[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket Number EERE-2010-BT-STD-0003]

RIN 1904-AC19

Energy Conservation Program: Energy Conservation Standards for Commercial Refrigeration Equipment

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including commercial refrigeration equipment (CRE). EPCA also requires the U.S. Department of Energy (DOE) to determine whether more-stringent standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this final rule, DOE is adopting more-stringent energy conservation standards for some classes of commercial refrigeration equipment. 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 commercial refrigeration equipment in today's final rule is required on **March 27, 2017.**

The incorporation by reference of certain publications listed in this final rule were approved by the Director of the Office of the Federal Register on January 9, 2009 and February 21, 2012.

ADDRESSES: The docket, 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 regulations.gov index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

A link to the docket web page can be found at: http://www.regulations.gov/#!docketDetail;D=EERE-2010-BT-STD-0003.The regulations.gov web page will contain simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

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SUPPLEMENTARY INFORMATION:

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I. Summary of the Final Rule and Its Benefits

Title III, Part C[1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291-6309, as codified), added by Public Law 95-619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment.[2] Pursuant to EPCA, any new or amended energy conservation standard that DOE prescribes for

[1] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A-1.
[2] All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Pub. L. 112-210 (Dec. 18, 2012).

certain products, such as commercial refrigeration equipment, shall be designed to achieve the maximum improvement in energy efficiency that DOE determines is both technologically feasible and economically justified. (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) and 6316(e)(1)) In accordance with these and other statutory provisions discussed in this document, DOE is adopting amended energy conservation standards for commercial refrigeration equipment. The amended standards, which consist of maximum daily energy consumption (MDEC) values as a function of either refrigerated volume or total display area (TDA), are shown in Table I.1. These amended standards apply to all equipment listed in Table I.1 and manufactured in, or imported into, the United States on or after **March 27, 2017**.

Table I.1. Energy Conservation Standards for Commercial Refrigeration Equipment (Compliance Required Starting March 27, 2017)

Equipment Class*	Standard Level**, †		Equipment Class*	Standard Level**, †
VOP.RC.M	0.64 x TDA + 4.07		VOP.RC.I	2.79 x TDA + 8.7
VOP.RC.L	2.2 x TDA + 6.85		SVO.RC.L	2.2 x TDA + 6.85
VOP.SC.M	1.69 x TDA + 4.71		SVO.RC.I	2.79 x TDA + 8.7
VCT.RC.M	0.15 x TDA + 1.95		HZO.RC.I	0.7 x TDA + 8.74
VCT.RC.L	0.49 x TDA + 2.61		VOP.SC.L	4.25 x TDA + 11.82
VCT.SC.M	0.1 x V + 0.86		VOP.SC.I	5.4 x TDA + 15.02
VCT.SC.L	0.29 x V + 2.95		SVO.SC.L	4.26 x TDA + 11.51
VCT.SC.I	0.62 x TDA + 3.29		SVO.SC.I	5.41 x TDA + 14.63
VCS.SC.M	0.05 x V + 1.36		HZO.SC.I	2.42 x TDA + 9
VCS.SC.L	0.22 x V + 1.38		SOC.RC.L	0.93 x TDA + 0.22
VCS.SC.I	0.34 x V + 0.88		SOC.RC.I	1.09 x TDA + 0.26
SVO.RC.M	0.66 x TDA + 3.18		SOC.SC.I	1.53 x TDA + 0.36
SVO.SC.M	1.7 x TDA + 4.59		VCT.RC.I	0.58 x TDA + 3.05
SOC.RC.M	0.44 x TDA + 0.11		HCT.RC.M	0.16 x TDA + 0.13
SOC.SC.M	0.52 x TDA + 1		HCT.RC.L	0.34 x TDA + 0.26
HZO.RC.M	0.35 x TDA + 2.88		HCT.RC.I	0.4 x TDA + 0.31
HZO.RC.L	0.55 x TDA + 6.88		VCS.RC.M	0.1 x V + 0.26
HZO.SC.M	0.72 x TDA + 5.55		VCS.RC.L	0.21 x V + 0.54
HZO.SC.L	1.9 x TDA + 7.08		VCS.RC.I	0.25 x V + 0.63
HCT.SC.M	0.06 x V + 0.37		HCS.SC.I	0.34 x V + 0.88

HCT.SC.L	0.08 x V + 1.23		HCS.RC.M	0.1 x V + 0.26
HCT.SC.I	0.56 x TDA + 0.43		HCS.RC.L	0.21 x V + 0.54
HCS.SC.M	0.05 x V + 0.91		HCS.RC.I	0.25 x V + 0.63
HCS.SC.L	0.06 x V + 1.12		SOC.SC.L	1.1 x TDA + 2.1
PD.SC.M	0.11 x V + 0.81			

* Equipment class designations consist of a combination (in sequential order separated by periods) of: (1) an equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed with transparent doors, VCS = vertical closed with solid doors, HCT = horizontal closed with transparent doors, HCS = horizontal closed with solid doors, SOC = service over counter, or PD = pull-down); (2) an operating mode code (RC = remote condensing or SC = self-contained); and (3) a rating temperature code (M = medium temperature (38±2 °F), L = low temperature (0±2 °F), or I = ice-cream temperature (-15±2 °F)). For example, "VOP.RC.M" refers to the "vertical open, remote condensing, medium temperature" equipment class. See discussion in chapter 3 of the final rule technical support document (TSD) for a more detailed explanation of the equipment class terminology.
** "TDA" is the total display area of the case, as measured in the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1200-2010, appendix D.
† "V" is the volume of the case, as measured in American National Standards Institute (ANSI) / Association of Home Appliance Manufacturers (AHAM) Standard HRF-1-2004.

A. Benefits and Costs to Customers

Table I.2 presents DOE's evaluation of the economic impacts of today's standards on customers of commercial refrigeration equipment, as measured by the average life-cycle cost (LCC) savings[3] and the median payback period (PBP).[4] The average LCC savings are positive for all equipment classes for which customers are impacted by the amended standards.

[3] Life-cycle cost of commercial refrigeration equipment is the cost to customers of owning and operating the equipment over the entire life of the equipment. Life-cycle cost savings are the reductions in the life-cycle costs due to amended energy conservation standards when compared to the life-cycle costs of the equipment in the absence of amended energy conservation standards.
[4]Payback period refers to the amount of time (in years) it takes customers to recover the increased installed cost of equipment associated with new or amended standards through savings in operating costs. Further discussion can be found in chapter 8 of the final rule TSD.

Table I.2 Impacts of Today's Standards on Customers of Commercial Refrigeration Equipment

Equipment Class*	Average LCC Savings 2012$	Median PBP Years
VOP.RC.M	922	5.7
VOP.RC.L	53	6.1
VOP.SC.M	---	---
VCT.RC.M	542	2.1
VCT.RC.L	526	2.7
VCT.SC.M	226	5.3
VCT.SC.L	5001	1.1
VCT.SC.I	18	7.2
VCS.SC.M	363	1.4
VCS.SC.L	507	2.5
VCS.SC.I	113	5.0
SVO.RC.M	564	6.2
SVO.SC.M	---	---
SOC.RC.M	---	---
SOC.SC.M	---	---
HZO.RC.M	---	---
HZO.RC.L	---	---
HZO.SC.M	55	6.9
HZO.SC.L	---	---
HCT.SC.M	101	5.8
HCT.SC.L	293	2.5
HCT.SC.I	---	---
HCS.SC.M	15	5.5
HCS.SC.L	64	2.5
PD.SC.M	165	5.6

* Values have been shown only for primary equipment classes, which are equipment classes that have significant volume of shipments and, therefore, were directly analyzed. See chapter 5 of the final rule TSD, Engineering Analysis, for a detailed discussion of primary and secondary equipment classes.
* For equipment classes VOP.SC.M, SVO.SC.M, SOC. RC.M, SOC. SC.M, HZO.RC.M, HZO.RC.L, HZO.SC.L, and HCT.SC.I, no efficiency levels above the baseline were found to be economically justifiable. Therefore, the standard levels contained in today's document for these equipment classes are the same as those set in the 2009 final rule. As a result, LCC savings and PBP values for these equipment classes are not relevant.

