Consumer Operating Cost Savings	304.4	293.6	326.0
Climate Benefits* (2023 SC-GHG estimates)	326.5	322.4	335.2
Climate Benefits* (2021 SC-GHG estimates)	96.5	95.3	99.1
Health Benefits**	140.9	139.1	144.4
Total Benefits† (2023 SC-GHG estimates)	771.8	755.1	805.6
Total Benefits† (2021 SC-GHG estimates)	541.8	528.0	569.4
Consumer Incremental Product Costs‡	99.1	120.7	97.0
Net Monetized Benefits (2023 SC-GHG estimates)	672.7	634.4	708.6
Net Monetized Benefits (2021 SC-GHG estimates)	442.7	407.3	472.4
Change in Producer Cashflow (INPV)‡‡	(6.7) - (4.5)	(6.7) - (4.5)	(6.7) - (4.5)

Note: These results include consumer, climate, and health benefits that accrue after 2057 from the products shipped during the period 2028-2057 for non-display doors and 2058 from the products shipped during the period 2029-2058 for refrigeration systems. 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 constant prices rate in the Primary Estimate, a declining rate in the High Net Benefits Estimate, and an inclining rate in the Low Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.2 and IV.H.3 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. 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 another set published in 2021 by the Interagency Working Group on the SC-GHG (IWG) ("2021 Interim SC-GHG") which was used in the NOPR (*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.
‡‡ Operating Cost Savings are calculated based on the life cycle costs 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.*, 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, cashflow, 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 9.4 percent for doors, 10.5 percent for panels, and 10.2 percent for refrigeration systems that is estimated in the manufacturer impact analysis (*see* chapter 12 of the final rule TSD for a complete description of the industry weighted average cost of capital). For walk-ins, the annualized change in INPV ranges from -$6.7 million to -$4.5 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level 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 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 (2023 SC-GHG estimates) for this final rule, the annualized net benefits would range from $777.8 million to $780.0 million at 3-percent discount rate and would range from $666.0 million to $668.2 million at 7-percent discount rate.

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, OIRA in OMB 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 walk-ins, 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 walk-ins 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

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 Public Law 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 walk-ins, the subject of this document. (42 U.S.C. 6311(1)(G)) EPCA prescribed initial standards for these products. EPCA further provides that, not later than 6 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 product 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(a); 42 U.S.C. 6295(m)(1))

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

In response to the September 2023 NOPR, AHRI commented that it could not provide market share on its members or distinguish whether any are classified as small businesses. (AHRI, No. 72 at p. 17) An anonymous commenter recommended special accommodations be given for small businesses. (Anonymous, No. 57 at p. 1)

DOE acknowledges that it can be challenging to identify small business manufacturers. DOE reviews a range of sources to identify small businesses potentially subject to this rulemaking, as detailed in the following section VI.B.3 of this document. Regarding special accommodations for small businesses, DOE discusses additional compliance flexibilities in section VI.B.5 of this document.

3. Description and Estimated Number of Small Entities Affected

DOE conducted a market survey using public information and subscription-based company reports to identify potential small manufacturers. DOE constructed databases of walk-in doors, panels, and refrigeration systems based on its review of models listed in

DOE's Compliance Certification Database ("CCD")[148] and supplemented the information in CCD with information from the California Energy Commission's Modernized Appliance Efficiency Database System (for refrigeration systems),[149] individual company websites, and prior walk-in rulemakings (79 FR 32050) to create a comprehensive database of walk-in components available on the U.S. market and their characteristics. DOE examined this database to identify companies that manufacture, produce, import, or assemble the equipment covered by this rulemaking. DOE then consulted publicly available data, such as manufacturer websites, manufacturer specifications and product literature, import/export logs (*e.g.*, bills of lading from ImportYeti[150]), and basic model numbers, to identify OEMs of walk-in doors, panels, and refrigeration systems. DOE further relied on public data and subscription-based market research tools (*e.g.*, Dun & Bradstreet reports) to determine company, location, head count, and annual revenue. 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.

Using these data sources, DOE identified 87 OEMs of WICFs that could be potentially affected by this rulemaking. Of these 87 OEMs, 61 are small, domestic manufacturers. DOE notes that some manufacturers may produce more than one of the principal components of WICFs: doors, panels, and refrigeration systems. Of these

[148] DOE's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (last accessed Jan. 26, 2024).
[149] The California Energy Commission's Modernized Appliance Efficiency Database System is available at *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (last accessed Jan. 18, 2024).
[150] ImportYeti, LLC. ImportYeti is available at: *www.importyeti.com* (last accessed April 1, 2024).

small, domestic OEMs, 49 manufacture doors; 38 manufacture panels; and 15 manufacture refrigeration systems.