Note: Equipment lifetimes are between 10 and 15 years for all equipment classes.

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 (2013) through the end of the analysis period (2046). Using a real discount rate of 10.0 percent, DOE estimates that the INPV for manufacturers of commercial refrigeration equipment is $2,660.0 million in 2012$.[5] Under today's standards, DOE expects the industry net present value to decrease by 3.53 percent to 6.60 percent. Total industry conversion costs are expected to total $184.0 million. Additionally, based on DOE's interviews with the manufacturers of commercial refrigeration equipment, DOE does not expect significant loss of domestic employment.

C. National Benefits and Costs

DOE's analyses indicate that today's standards would save a significant amount of energy. The lifetime savings for commercial refrigeration equipment purchased in the 30-year period that begins in the year of compliance with amended standards (2017–2046) amount to 2.89 quadrillion British thermal units (quads). The annualized energy savings (0.10 quads) are equivalent to 0.5 percent of total U.S. commercial primary energy consumption in 2014.[6]

The cumulative net present value (NPV) of total consumer costs and savings of today's standards for commercial refrigeration equipment ranges from $4.93 billion (at a 7-percent

[5] All monetary values in this notice are expressed in 2012 dollars.
[6] Based on U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2013 (AEO 2013) data.

discount rate) to $11.74 billion (at a 3-percent discount rate).[7] This NPV expresses the estimated total value of future operating cost savings minus the estimated increased product costs for products purchased in 2016–2047.

In addition, today's standards are expected to have significant environmental benefits. The energy savings would result in cumulative emission reductions of approximately 142 million metric tons (Mt)[8] of carbon dioxide (CO_2), 762 thousand tons of methane, 207 thousand tons of sulfur dioxide (SO_2), 94 tons of nitrogen oxides (NO_X) and 0.25 tons of mercury (Hg).[9] Through 2030, the estimated energy savings would result in cumulative emissions reductions of 48 Mt of CO_2.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by a recent Federal interagency process.[10] The derivation of the SCC values is discussed in section IV.M. Using discount rates appropriate for each set of SCC values, DOE estimates that the net present monetary value of the CO_2 emissions reductions is between $1.0 billion and $14.0 billion. DOE

[7] All present value results reflect discounted to beginning of 2014.
[8] A metric ton is equivalent to 1.1 short tons. Results for NO_X and Hg are presented in short tons.
[9] DOE calculated emissions reductions relative to the AEO 2013 Reference case, which generally represents current legislation and environmental regulations for which implementing regulations were available as of December 31, 2012.
[10] Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government. May 2013; revised November 2013. http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf.

also estimates that the net present monetary value of the NO_X emissions reductions is $33 million at a 7-percent discount rate, and $104 million at a 3-percent discount rate.[11]

Table I.3 summarizes the national economic costs and benefits expected to result from today's standards for commercial refrigeration equipment.

[11] DOE is investigating the valuation of avoided Hg and SO_2 emissions.

Table I.3 Summary of National Economic Benefits and Costs of Amended Commercial Refrigeration Equipment Energy Conservation Standards*

Category	Present Value Billion 2012$	Discount Rate
Benefits		
Operating Cost Savings	7.70	7%
	16.63	3%
CO_2 Reduction Monetized Value ($11.8/t case)**	1.01	5%
CO_2 Reduction Monetized Value ($39.7/t case)**	4.55	3%
CO_2 Reduction Monetized Value ($61.2/t case)**	7.20	2.5%
CO_2 Reduction Monetized Value ($117/t case)**	14.05	3%
NO_X Reduction Monetized Value (at $2,591/ton)**	0.03	7%
	0.10	3%
Total Benefits†	12.28	7%
	21.28	3%
Costs		
Incremental Installed Costs	2.77	7%
	4.89	3%
Net Benefits		
Including CO_2 and NO_X† Reduction Monetized Value	9.51	7%
	16.40	3%

* This table presents the costs and benefits associated with commercial refrigeration equipment shipped in 2017−2046. These results include benefits to customers which accrue after 2046 from the equipment purchased in 2017−2046. The results account for the incremental variable and fixed costs incurred by manufacturers due to the amended standard, some of which may be incurred in preparation for this final rule.
** The CO_2 values represent global monetized values of the SCC, in 2012$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporates an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC with 3-percent discount rate.

The benefits and costs of today's standards, for equipment sold in 2017−2046, can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value of the benefits from operating the product (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing consumer NPV, plus (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[12]

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of commercial refrigeration equipment shipped in 2017–2046. The SCC values, on the other hand, reflect the present value of all future climate-related impacts resulting from the emission of one metric ton of carbon dioxide in each year. These impacts continue well beyond 2100.

Estimates of annualized benefits and costs of today's standards are shown in Table I.4. The results under the primary estimate are as follows. Using a 7-percent discount rate for

[12] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2013, the year used for discounting the NPV of total customer costs and savings, for the time-series of costs and benefits, using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.3. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2017 through 2046) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined is a steady stream of payments.

benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate, the cost of the amended standards in today's rule is \$256 million per year in increased equipment costs, while the benefits are \$710 million per year in reduced equipment operating costs, \$246 million in CO_2 reductions, and \$3.01 million in reduced NO_X emissions. In this case, the net benefit amounts to \$704 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series, the cost of the standards in today's rule is \$264 million per year in increased equipment costs, while the benefits are \$900 million per year in reduced operating costs, \$246 million in CO_2 reductions, and \$5.64 million in reduced NO_X emissions. In this case, the net benefit amounts to \$888 million per year.

Table I.4. Annualized Benefits and Costs of Amended Standards for Commercial Refrigeration Equipment*

	Discount Rate	Primary Estimate*	Low Net Benefits Estimate*	High Net Benefits Estimate*
		million 2012$/year		
Benefits				
Operating Cost Savings	7%	710	688	744
	3%	900	865	947
CO_2 Reduction at ($11.8/t case)**	5%	73	73	73
CO_2 Reduction at ($39.7/t case)**	3%	246	246	246
CO_2 Reduction at ($61.2/t case)**	2.5%	361	361	361
CO_2 Reduction at ($117.0/t case)**	3%	760	760	760
NO_X Reduction at ($2,591/ton)**	7%	3.01	3.01	3.01
	3%	5.64	5.64	5.64
Total Benefits†	7% plus CO_2 range	786 to 1,474	764 to 1,451	820 to 1,508
	7%	960	937	994
	3% plus CO_2 range	978 to 1,666	943 to 1,631	1,026 to 1,713
	3%	1,152	1,117	1,200
Costs				
Incremental Equipment Costs	7%	256	250	261
	3%	264	258	271
Net Benefits				
Total†	7% plus CO_2 range	530 to 1,218	513 to 1,201	559 to 1,246
	7%	704	687	733
	3% plus CO_2 range	714 to 1,402	685 to 1,373	755 to 1,442
	3%	888	859	929

* This table presents the annualized costs and benefits associated with commercial refrigeration equipment shipped in 2017 - 2046. These results include benefits to customers which accrue after 2046 from the products purchased in 2017 - 2046. The results account for the incremental variable and fixed costs incurred by manufacturers due to the amended standard, some of which may be incurred in preparation for the final rule. The primary, low, and high estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental equipment costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a low decline rate for projected product price trends in the Low Benefits Estimate, and a high decline rate for projected product price trends in the High Benefits Estimate. The method used to derive projected price trends are explained in section IV.H.
** The CO_2 values represent global monetized values of the SCC, in 2012$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.

† Total Benefits for both the 3-percent and 7-percent cases are derived using the series corresponding to average SCC with 3-percent discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

D. Conclusion

Based on the analyses culminating in this final rule, DOE found the benefits to the nation of the amended standards (energy savings, consumer LCC savings, positive NPV of consumer benefit, and emission reductions) outweigh the burdens (loss of INPV and LCC increases for some users of this equipment). DOE has concluded that the standards in today's final rule represent the maximum improvement in energy efficiency that is both technologically feasible and economically justified, and would result in significant conservation of energy. (42 U.S.C. 6295(o), 6316(e))

II. Introduction

The following section briefly discusses the statutory authority underlying today's final rule, as well as some of the relevant historical background related to the establishment of amended standards for commercial refrigeration equipment.

A. Authority

Title III, Part C of EPCA, Pub. L. 94-163 (42 U.S.C. 6311-6317, as codified), added by Pub. L. 95-619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, a program covering certain industrial equipment, which includes the commercial refrigeration equipment that is the focus of this document.[13,14] EPCA prescribes energy conservation standards for commercial refrigeration equipment (42 U.S.C. 6313(c)(2)–(4)), and directs DOE to conduct rulemakings to establish new and amended standards for commercial refrigeration equipment. (42 U.S.C. 6313(c)(4)–(6)) (DOE notes that under 42 U.S.C. 6295(m) and 6316(e)(1) the agency must periodically review its already established energy conservation standards for covered equipment. Under this requirement, the next review that DOE would need to conduct must occur no later than 6 years from the issuance of a final rule establishing or amending a standard for covered equipment.)

Pursuant to EPCA, DOE's energy conservation program for covered equipment generally consists of four parts: (1) testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. For commercial refrigeration equipment, DOE is responsible for the entirety of this program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each type or class of covered equipment. (42 U.S.C. 6314) Manufacturers of covered equipment must use the prescribed DOE test procedure as the basis for certifying to DOE that their equipment complies with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of that equipment. (42 U.S.C. 6315(b), 6295(s), and 6316(e)(1)) Similarly, DOE must use these test procedures to determine whether

[13] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.
[14] All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Pub. L. 112-210 (Dec. 18, 2012).

that equipment complies with standards adopted pursuant to EPCA. The DOE test procedure for commercial refrigeration equipment currently appears at title 10 of the Code of Federal Regulations (CFR) part 431, subpart C.

DOE must follow specific statutory criteria for prescribing amended standards for covered equipment. As indicated above, any amended standard for covered equipment must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 6316(e)(1)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3) and 6316(e)(1)) DOE also may not prescribe a standard: (1) for certain equipment, including commercial refrigeration equipment, if no test procedure has been established for the product; or (2) if DOE determines by rule that the proposed standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)–(B) and 6316(e)(1)) 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. 6295(o)(2)(B)(i) and 6316(e)(1)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven factors:

1. The economic impact of the standard on manufacturers and consumers of the equipment subject to the standard;
2. The savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price,

initial charges, or maintenance expenses for the covered equipment that are likely to result from the imposition of the standard;

3. The total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;
4. Any lessening of the utility or the performance of the covered equipment likely to result from the imposition of the standard;
5. The impact of any lessening of competition, as determined in writing by the U.S. Attorney General (Attorney General), that is likely to result from the imposition of the standard;
6. The need for national energy and water conservation; and
7. Other factors the Secretary considers relevant.

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

EPCA, as codified, also contains what is known as an “anti-backsliding” provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of covered equipment. (42 U.S.C. 6295(o)(1) and 6316(e)(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 of 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. 6295(o)(4) and 6316(e)(1))

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. (See 42 U.S.C. 6295(o)(2)(B)(iii) and 6316(e)(1)) Section III.D.2 presents additional discussion about the rebuttable presumption payback period.

Additionally, 42 U.S.C. 6295(q)(1) and 6316(e)(1) specify requirements when promulgating a standard for a type or class of covered equipment that has two or more subcategories that may justify different standard levels. DOE must specify a different standard level than that which applies generally to such type or class of equipment for any group of covered 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 equipment within such type (or class); or (B) have a capacity or other performance-related feature that other equipment within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1) and 6316(e)(1)) In determining whether a performance-related feature justifies a different standard for a group of equipment, DOE must consider such factors as the utility to the consumer of the 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. 6295(q)(2) and 6316(e)(1))

Federal energy conservation requirements generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c) and 6316(e))

B. Background

1. Current Standards

The current energy conservation standards for commercial refrigeration equipment were established by two different legislative actions and one DOE final rule. EPCA, as amended by the Energy Policy Act of 2005 (EPACT 2005), established standards for self-contained commercial refrigerators and freezer with solid or transparent doors, self-contained commercial refrigerator-freezers with solid doors, and self-contained commercial refrigerators designed for pull-down applications. (42 U.S.C. 6313(c)(2)–(3)) On January 9, 2009, DOE published a final rule (January 2009 final rule) prescribing standards for commercial refrigeration equipment. 74 FR at 1092. Specifically, this final rule completed the first standards rulemaking for commercial refrigeration equipment by establishing standards for equipment types specified in 42 U.S.C. 6313(c)(5), and for which EPCA did not prescribe standards in 42 U.S.C. 6313(c)(2)–(3). These types consisted of commercial ice-cream freezers; self-contained commercial refrigerators, commercial freezers, and commercial refrigerator-freezers without doors; and remote condensing commercial refrigerators, commercial freezers, and commercial refrigerator-freezers. More recently, the American Energy Manufacturing Technical Corrections Act (AEMTCA), Pub. L. 112-210 (December 18, 2012), amended section 342(c) of EPCA to establish a new standard for self-contained service over counter medium temperature commercial refrigerators (this class is known as SOC.SC.M per DOE's equipment class nomenclature). (42 U.S.C. 6313(c)(4)) As a result, DOE's current energy conservation standards for commercial refrigeration equipment include the following: standards established by EPCA for commercial refrigeration equipment manufactured on or after January 1, 2010; standards established in the January 2009 final rule for commercial refrigeration equipment manufactured on or after January 1, 2012; and standards established by AEMTCA for SOC.SC.M equipment manufactured on or after January 1, 2012.

Table II.1 and Table II.2 present DOE's current energy conservation standards for commercial refrigeration equipment set by EPCA and the January 2009 final rule, respectively. The AEMTCA standard for SOC.SC.M equipment manufactured on or after January 1, 2012 is prescribed as 0.6 × TDA + 1.0. (42 U.S.C. 6313(c)(4))

Table II.1 Commercial Refrigeration Equipment Standards Prescribed by EPCA – Compliance Required Beginning on January 1, 2010

Category	Maximum Daily Energy Consumption kWh/day*
Refrigerators with solid doors	0.10 V** + 2.04
Refrigerators with transparent doors	0.12 V + 3.34
Freezers with solid doors	0.40 V + 1.38
Freezers with transparent doors	0.75 V + 4.10
Refrigerators/freezers with solid doors	the greater of 0.27 AV† - 0.71 or 0.70
Self-contained refrigerators with transparent doors designed for pull-down temperature applications	0.126V + 3.51

* kilowatt-hours per day
** Where "V" means the chilled or frozen compartment volume in cubic feet as defined in the Association of Home Appliance Manufacturers Standard HRF-1-1979. 10 CFR 431.66.
† Where "AV" means that adjusted volume in cubic feet measured in accordance with the Association of Home Appliance Manufacturers Standard HRF-1-1979. 10 CFR 431.66.

Table II.2 Commercial Refrigeration Equipment Standards Established in the January 2009 Final Rule – Compliance Required Beginning on January 1, 2012

Equipment Class*	Standard Level ** kWh/day
VOP.RC.M	0.82 × TDA + 4.07
SVO.RC.M	0.83 × TDA + 3.18
HZO.RC.M	0.35 × TDA + 2.88
VOP.RC.L	2.27 × TDA + 6.85
HZO.RC.L	0.57 × TDA + 6.88
VCT.RC.M	0.22 × TDA + 1.95
VCT.RC.L	0.56 × TDA + 2.61
SOC.RC.M	0.51 × TDA + 0.11
VOP.SC.M	1.74 × TDA + 4.71
SVO.SC.M	1.73 × TDA + 4.59
HZO.SC.M	0.77 × TDA + 5.55
HZO.SC.L	1.92 × TDA + 7.08
VCT.SC.I	0.67 × TDA + 3.29
VCS.SC.I	0.38 × V + 0.88
HCT.SC.I	0.56 × TDA + 0.43
SVO.RC.L	2.27 × TDA + 6.85
VOP.RC.I	2.89 × TDA + 8.7
SVO.RC.I	2.89 × TDA + 8.7
HZO.RC.I	0.72 × TDA + 8.74
VCT.RC.I	0.66 × TDA + 3.05
HCT.RC.M	0.16 × TDA + 0.13
HCT.RC.L	0.34 × TDA + 0.26
HCT.RC.I	0.4 × TDA + 0.31
VCS.RC.M	0.11 × V + 0.26
VCS.RC.L	0.23 × V + 0.54
VCS.RC.I	0.27 × V + 0.63
HCS.RC.M	0.11 × V + 0.26
HCS.RC.L	0.23 × V + 0.54
HCS.RC.I	0.27 × V + 0.63
SOC.RC.L	1.08 × TDA + 0.22
SOC.RC.I	1.26 × TDA + 0.26
VOP.SC.L	4.37 × TDA + 11.82
VOP.SC.I	5.55 × TDA + 15.02
SVO.SC.L	4.34 × TDA + 11.51
SVO.SC.I	5.52 × TDA + 14.63
HZO.SC.I	2.44 × TDA + 9.
SOC.SC.I	1.76 × TDA + 0.36
HCS.SC.I	0.38 × V + 0.88