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

a. Doors

In this final rule, DOE is not amending energy conservation standards for walk-in display doors. Therefore, DOE does not expect that manufacturers of walk-in display doors, including small business manufacturers, would be directly impacted by the efficiency levels adopted in this final rule as the levels would remain at the current DOE minimum efficiency.

In this final rule, DOE is amending energy conservation standards for walk-in non-display doors. Of the 49 small, domestic OEMs of walk-in doors, 44 manufacture non-display doors. Of these 44 small, domestic OEMs of walk-in non-display doors, three also manufacture walk-in refrigeration systems. Since these three small businesses would need to meet the adopted standards for both non-display doors and refrigeration systems, DOE presents the cumulative impacts of walk-in standards separately in section VI.B.4.d of this document.

At TSL 1, DOE expects manufacturers would likely need to update all non-display door designs to incorporate anti-sweat heater controls. DOE does not expect manufacturers would need to incorporate thermally-improved frame designs or increase insulation thickness to meet the efficiency levels required by the adopted standard level.

Therefore, DOE does not expect industry, including small businesses, would incur notable 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 amended energy conservation standards. For the purposes of this subgroup analysis, DOE assumed that industry conversion costs would be evenly distributed across the walk-in non-display door OEMs to avoid underestimating the potential investments small manufacturers may incur as a result of the adopted standard.

All 44 small, domestic OEMs of walk-in non-display doors manufacture manual non-display doors (*i.e.*, NM.L, NM.M). Twelve of these 44 small businesses also manufacture motorized non-display doors (*i.e.*, NO.L, NO.M). DOE estimates that the 44 small businesses that manufacture manual non-display doors may each incur $23,000 in conversion costs and that the 12 small businesses that also manufacture motorized doors may each incur additional conversion costs of approximately $34,000 to meet the efficiencies required at TSL 1. DOE did not identify any small businesses that only manufacture motorized doors.

Based on market research tools (*e.g.*, Dun & Bradstreet reports), DOE estimates that the annual revenue of the small walk-in non-display door OEMs that do not make walk-in refrigeration systems ranges from approximately $0.3 million to approximately $217.0 million, with an average annual revenue of $20.0 million. Conversion costs range from $23,000 to $57,000, with average per OEM conversion costs of $33,000, which is approximately 0.4 percent of company revenue, on average, over the 3-year conversion period. *See* Table VI.1 for additional details.

Table VI.1 Potential Small Business Impacts: Walk-In Non-Display Doors

Number of Small, Domestic OEMs	**Range of Estimated Annual Revenue** (*$ millions*)	**Average per-OEM Conversion Costs** (*$ millions*)	**Average Conversion Costs as a % of Conversion Period Revenue**
6	<=1.0	$29,000	2.2%
12	>1.0 and <=5.0	$23,000	0.3%
14	>5.0 and <=25.0	$36,000	0.1%
9	>25.0	$43,000	0.0%

b. Panels

In this final rule, DOE is not amending energy conservation standards for walk-in panels. Therefore, DOE does not expect that manufacturers of walk-in panels, including small business manufacturers, would be directly impacted by the efficiency levels established in this final rule, as the levels would remain at the current DOE minimum efficiency.

c. Refrigeration Systems

In this final rule, DOE is amending energy conservation standards for walk-in refrigeration systems. DOE expects that at TSL 2, manufacturers would likely need to incorporate the following design options: all dedicated condensing system equipment classes would generally incorporate EC condenser fan motors; all outdoor dedicated condensing system equipment would generally incorporate self-regulating crankcase heater controls with a temperature switch; additionally, low-temperature outdoor dedicated condensing system equipment classes would generally incorporate variable-speed condenser fan motors and all but the highest capacity units would generally incorporate ambient subcooling circuits; some medium-temperature outdoor dedicated condensing unit equipment classes would incorporate improved single-speed compressors; low-temperature and indoor medium-temperature dedicated condensing unit equipment classes would generally incorporate larger condenser coils; low- and medium-temperature single-packaged dedicated system equipment classes would generally incorporate larger evaporator coils and variable speed evaporator fans; lower-capacity low- and medium-temperature single-packaged dedicated condensing units would generally incorporate propane compressors; higher capacity indoor low-temperature single-packaged dedicated system equipment classes would generally incorporate thermal insulation up to 4 inches in thickness; outdoor medium-temperature single-packaged dedicated system equipment classes would generally incorporate variable speed condenser fans; lower capacity outdoor medium-temperature single-packaged dedicated system equipment classes would generally incorporate thermal insulation up to 4 inches in thickness and ambient subcooling circuits; high-temperature indoor, and outdoor ducted, dedicated condensing system equipment classes would generally incorporate max-tech design options; finally high-temperature outdoor non-ducted dedicated condensing system equipment classes would generally incorporate thermal insulation up to 1.5 inches in thickness and variable speed condenser fans.