* Equipment class designations consist of a combination (in sequential order separated by periods) of: (1) an equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed with transparent doors, VCS = vertical closed with solid doors, HCT = horizontal closed with transparent doors, HCS = horizontal closed with solid doors, or SOC = service over counter); (2) an operating mode code (RC = remote condensing or SC = self-contained); and (3) a rating temperature code (M = medium temperature (38 °F), L = low temperature (0 °F), or I = ice-cream temperature (-15 °F)). For example, "VOP.RC.M" refers to the "vertical open, remote condensing, medium temperature" equipment class.
** TDA is the total display area of the case, as measured in ANSI/Air-Conditioning and Refrigeration Institute (ARI) Standard 1200-2006, appendix D. V is the volume of the case, as measured in AHAM Standard HRF-1-2004.

In December 2012, AEMTCA amended EPCA by establishing new standards for SOC.SC.M equipment with a compliance date of January 1, 2012. (42 U.S.C. 6313(c)(4)) The SOC.SC.M equipment had previously been classified under the category self-contained commercial refrigerators with transparent doors, for which standards were established by EPACT 2005. (42 U.S.C. 6313(c)(2)) The standard established by AEMTCA for SOC.SC.M equipment reduces the stringency of the standard applicable to this equipment.

AEMTCA also directs DOE to determine, within three years of enactment of the new SOC.SC.M standard, whether this standard should be amended. (42 U.S.C. 6313(c)(4)(B)(i)) If DOE determines that the standard should be amended, then DOE must issue a final rule establishing an amended standard within this same three-year period. (42 U.S.C. 6313(c)(4)(B)(ii))

2. History of Standards Rulemaking for Commercial Refrigeration Equipment

EPCA, as amended by EPACT 2005, prescribes energy conservation standards for certain self-contained commercial refrigeration equipment designed for holding temperatures[15] (i.e., commercial refrigerators, freezers, and refrigerator-freezers with transparent and solid doors designed for holding temperature applications) and self-contained commercial refrigerators with transparent doors designed for pull-down temperature applications.[16] Compliance with these

[15] EPCA defines the term "holding temperature application" as a use of commercial refrigeration equipment other than a pull-down temperature application, except a blast chiller or freezer. (42 U.S.C. 6311(9)(B))
[16] EPCA defines the term "pull-down temperature application" as a commercial refrigerator with doors that, when fully loaded with 12 ounce beverage cans at 90 °F, can cool those beverages to an average stable temperature of 38 °F in 12 hours or less. (42 U.S.C. 6311(9)(D))

standards was required as of January 1, 2010. (42 U.S.C. 6313(c)(2)–(3)) DOE published a technical amendment final rule on October 18, 2005 codifying these standards into subpart C of part 431 under title 10 of the Code of Federal Regulations (CFR). 70 FR at 60407.

In addition, EPCA requires DOE to set standards for additional commercial refrigeration equipment that is not covered by 42 U.S.C. 6313(c)(2)–(3), namely commercial ice-cream freezers; self-contained commercial refrigerators, freezers, and refrigerator-freezers without doors; and remote condensing commercial refrigerators, freezers, and refrigerator-freezers. (42 U.S.C. 6313(c)(5)) DOE published a final rule establishing these standards on January 9, 2009 (74 FR 1092), and manufacturers must comply with these standards starting on January 1, 2012. (42 U.S.C. 6313(c)(5)(A))

EPCA requires DOE to conduct a subsequent rulemaking to determine whether to amend the standards established under 42 U.S.C. 6313(c), which includes both the standards prescribed by EPACT 2005 and those prescribed by DOE in the January 2009 final rule. (42 U.S.C. 6313(c)(6)) If DOE decides as part of this ongoing rulemaking to amend the current standards, DOE must publish a final rule establishing any such amended standards by January 1, 2013. Id.

To satisfy this requirement, DOE initiated the current rulemaking on April 30, 2010 by publishing on its website its "Rulemaking Framework for Commercial Refrigeration Equipment." (The Framework document is available at: www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/cre_framework_04-30-

10.pdf.) DOE also published a document in the Federal Register announcing the availability of the Framework document, as well as a public meeting to discuss the document. The document also solicited comment on the matters raised in the document. 75 FR 24824 (May 6, 2010). The Framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for commercial refrigeration equipment, and identified various issues to be resolved in the rulemaking.

DOE held the Framework public meeting on May 18, 2010, at which it: (1) presented the contents of the Framework document; (2) described the analyses it planned to conduct during the rulemaking; (3) sought comments from interested parties on these subjects; and (4) in general, sought to inform interested parties about, and facilitate their involvement in, the rulemaking. Major issues discussed at the public meeting included: (1) the scope of coverage for the rulemaking; (2) potential updates to the test procedure and appropriate test metrics (being addressed in a concurrent rulemaking); (3) manufacturer and market information, including distribution channels; (4) equipment classes, baseline units,[17] and design options to improve efficiency; (5) life-cycle costs to customer, including installation, maintenance, and repair costs; and (6) any customer subgroups DOE should consider. At the meeting and during the comment period on the Framework document, DOE received many comments that helped it identify and resolve issues pertaining to commercial refrigeration equipment relevant to this rulemaking. These are discussed in subsequent sections of this document.

[17] Baseline units consist of units possessing features and levels of efficiency consistent with the least-efficient equipment currently available and widely sold on the market.

DOE then gathered additional information and performed preliminary analyses to help review energy conservation standards for this equipment. This process culminated in DOE's notice of a public meeting to discuss and receive comments regarding the tools and methods DOE used in performing its preliminary analysis, as well as the analyses results. 76 FR 17573 (March 30, 2011) (the March 2011 notice). DOE also invited written comments on these subjects and announced the availability on its website of a preliminary analysis technical support document (preliminary analysis TSD). Id. (The preliminary analysis TSD is available at: www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0003-0030.)

The preliminary analysis TSD provided an overview of DOE's review of the standards for commercial refrigeration equipment, discussed the comments DOE received in response to the Framework document, and addressed issues including the scope of coverage of the rulemaking. The document also described the analytical framework that DOE used (and continues to use) in considering amended standards for commercial refrigeration equipment, including a description of the methodology, the analytical tools, and the relationships between the various analyses that are part of this rulemaking. Additionally, the preliminary analysis TSD presented in detail each analysis that DOE had performed for this equipment up to that point, including descriptions of inputs, sources, methodologies, and results. These analyses were as follows:

- A market and technology assessment addressed the scope of this rulemaking, identified existing and potential new equipment classes for commercial refrigeration equipment, characterized the markets for this equipment, and reviewed techniques and approaches for improving its efficiency;

- A screening analysis reviewed technology options to improve the efficiency of commercial refrigeration equipment, and weighed these options against DOE's four prescribed screening criteria;
- An engineering analysis estimated the manufacturer selling prices (MSPs) associated with more energy efficient commercial refrigeration equipment;
- An energy use analysis estimated the annual energy use of commercial refrigeration equipment;
- A markups analysis converted estimated MSPs derived from the engineering analysis to customer purchase prices;
- A life-cycle cost analysis calculated, for individual customers, the discounted savings in operating costs throughout the estimated average life of commercial refrigeration equipment, compared to any increase in installed costs likely to result directly from the imposition of a given standard;
- A payback period analysis estimated the amount of time it would take customers to recover the higher purchase price of more energy efficient equipment through lower operating costs;
- A shipments analysis estimated shipments of commercial refrigeration equipment over the time period examined in the analysis;

- A national impact analysis (NIA) assessed the national energy savings (NES), and the national NPV of total customer costs and savings, expected to result from specific, potential energy conservation standards for commercial refrigeration equipment; and
- A preliminary manufacturer impact analysis (MIA) took the initial steps in evaluating the potential effects on manufacturers of amended efficiency standards.

The public meeting announced in the March 2011 notice took place on April 19, 2011 (April 2011 preliminary analysis public meeting). At the April 2011 preliminary analysis public meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary analysis TSD. Interested parties provided comments on the following issues: (1) equipment classes; (2) technology options; (3) energy modeling; (4) installation, maintenance, and repair costs; (5) markups and distributions chains; (6) commercial refrigeration equipment shipments; and (7) test procedures.

On September 11, 2013, DOE published a notice of proposed rulemaking (NOPR) in this proceeding (September 2013 NOPR). 78 FR 55890. In the September 2013 NOPR, DOE addressed, in detail, the comments received in earlier stages of rulemaking, and proposed amended energy conservation standards for commercial refrigeration equipment. In conjunction with the September 2013 NOPR, DOE also published on its website the complete technical support document (TSD) for the proposed rule, which incorporated the analyses DOE conducted and technical documentation for each analysis. Also published on DOE's website were the engineering analysis spreadsheets, the LCC spreadsheet, and the national impact analysis standard spreadsheet. These materials are available at

http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/27

The standards which DOE proposed for commercial refrigeration equipment at the NOPR stage of this rulemaking are shown in Table II.3. They are provided solely for background informational purposes and differ from the amended standards set forth in this final rule.

Table II.3 Proposed Energy Conservation Standards for Commercial Refrigeration Equipment (for compliance in 2017)

Equipment Class*	Proposed Standard Level**, †		Equipment Class*	Proposed Standard Level**
VCT.RC.L	0.43 × TDA + 2.03		VOP.RC.I	2.68 × TDA + 8.08
VOP.RC.M	0.61 × TDA + 3.03		SVO.RC.L	2.11 × TDA + 6.36
SVO.RC.M	0.63 × TDA + 2.41		SVO.RC.I	2.68 × TDA + 8.08
HZO.RC.L	0.57 × TDA + 6.88		HZO.RC.I	0.72 × TDA + 8.74
HZO.RC.M	0.35 × TDA + 2.88		VOP.SC.L	3.79 × TDA + 10.26
VCT.RC.M	0.08 × TDA + 0.72		VOP.SC.I	4.81 × TDA + 13.03
VOP.RC.L	2.11 × TDA + 6.36		SVO.SC.L	3.77 × TDA + 10.01
SOC.RC.M	0.39 × TDA + 0.08		SVO.SC.I	4.79 × TDA + 12.72
VOP.SC.M	1.51 × TDA + 4.09		HZO.SC.I	2.44 × TDA + 9.0
SVO.SC.M	1.5 × TDA + 3.99		SOC.RC.L	0.83 × TDA + 0.18
HZO.SC.L	1.92 × TDA + 7.08		SOC.RC.I	0.97 × TDA + 0.21
HZO.SC.M	0.75 × TDA + 5.44		SOC.SC.I	1.35 × TDA + 0.29
HCT.SC.I	0.49 × TDA + 0.37		VCT.RC.I	0.51 × TDA + 2.37
VCT.SC.I	0.52 × TDA + 2.56		HCT.RC.M	0.14 × TDA + 0.11
VCS.SC.I	0.35 × V + 0.81		HCT.RC.L	0.3 × TDA + 0.23
VCT.SC.M	0.04 × V + 1.07		HCT.RC.I	0.35 × TDA + 0.27
VCT.SC.L	0.22 × V + 1.21		VCS.RC.M	0.1 × V + 0.24
VCS.SC.M	0.03 × V + 0.53		VCS.RC.L	0.21 × V + 0.5
VCS.SC.L	0.13 × V + 0.43		VCS.RC.I	0.25 × V + 0.58
HCT.SC.M	0.02 × V + 0.51		HCS.SC.I	0.35 × V + 0.81
HCT.SC.L	0.11 × V + 0.6		HCS.RC.M	0.1 × V + 0.24
HCS.SC.M	0.02 × V + 0.37		HCS.RC.L	0.21 × V + 0.5
HCS.SC.L	0.12 × V + 0.42		HCS.RC.I	0.25 × V + 0.58
PD.SC.M	0.03 × V + 0.83		SOC.SC.L	0.67 × TDA + 1.12
SOC.SC.M	0.32 × TDA + 0.53			

* Equipment class designations consist of a combination (in sequential order separated by periods) of: (1) an equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed with transparent doors, VCS = vertical closed with solid doors, HCT = horizontal closed with transparent doors, HCS = horizontal closed with solid doors, SOC = service over counter, or PD = pull-down); (2) an operating mode code (RC = remote condensing or SC = self-contained); and (3) a rating temperature code (M = medium temperature (38±2 °F), L = low temperature (0±2 °F), or I = ice-cream temperature (-15±2 °F)). For example, "VOP.RC.M" refers to the "vertical open, remote condensing,

medium temperature" equipment class. See discussion in chapter 3 of the final rule technical support document (TSD) for a more detailed explanation of the equipment class terminology.
** "TDA" is the total display area of the case, as measured in the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1200-2010, appendix D. "V" is the volume of the case, as measured in American National Standards Institute (ANSI) / Association of Home Appliance Manufacturers (AHAM) Standard HRF-1-2004.

In the September 2013 NOPR, DOE identified seven issues on which it was particularly interested in receiving comments and views of interested parties: light-emitting diode (LED) price projections, base case efficiency trends, operating temperature ranges, offset factors for smaller equipment, extension of standards developed for the 25 primary classes to the remaining 24 secondary classes, standards for hybrid cases and wedges, and standard levels. 78 FR 55987 (September 11, 2013) After the publication of the September 2013 NOPR, DOE received written comments on these and other issues. DOE also held a public meeting in Washington, DC, on October 3, 2013, to hear oral comments on and solicit information relevant to the proposed rule. These comments are addressed in today's document.

III. General Discussion

A. Test Procedures and Normalization Metrics

1. Test Procedures

On December 8, 2006, DOE published a final rule in which it adopted American National Standards Institute (ANSI) / Air-Conditioning and Refrigeration Institute (ARI) Standard 1200-2006, "Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets," as the DOE test procedure for this equipment. 71 FR at 71340, 71369–70. ANSI/ARI Standard 1200-2006 requires performance tests to be conducted according to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 72-

2005, "Method of Testing Commercial Refrigerators and Freezers." The standard also contains rating temperature specifications of 38 °F (+/-2 °F) for commercial refrigerators and refrigerator compartments, 0 °F (+/-2 °F) for commercial freezers and freezer compartments, and -5 °F (+/-2 °F) for commercial ice-cream freezers. During the 2006 test procedure rulemaking, DOE determined that testing at a -15 °F (±2 °F) rating temperature was more representative of the actual energy consumption of commercial freezers specifically designed for ice-cream application. 71 FR at 71357 (December 8, 2006). Therefore, in the test procedure final rule, DOE adopted a -15 °F (±2 °F) rating temperature for commercial ice-cream freezers, rather than the -5 °F (±2 °F) prescribed in the ANSI/ARI Standard 1200-2006. In addition, DOE adopted ANSI/Association of Home Appliance Manufacturers (AHAM) Standard HRF-1-2004, "Energy, Performance, and Capacity of Household Refrigerators, Refrigerator-Freezers, and Freezers," for determining compartment volumes for this equipment. 71 FR at 71369–70 (December 8, 2006).