DOE expects that at TSL 2, all unit cooler equipment classes would incorporate the max-tech design options, except for high-temperature non-ducted unit coolers, which would generally require evaporator coils 4 rows deep, and higher-capacity medium-temperature unit coolers, which would generally only require 3-row deep evaporator coils.

Of the 15 small, domestic OEMs of walk-in refrigeration systems, five OEMs only manufacture high-temperature units (*i.e.*, SP.H.I, SP.H.ID, SP.H.O, SP.H.OD, UC.H, and/or UC.H.ID), five OEMs only manufacture low- and medium-temperature dedicated condensing systems, two OEMs only manufacture low- and medium-temperature unit coolers, and the remaining three OEMs manufacture low- and medium-temperature dedicated condensing systems and unit coolers. As discussed in section VI.B.4.a of this document, three of these 15 small, domestic OEMs also manufacture walk-in non-display doors. Since these three small businesses would need to meet the adopted standards for both non-display doors and refrigeration systems, DOE presents the cumulative impacts of walk-in standards separately in section VI.B.4.d of this document.

For the five high-temperature OEMs, at TSL 2, DOE does not expect these small manufacturers would incur any capital conversion costs. Based on information gathered during manufacturer interviews, DOE understands that manufacturers of high-temperature units typically purchase the heat exchangers used for walk-in systems and would therefore not incur any capital conversion costs as a direct result of the final rule. For the remaining ten small, domestic OEMs of dedicated condensing systems and/or unit coolers, manufacturers would need to invest in new tooling to accommodate larger condenser coils, ambient subcooling, and/or larger evaporator coils. For the purposes of this subgroup analysis, DOE assumed that the industry capital and product conversion costs for each equipment class would be evenly distributed across the OEMs that manufacture those equipment classes to avoid underestimating the potential capital and R&D investments small manufacturers may incur as a result of the adopted standard. DOE believes this conservative approach represents an upper bound of potential small business investments. DOE's capital investment estimates are based on results from the equipment teardown analysis, which assumed an average, representative production volume and array of capacity offerings. However, small manufacturers have lower production volumes and require less production capacity (*e.g.*, lower tooling costs).

Based on market research tools (*e.g.*, Dun & Bradstreet reports), DOE estimates that annual revenue of small walk-in refrigeration system OEMs that do not make walk-in non-display doors ranges from approximately $3.7 million to approximately $209.8 million, with an average annual revenue of $77.1 million. The conversion costs range from $0.5 million to $4.9 million, with average per OEM conversion costs of $2.2 million, which are approximately 2.3 percent of company revenue, on average, over the 4-year conversion period. *See* Table VI.2 for additional details.

Table VI.2 Potential Small Business Impacts: Walk-In Refrigeration Systems

Company	Estimated Capital Conversion Costs *($ Millions)*	Estimated Product Conversion Costs *($ Millions)*	Estimated Total Conversion Costs *($ Millions)*	Estimated Annual Revenue *($ Millions)*	Conversion Costs as a % of Conversion Period Revenue
Manufacturer 1	0.0	0.5	0.5	3.7	3.2%
Manufacturer 2	0.0	0.5	0.5	3.9	3.0%
Manufacturer 3	0.8	1.2	2.1	5.1	10.2%
Manufacturer 4	0.0	0.5	0.5	8.2	1.4%
Manufacturer 5	0.0	0.5	0.5	9.7	1.2%
Manufacturer 6	0.8	1.2	2.1	12.0	4.3%
Manufacturer 7	2.3	2.5	4.9	88.7	1.4%
Manufacturer 8	2.3	2.5	4.9	110.3	1.1%
Manufacturer 9	2.3	2.5	4.9	116.2	1.0%
Manufacturer 10	1.5	1.3	2.8	150.0	0.5%
Manufacturer 11	0.0	0.5	0.5	208.0	0.1%
Manufacturer 12	0.8	1.2	2.1	209.8	0.2%

d. Doors and Refrigeration Systems

As previously discussed, DOE identified three small businesses that manufacture both non-display doors and refrigeration systems subject to more stringent standards. To better reflect the overall impact of this final rule on these three small businesses, DOE presents the estimated conversion costs to comply with the adopted standards for both non-display doors and refrigeration systems in Table VI.3.