On February 21, 2012, DOE published a test procedure final rule (2012 test procedure final rule) in which it adopted several amendments to the DOE test procedure. This included an amendment to incorporate by reference ANSI/ Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1200-2010, "Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets," as the DOE test procedure for this equipment. 77 FR 10292, 10314 (February 21, 2012). The 2012 test procedure final rule also included an amendment to incorporate by reference the updated ANSI/AHAM Standard HRF-1-2008, "Energy, Performance, and Capacity of Household Refrigerators, Refrigerator-Freezers, and Freezers," for determining compartment volumes for this equipment.

In addition, the 2012 test procedure final rule included several amendments designed to address certain energy efficiency features that were not accounted for by the previous DOE test procedure, including provisions for measuring the impact of night curtains[18] and lighting occupancy sensors and scheduled controls. 77 FR at 10296–98 (February 21, 2012). In the 2012 test procedure final rule, DOE also adopted amendments to allow testing of commercial refrigeration equipment at temperatures other than one of the three rating temperatures previously specified in the test procedure. Specifically, the 2012 test procedure final rule allows testing of commercial refrigeration equipment at its lowest application product temperature, for equipment that cannot be tested at the prescribed rating temperature. The 2012 test procedure final rule also allows manufacturers to test and certify equipment at the more-stringent temperatures and ambient conditions required by NSF for food safety testing.[19] 77 FR at 10305 (February 21, 2012).

The test procedure amendments established in the 2012 test procedure final rule are required to be used in conjunction with the amended standards promulgated in this energy conservation standards final rule. As such, use of the amended test procedure to show compliance with DOE energy conservation standards or make representations with respect to energy consumption of commercial refrigeration equipment is required on the compliance date of

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[18] Night curtains are devices made of an insulating material, typically insulated aluminum fabric, designed to be pulled down over the open front of the case to decrease infiltration and heat transfer into the case when the merchandizing establishment is closed.
[19] The NSF was founded in 1944 as the National Sanitation Foundation, and is now referred to simply as NSF.

the revised energy conservation standards established by today's document. 77 FR at 10308 (February 21, 2012).

DOE has initiated a test procedure rulemaking for commercial refrigeration equipment to revise and reorganize its test procedure for commercial refrigeration equipment in order to clarify certain terms, procedures, and compliance dates. A NOPR for this rulemaking was published on October 28, 2013. 78 FR 64206 (October 28. 2013). In the NOPR, DOE addressed:

- Several inquiries received from interested parties regarding the applicability of DOE's test procedure and current Federal energy conservation standards;
- The definitions of certain terms pertinent to commercial refrigeration equipment;
- The proper configuration and use of certain components and features of commercial refrigeration equipment when testing according to the DOE test procedure;
- The proper application of certain test procedure provisions;
- The compliance date of certain provisions specified in the DOE test procedure final rule published on February 21, 2012; and
- A number of test procedure clarifications which arose as a result of the negotiated rulemaking process for certification of commercial heating, ventilation, air conditioning, refrigeration, and water heating equipment.

DOE also held a public meeting in Washington, DC, on December 5, 2013, to hear oral comments on and solicit information relevant to the proposed rule.

2. Normalization Metrics

Both the January 2009 final rule and EPACT 2005 contain energy conservation standards for respective covered types of commercial refrigeration equipment, expressed in the form of equations developed as a function of unit size. This use of normalization metrics allows for a single standard-level equation developed for an equipment class to apply to a broad range of equipment sizes offered within that class by manufacturers. In the aforementioned commercial refrigeration equipment standards, the two normalization metrics used are refrigerated compartment volume, as determined using AHAM HRF-1-2004, and TDA, as determined using ANSI/ARI 1200-2006. In particular, the EPACT 2005 standards utilize volume as the normalization metric for all equipment types, with the exception of refrigerator-freezers with solid doors, for which the standard specifies adjusted volume. (42 U.S.C. 6313(c)(2)) The January 2009 final rule, meanwhile, utilizes TDA as the normalization metric for all equipment with display capacity while specifying volume as the metric for solid-door (VCS and HCS) equipment. 74 FR at 1093 (January. 9, 2009).

At the May 2010 Framework public meeting, interested parties raised several questions regarding the potential normalization metrics that could be used in amended standards. DOE also received stakeholder feedback pertaining to this issue following the publication of the Framework document. In the preliminary analysis, DOE suggested that it would consider retaining the normalization metrics in this rulemaking for the respective classes to which they were applied in EPCA (42 U.S.C. 6313(c)(2)–(3)) and the January 2009 final rule. 74 FR at 1093

(January 9, 2009). In chapter 2 of the preliminary analysis TSD, DOE presented its rationale for the continued use of TDA for equipment with display areas addressed in the January 2009 final rule and the continued use of volume as the metric for solid-door remote condensing equipment and ice-cream freezers, as well as for the equipment covered by EPACT 2005 standards. DOE maintained this stance in the NOPR document and TSD. DOE did not receive any significant information or data while conducting the final rule analyses that would alter this position, and thus DOE includes continued use of the existing normalization metrics in today's document.

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis, which is based on information that the Department has gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such analysis, DOE develops a list of design options for consideration, in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of these options for improving efficiency are technologically feasible. DOE considers a design option to be technologically feasible if it is used by the relevant industry or if a working prototype has been developed. Technologies incorporated in commercially available equipment or in working prototypes will be considered technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i) Although DOE considers technologies that are proprietary, it will not consider efficiency levels that can only be reached through the use of proprietary technologies (i.e., a unique pathway), which could allow a single manufacturer to monopolize the market.

Once DOE has determined that particular design options are technologically feasible, it further evaluates each of these design options in light of the following additional screening criteria: (1) practicability to manufacture, install, or service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(ii)–(iv) Chapter 4 of the final rule TSD discusses the results of the screening analyses for commercial refrigeration equipment. Specifically, it presents the designs DOE considered, those it screened out, and those that are the bases for the TSLs considered in this rulemaking.

2. Maximum Technologically Feasible Levels

When DOE adopts (or does not adopt) an amended or new energy conservation standard for a type or class of covered equipment such as commercial refrigeration equipment, it determines the maximum improvement in energy efficiency that is technologically feasible for such equipment. (See 42 U.S.C. 6295(p)(1) and 6316(e)(1)) Accordingly, DOE determined the maximum technologically feasible ("max-tech") improvements in energy efficiency for commercial refrigeration equipment in the engineering analysis using the design parameters that passed the screening analysis.

As indicated previously, whether efficiency levels exist or can be achieved in commonly used equipment is not relevant to whether they are considered max-tech levels. DOE considers technologies to be technologically feasible if they are incorporated in any currently available equipment or working prototypes. Hence, a max-tech level results from the combination of design options predicted to result in the highest efficiency level possible for an equipment class, with such design options consisting of technologies already incorporated in commercial equipment or working prototypes. DOE notes that it reevaluated the efficiency levels, including the max-tech levels, when it updated its results for this final rule. See chapter 5 of the TSD for the results of the analyses and a list of technologies included in max-tech equipment. Table III.1 shows the max-tech levels determined in the engineering analysis for commercial refrigeration equipment.

Table III.1 "Max-Tech" Levels for Commercial Refrigeration Equipment Primary Classes

Equipment Class	"Max-Tech" Level kWh/day
VCT.RC.L	33.044
VOP.RC.M	35.652
SVO.RC.M	27.702
HZO.RC.L	31.078
HZO.RC.M	14.15
VCT.RC.M	10.988
VOP.RC.L	100.006
SOC.RC.M	21.560
VOP.SC.M	29.714
SVO.SC.M	25.400
HZO.SC.L	29.922
HZO.SC.M	13.748
HCT.SC.I	2.327
VCT.SC.I	18.106
VCS.SC.I	16.042
VCT.SC.M	5.148
VCT.SC.L	16.048
VCS.SC.M	3.028
VCS.SC.L	11.130
HCT.SC.M	0.614
HCT.SC.L	1.315

HCS.SC.M	0.981
HCS.SC.L	0.713
PD.SC.M	3.405
SOC.SC.M	26.119

C. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the products that are the subjects of this rulemaking purchased during a 30-year period that begins in the year of compliance with amended standards (2017–2046).[20] The savings are measured over the entire lifetime of products purchased in the 30-year period.[21] DOE used the NIA model to estimate the NES for equipment purchased over the period 2017–2046. The model forecasts total energy use over the analysis period for each representative equipment class at efficiency levels set by each of the considered TSLs. DOE then compares the energy use at each TSL to the base-case energy use to obtain the NES. The NIA model is described in section IV.H of this document and in chapter 10 of the final rule TSD.

DOE used its NIA spreadsheet model to estimate energy savings from amended standards for the equipment that is the subject of this rulemaking. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports

[20] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.
[21] In the past, DOE presented energy savings results for only the 30-year period that begins in the year of compliance. In the calculation of economic impacts, however, DOE considered operating cost savings measured over the entire lifetime of products purchased during the 30-year period. DOE has chosen to modify its presentation of national energy savings to be consistent with the approach used for its national economic analysis.

national energy savings in terms of the savings in the energy that is used to generate and transmit the site electricity. To calculate this quantity, DOE derives annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) Annual Energy Outlook (AEO).

DOE also has begun to estimate full-fuel-cycle energy savings. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012). The full-fuel-cycle (FFC) metric includes the energy consumed in extracting, processing, and transporting primary fuels, and thus presents a more complete picture of the impacts of energy efficiency standards. DOE's evaluation of FFC savings is driven in part by the National Academy of Science's (NAS) report on FFC measurement approaches for DOE's Appliance Standards Program.[22] The NAS report discusses that FFC was primarily intended for energy efficiency standards rulemakings where multiple fuels may be used by a particular product. In the case of this rulemaking pertaining to commercial refrigeration equipment, only a single fuel—electricity—is consumed by the equipment. DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered equipment. Although the addition of FFC energy savings in the rulemakings is consistent with the recommendations, the methodology for estimating FFC does not project how fuel markets would respond to this particular standard rulemaking. The FFC methodology simply estimates how much additional energy, and in turn how many tons of emissions, may be displaced if the estimated fuel were not consumed by the equipment covered

[22] "Review of Site (Point-of-Use) and Full-Fuel-Cycle Measurement Approaches to DOE/EERE Building Appliance Energy- Efficiency Standards,'' (Academy report) was completed in May 2009 and included five recommendations. A copy of the study can be downloaded at: http://www.nap.edu/catalog.php?record_id=12670.

in this rulemaking. It is also important to note that inclusion of FFC savings does not affect DOE's choice of proposed standards. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012). 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 efficiency standards. For more information on FFC energy savings, see section IV.H.2.

2. Significance of Savings

EPCA prohibits DOE from adopting a standard that would not result in significant additional energy savings. (42 U.S.C. 6295(o)(3)(B),(v) and 6316(e)(1)) While the term "significant" is not defined in EPCA, the U.S. Court of Appeals for the District of Columbia in Natural Resources Defense Council v. Herrington, 768 F.2d 1355, 1373 (D.C. Cir. 1985), indicated that Congress intended significant energy savings to be savings that were not "genuinely trivial."

D. Economic Justification

1. Specific Criteria

As discussed in section III.D.1, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i) and 6316(e)(1)) The following sections generally discuss how DOE is addressing each of those seven factors in this rulemaking. For further details and the results of

DOE's analyses pertaining to economic justification, see sections III.C and V of today's document.

a. Economic Impact on Manufacturers and Commercial Customers

In determining the impacts of a potential new or amended energy conservation standard on manufacturers, DOE first determines its quantitative impacts using an annual cash flow approach. This includes both a short-term assessment (based on the cost and capital requirements associated with new or amended standards during the period between the announcement of a regulation and the compliance date of the regulation) and a long-term assessment (based on the costs and marginal impacts over the 30-year analysis period). The impacts analyzed include INPV (which values the industry based on expected future cash flows), cash flows by year, changes in revenue and income, and other measures of impact, as appropriate. Second, DOE analyzes and reports the potential impacts on different types of manufacturers, paying particular attention to impacts on small manufacturers. Third, DOE considers the impact of new or amended standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for new or amended standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of other DOE regulations and non-DOE regulatory requirements on manufacturers.

For individual customers, measures of economic impact include the changes in LCC and the 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 economic impacts applicable to a particular rulemaking. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national standard.

b. Savings in Operating Costs Compared to Increase in Price

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product compared to any increase in the price of the covered product that are likely to result from the imposition of the standard. (42 U.S.C. 6295(o)(2)(B)(i)(II) and 6316(e)(1)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of equipment (including the cost of its installation) and the operating costs (including energy and maintenance and repair costs) discounted over the lifetime of the equipment. To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value. For its analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with amended standards.

The LCC savings and the PBP for the considered efficiency levels are calculated relative to a base-case scenario, which reflects likely trends in the absence of new or amended standards. DOE identifies the percentage of consumers estimated to receive LCC savings or experience an LCC increase, in addition to the average LCC savings associated with a particular standard level.

c. Energy Savings

While significant conservation of energy is a statutory requirement for imposing an energy conservation standard, EPCA also 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. 6295(o)(2)(B)(i)(III) and 6316(e)(1)) DOE uses NIA spreadsheet results in its consideration of total projected savings. For the results of DOE's analyses related to the potential energy savings, see section I.A.3 of this document and chapter 10 of the final rule TSD.

d. Lessening of Utility or Performance of Equipment

In establishing classes of equipment, and in evaluating design options and the impact of potential standard levels, DOE seeks to develop standards that would not lessen the utility or performance of the equipment under consideration. DOE has determined that none of the TSLs presented in today's final rule would reduce the utility or performance of the equipment considered in the rulemaking. (42 U.S.C. 6295(o)(2)(B)(i)(IV) and 6316(e)(1)) During the screening analysis, DOE eliminated from consideration any technology that would adversely impact customer utility. For the results of DOE's analyses related to the potential impact of amended standards on equipment utility and performance, see section IV.C of this document and chapter 4 of the final rule TSD.

e. Impact of Any Lessening of Competition

EPCA requires DOE to consider any lessening of competition that is likely to result from setting new or amended standards for covered equipment. Consistent with its obligations under EPCA, DOE sought the views of the United States Department of Justice (DOJ). DOE asked DOJ to provide a written determination of the impact, if any, of any lessening of competition likely to result from the amended standards, together with an analysis of the nature and extent of such impact. 42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii).

To assist DOJ in making such a determination, DOE provided DOJ with copies of both the NOPR and NOPR TSD for review. DOJ subsequently determined that the amended standards are unlikely to have a significant adverse impact on competition.

f. Need of the Nation to Conserve Energy

Another factor that DOE must consider in determining whether a new or amended standard is economically justified is the need for national energy and water conservation. (42 U.S.C. 6295(o)(2)(B)(i)(VI) and 6316(e)(1)) The energy savings from new or amended standards are likely to provide improvements to the security and reliability of the Nation’s energy system. Reductions in the demand for electricity may also result in reduced costs for maintaining the reliability of the Nation’s electricity system. DOE conducts a utility impact analysis to estimate how new or amended standards may affect the Nation’s needed power generation capacity.

Energy savings from amended standards for commercial refrigeration equipment are also likely to result in environmental benefits in the form of reduced emissions of air pollutants and GHGs associated with energy production (i.e., from power plants). For a discussion of the results of the analyses relating to the potential environmental benefits of the amended standards, see sections IV.K, IV.L and V.B.6 of this document. DOE reports the expected environmental effects from the amended standards, as well as from each TSL it considered for commercial refrigeration equipment, in the emissions analysis contained in chapter 13 of the final rule TSD. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs in chapter 14 of the final rule TSD.

g. Other Factors

EPCA allows the Secretary, in determining whether a new or amended standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII) and 6316(e)(1)) There were no other factors considered for today's final rule.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii) and 6316(e)(1), EPCA provides for a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the customer of equipment that meets the new or amended standard level is less than three times the value of the first-year energy (and, as applicable, water) savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values that calculate the PBP for customers of potential new and amended energy conservation standards. These analyses include, but are not limited to, the 3-year PBP contemplated under the rebuttable presumption test. However, DOE routinely conducts a full economic analysis that considers the full range of impacts to the customer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i) and 6316(e)(1). The results of these analyses serve as the basis for DOE to evaluate the economic justification for a potential standard level definitively (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.12 of this document and chapter 8 of the final rule TSD.