Table VI.3 Potential Small Business Impacts: Walk-in Non-Display Doors and Refrigeration Systems

Company	Estimated Capital Conversion Costs *($ Millions)*	Estimated Product Conversion Costs *($ Millions)*	Estimated Total Conversion Costs *($ Millions)*	Estimated Annual Revenue *($Millions)*	Average Conversion Costs as a Percent of Conversion Period Revenue*
Manufacturer A	0.8	1.3	2.1	11.3	4.7%

Manufacturer B	0.8	1.2	2.1	156.3	0.3%
Manufacturer C	1.5	1.4	2.8	276.8	0.3%

*DOE used a 3-year conversion period for investments associated with non-display doors and a 4-year conversion period for investments associated with refrigeration systems.

5. 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 1 for walk-in non-display doors and TSL 2 for walk-in refrigeration systems. DOE is not adopting more stringent standards for display door and panel equipment classes in this final rule. In reviewing alternatives to the adopted standards, DOE examined energy conservation standards set at lower efficiency levels for walk-in refrigeration systems. While TSL 1 would reduce the impacts on small business manufacturers of refrigeration systems, it would come at the expense of a reduction in energy savings. For walk-in refrigeration systems, TSL 1 achieves 42.1 percent lower energy savings compared to the energy savings at TSL 2.

Based on the presented discussion, establishing standards at TSL 1 for walk-in non-display doors and TSL 2 refrigeration systems balances the benefits of the energy savings at TSL 1 (non-display doors) and TSL 2 (refrigeration systems) with the potential burdens placed on walk-in 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 RIA 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 establish an effective date for WICFs manufactured beginning on the date that is not more than 5 years after the date of publication of a final rule for WICFs. (*See* 42 U.S.C. 6313(f)(5)(B)(ii)) Pursuant to this EPCA provision, DOE is extending the compliance period for WICF refrigeration systems so that compliance is required December 31, 2028, approximately 1 year later than the expected compliance year (2027) analyzed in the September 2023 NOPR (which was based on a 3-year compliance period). DOE has determined that a longer compliance period for WICF refrigeration systems is warranted based on based on stakeholder comments and DOE's assessment of the investments and redesign required to meet the adopted levels, combined with the impact of overlapping Federal refrigerant regulations. DOE understands that the longer compliance period will help mitigate cumulative regulatory burden by allowing manufacturers of WICF refrigeration systems, including small businesses, more flexibility to spread investments across approximately 4 years instead of 3 years. Manufacturers, including small businesses, will also have more time to recoup any investments made to redesign walk-in equipment for the October 2023 EPA Technology Transitions Final Rule as compared to a 3-year compliance period.

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 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of walk-ins 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 walk-ins, 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 walk-ins. (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.

Although DOE is adopting amended standards in terms of a new metric for walk-in refrigeration systems, DOE is not amending certification or reporting requirements for walk-in refrigeration systems in this final rule. Instead, if determined to be necessary, DOE may consider proposals to amend its certification requirements and reporting for walk-in refrigeration systems under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910-1400 at that time, as necessary.

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. (*See* 42 U.S.C. 6316(a) and (b); 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 (Feb. 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 1 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.*

This final rule does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by the private sector. As a result, the analytical requirements of UMRA do not apply.

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.

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. Families 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 improved (*i.e.*, higher LCC savings and lower PBP) as compared to the average for all households. Further, the standards will also result in climate and health benefits for families.

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 (Feb. 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 amended energy conservation standards for walk-ins, 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, 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.[151] 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 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.[152]

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 final 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.

[151] The 2007 "Energy Conservation Standards Rulemaking Peer Review Report" is available at the following website: *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed May 31, 2024).
[152] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards*.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, and Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on November 27, 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 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 November 27, 2024.

Jeffrey M. Marootian

Digitally signed by Jeffrey M. Marootian
Date: 2024.11.27 14:13:27 -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 §431.306 by revising paragraphs (d) and (e) to read as follows:

§431.306 Energy conservation standards and their effective dates.

* * * * *

(d) ***Walk-in cooler and freezer non-display doors.***

(1) All walk-in cooler and walk-in freezer non-display doors manufactured starting on June 5, 2017 and before [**INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***] must satisfy the following standards:

Equipment Class	**Equations for maximum energy consumption (kWh/day) ***
Passage Door, Medium-Temperature	$0.05 \times A_{nd} + 1.7$
Passage Door, Low-Temperature	$0.14 \times A_{nd} + 4.8$
Freight Door, Medium-Temperature	$0.04 \times A_{nd} + 1.9$
Freight Door, Low-Temperature	$0.12 \times A_{nd} + 5.6$

*A_{nd} represents the surface area of the non-display door.

(2) All walk-in cooler and walk-in freezer non-display doors manufactured starting on [**INSERT DATE 3 YEARS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***], must satisfy the following standards:

Equipment Class	Maximum Daily Energy Consumption (kWh/day)
Non-Display Door, Manual, Medium-Temperature	$0.02 \times A_{nd} + 0.58 + 0.33 \times a + 0.07 \times b + 0.24 \times c + e$
Non-Display Door, Manual, Low-Temperature	$0.10 \times A_{nd} + 2.63 + 0.40 \times a + 0.09 \times b + 0.30 \times c + 0.85 \times d + f$
Non-Display Door, Motorized, Medium-Temperature	$0.02 \times A_{nd} + 0.77 + 0.33 \times a + 0.07 \times b + 0.24 \times c + e$
Non-Display Door, Motorized, Low-Temperature	$0.09 \times A_{nd} + 2.88 + 0.40 \times a + 0.09 \times b + 0.30 \times c + 0.85 \times d + f$

A_{nd} represents the surface area of the non-display door in square feet.
a = 1 for a door with lighting and = 0 for a door without lighting.
b = 1 for a door with a digital temperature display without alarms and = 0 for a door without a digital display without alarms.
c = 1 for a door with a digital temperature display with alarms and = 0 for a door without a digital temperature display with alarms.
d = 1 for a door with a heated pressure relief vent and = 0 for a door without a heated pressure relief vent.
e = 0.06 x A_{window} + 0.10, with a maximum value of 0.25 for a door with a heated viewport window, and = 0 for a door without a heated viewport window.
f = 0.54 x A_{window} + 0.23, with a maximum value of 1.50 for a door with a heated viewport window, and = 0 for a door without a heated viewport window.
A_{window} represents the surface area of the viewing window in square feet.

(e) ***Walk-in cooler refrigeration systems.***

(1) All walk-in cooler and walk-in freezer refrigeration systems manufactured starting on the dates listed in the table and before December 31, 2028, except for walk-in process cooling refrigeration systems (as defined in § 431.302), must satisfy the following standards:

Equipment class	Minimum AWEF (Btu/W-h)*	Compliance date: equipment manufactured starting on . . .
Dedicated Condensing System—Medium-Temperature, Indoor	5.61	June 5, 2017.
Dedicated Condensing System—Medium-Temperature, Outdoor	7.60	

Dedicated Condensing System—Low-Temperature, Indoor with a Net Capacity (q_{net}) of:		
< 6,500 Btu/h	$9.091 \times 10^{-5} \times q_{net} + 1.81$	July 10, 2020.
≥ 6,500 Btu/h	2.40	
Dedicated Condensing System—Low-Temperature, Outdoor with a Net Capacity (q_{net}) of:		
< 6,500 Btu/h	$6.522 \times 10^{-5} \times q_{net} + 2.73$	
≥ 6,500 Btu/h	3.15	
Unit Cooler—Medium-Temperature	9.00	
Unit Cooler—Low-Temperature with a Net Capacity (q_{net}) of:		
< 15,500 Btu/h	$1.575 \times 10^{-5} \times q_{net} + 3.91$	
≥ 15,500 Btu/h	4.15	

* Where q_{net} is net capacity as determined in accordance with § 431.304 and certified in accordance with 10 CFR part 429.

(2) All walk-in cooler and walk-in freezer refrigeration systems manufactured starting on December 31, 2028, except for walk-in process cooling refrigeration systems (as defined in § 431.302), must satisfy the following standards:

Equipment Class	Net Capacity (q_{net})*	Minimum AWEF2* Btu/W-h
Dedicated Condensing System - High-Temperature, Indoor, Non-Ducted	< 7,000 Btu/h	$7.55 \times 10^{-4} \times q_{net} + 2.37$
	≥ 7,000 Btu/h	7.66
Dedicated Condensing System – High-Temperature, Outdoor, Non-Ducted	< 7,000 Btu/h	$1.02 \times 10^{-3} \times q_{net} + 2.40$
	≥ 7,000 Btu/h	9.55
Dedicated Condensing System - High-Temperature, Indoor, Ducted	< 7,000 Btu/h	$2.46 \times 10^{-4} \times q_{net} + 1.55$
	≥ 7,000 Btu/h	3.27
Dedicated Condensing System - High-Temperature, Outdoor, Ducted	< 7,000 Btu/h	$3.60 \times 10^{-4} \times q_{net} + 1.88$
	≥ 7,000 Btu/h	4.39
Dedicated Condensing System other than Single-Packaged - Medium-Temperature, Indoor	< 8,000 Btu/h	5.61
	≥ 8,000 Btu/h and < 25,000 Btu/h	$3.35 \times 10^{-5} \times q_{net} + 5.34$
	≥ 25,000 Btu/h	6.18
Dedicated Condensing System other than Single-Packaged - Medium-Temperature, Outdoor	< 25,000 Btu/h	$1.61 \times 10^{-5} \times q_{net} + 7.26$
	≥ 25,000 Btu/h and < 54,000 Btu/h	$7.59 \times 10^{-6} \times q_{net} + 7.47$
	≥ 54,000 Btu/h	7.88
Dedicated Condensing System other than Single-Packaged - Low-Temperature, Indoor	< 9,000 Btu/h	$4.64 \times 10^{-5} \times q_{net} + 2.18$
	≥ 9,000 Btu/h and < 25,000 Btu/h	$2.52 \times 10^{-5} \times q_{net} + 2.37$
	≥ 25,000 Btu/h and < 54,000 Btu/h	$1.45 \times 10^{-6} \times q_{net} + 2.96$
	≥ 54,000 Btu/h	3.04
Dedicated Condensing System other than Single-Packaged - Low-Temperature, Outdoor	< 9,000 Btu/h	$9.93 \times 10^{-5} \times q_{net} + 2.62$
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.14 \times 10^{-5} \times q_{net} + 3.23$
	≥ 25,000 Btu/h and < 75,000 Btu/h	$4.72 \times 10^{-6} \times q_{net} + 3.90$
	≥ 75,000 Btu/h	4.25
Single-Packaged Dedicated Condensing System - Medium-Temperature, Indoor	< 9,000 Btu/h	$1.00 \times 10^{-4} \times q_{net} + 4.91$
	≥ 9,000 Btu/h	5.81
Single-Packaged Dedicated Condensing System - Medium-Temperature, Outdoor	< 9,000 Btu/h	$3.07 \times 10^{-4} \times q_{net} + 4.73$
	≥ 9,000 Btu/h	7.49
Single-Packaged Dedicated Condensing System - Low-Temperature, Indoor	< 6,000 Btu/h	$8.00 \times 10^{-5} \times q_{net} + 1.80$
	≥ 6,000 Btu/h	2.28
Single-Packaged Dedicated Condensing System - Low-Temperature, Outdoor	< 6,000 Btu/h	$1.39 \times 10^{-4} \times q_{net} + 1.95$
	≥ 6,000 Btu/h	2.78
Unit Cooler - High-Temperature Non-Ducted	< 9,000 Btu/h	10.33
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.83 \times 10^{-4} \times q_{net} + 6.89$
	≥ 25,000 Btu/h	16.45
Unit Cooler - High-Temperature Ducted	< 9,000 Btu/h	6.64
	≥ 9,000 Btu/h and < 25,000 Btu/h	$3.70 \times 10^{-4} \times q_{net} + 3.31$
	≥ 25,000 Btu/h	12.57
Unit Cooler - Medium-Temperature	< 54,000 Btu/h	9.65
	≥ 54,000 Btu/h and < 75,000 Btu/h	$-3.10 \times 10^{-5} \times q_{net} + 11.32$
	≥ 75,000 Btu/h	9.00
Unit Cooler - Low-Temperature	All	4.57

* Where q_{net} is net capacity as determined in accordance with § 431.304 and certified in accordance with 10 CFR part 429.