IV. Methodology and Discussion of Comments

A. General Rulemaking Issues

During the October 2013 NOPR public meeting, and in subsequent written comments, stakeholders provided input regarding general issues pertinent to the rulemaking, including the trial standard levels and proposed standard levels presented, the rulemaking timeline, the metrics used to normalize equipment size, and other subjects. These issues are discussed in this section.

1. Trial Standard Levels

In his comment, Mr. R. Kopp (Kopp) suggested that using continuous energy-efficiency cost-curves as opposed to discrete TSLs would provide a more accurate analysis. Further, he suggested that instead of setting a single TSL standard, DOE should adopt pathways to improve efficiency. (Kopp, No. 60 at p. 5)

In its engineering analysis, DOE utilized a design-option approach, in which it began by modeling baseline units and then modeled increasingly efficient designs up to max-tech by adding design options one at a time in order of ascending payback period. This methodology reflects the options available to manufacturers in increasing the efficiency of their equipment, which consist of piecewise design improvements corresponding to the design options modeled in the engineering analysis. Therefore, the efficiency levels generated from the engineering analysis and carried through the downstream analyses to the development of TSLs correspond to specific packages of technologies and design features which could be developed and built by manufacturers. Since the stepwise increments along the cost-efficiency curve represent tangible efficiency improvements attainable through the implementation of design options, DOE asserts that a smooth cost-efficiency curve would not be realistic, as the areas on the curve between the current efficiency levels would not correspond to any design that exists. Therefore, DOE has retained the approach used in the NOPR in developing this final rule.

2. Proposed Standard Levels

Traulsen, Structural Concepts Corp. (Structural Concepts), National Rural Electric Cooperative Association (NRECA), and the Edison Electric Institute (EEI) asserted that TSL4, the level proposed in the NOPR, was not economically viable, noting that the marginal efficiency increase over TSL 3 did not justify the increased costs of compliance. (Traulsen, No. 65 at p.

16;[23] Structural Concepts, Public Meeting Transcript, No. 62 at p. 337; NRECA, No. 88 at p. 2; EEI, No. 89 at p. 4) Traulsen opined that any TSL with a payback period longer than 3 years was not feasible for most manufacturers. (Traulsen, No. 65 at p. 21) Further, NRECA and EEI urged DOE to select TSL 3 instead of TSL 4. However, the joint comments from the American Council for an Energy-Efficient Economy (ACEEE), National Resources Defense Council (NRDC), Appliance Standards Awareness Project (ASAP), Alliance to Save Energy (ASE), and Northwest Energy Efficiency Alliance (NEEA) (hereafter referred to as the "Joint Comment") supported DOE's proposal to adopt TSL 4, noting that it represented maximum energy savings with a positive NPV. (Joint Comment, No. 91 at p. 1)

Several manufacturers expressed an expected inability to meet the proposed standard levels, even with the best available technology. At the October public meeting, Zero Zone Inc. (Zero Zone) noted that there had been no significant technological advancements since the previous rulemaking which would make an amended standard feasible. (Zero Zone, Public Meeting Transcript, No. 62 at p. 62) Structural Concepts raised a similar concern, noting that despite using the most efficient technology currently available, its minimum attainable daily energy consumption was 30-40% above the proposed standard level. (Structural Concepts, Public Meeting Transcript, No. 62 at p. 133) Royal Vendors Inc. (Royal Vendors), in its written comment, noted that even with the most efficient currently-available technology, the maximum

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[23] In the comment citation format used in this document, the citation first presents the name of the commenter, followed by the number on the docket corresponding to the document in which the comment is contained, followed by a reference to the page in that document on which the comment can be found.

possible efficiency gain was 10% over the levels contained in the ENERGY STAR[24] Version 3 specification. However, the Joint Comment opined that most of these concerns were limited to pull-down equipment, and that if the standard for that class were revised, there would be no need to revise standards for other classes. (Joint Comment, No. 91 at p. 2) Additionally, manufacturers opined that the percentage reduction in energy consumption between the existing standard and the proposed rule was not achievable. Hussmann Corp. (Hussmann), True Manufacturing Co., Inc. (True), and Hoshizaki America, Inc. (Hoshizaki) all commented that the efficiency improvements in excess of 60%, as proposed for SC equipment and the VCT.RC.M class, were neither economically feasible nor technologically possible. (Hussmann, No. 77 at p. 10) (True, No. 76 at p. 1) (Hoshizaki, No. 84 at p. 1)

Hoshizaki noted in its written comment that a large majority of currently ENERGY STAR-certified equipment would fail to meet the proposed standard. (Hoshizaki, No. 84 at p. 1) During the public meeting, Structural Concepts pointed out the relationship between the proposed standard and the ENERGY STAR Version 3.0 requirement, opining that it was impractical for a standard to be more stringent than the ENERGY STAR requirement. (Structural Concepts, Public Meeting Transcript, No. 62 at p. 305) The Joint Comment, however, noted that according to the ENERGY STAR-qualified products list, there already are products in five major self-contained equipment classes that meet or exceed the proposed standard. Further, the Joint

[24] ENERGY STAR is a joint program of the U.S. Environmental Protection Agency (EPA) and DOE that establishes a voluntary rating, certification, and labeling program for highly energy efficient consumer products and commercial equipment. Information on the program is available at: www.energystar.gov.

Comment drew comparison to the 2009 final rule for residential refrigerators, noting that proceeding to be a precedent in which units on the market were not reaching the maximum technically feasible efficiency level modeled, since no product was using all the design options considered in DOE's analysis. (Joint Comment, No. 91 at p. 3) Additionally, joint comments from the California Investor Owned Utilities (CA IOUs) noted that all equipment currently listed in the CEC product database for the VOP.SC.M, SVO.SC.M, HZO.SC.M, and HZO.RC.M classes already met the proposed standard. (CA IOUs, No. 63 at p. 1)

Stakeholders noted that, in the proposed rule, the expected efficiency improvement over existing standards was more stringent for some equipment classes than for others. Lennox International Inc. (Lennox) urged DOE to set standards for VCT classes which had the same percentage reduction from existing standard levels as open-case classes, and suggested that stricter VCT standards would encourage consumers to switch from closed to open equipment. (Lennox, No. 73 at p. 4) Structural Concepts opined that the proposed change in MDEC for SOC equipment was too drastic, further noting that for SOC and VCS equipment classes, it is counterintuitive for DOE to propose a greater relationship between size and daily energy consumption for remote condensing units than for self-contained units, since SC units are inherently less efficient. (Structural Concepts, No. 85 at p. 3) Coca-Cola, Inc. (Coca-Cola) commented that the TSL 4 standard was more stringent for PD.SC.M units than for VCT.SC.M, and that this was counterintuitive. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 100) The CA IOUs pointed out in its written comment that the current standards for PD.SC.M were set through a negotiated process, whereas the standards for other classes were modeled. (CA IOUs, No. 63 at p. 6) China commented that while DOE proposed stricter standards for the VCT.RC.M class since the 2009 final rule, DOE was not suggesting amended standards for the HZO class. (China, No. 92 at p. 3)

Another concern amongst manufacturers and consumers was the belief that the proposed standard levels were based on technology that was currently not available, but rather which DOE projected would be available at the time of required compliance with the proposed rule. Continental opined that it was impractical to develop standards based on currently unavailable technologies. (Continental, Public Meeting Transcript, No. 62 at p. 96) Coca-Cola commented that since the proposed standards were based on technology which was not yet available, the proposed standards, specifically TSL4 for VCT.SC.M units, were not technologically feasible. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 74) True expressed agreement with Coca-Cola, stating that the proposed efficiency levels were beyond the level of what industry can meet at the current time. (True, Public Meeting Transcript, No. 62 at p. 307) Lennox commented that the proposed standards for VCT units were unattainable with currently known technology and were not economically justified. Lennox further commented that under the proposed rule, only a very limited number of compliant VCT products would be produced and sold. (Lennox, No. 73 at p. 2) The North American Association of Food Equipment Manufacturers (NAFEM) noted that none of its member manufacturers were able to identify current technology options or prototype designs which met the proposed standard levels, and that using assumptions beyond what was available in the current market landscape would also improperly quantify the impact of the proposed rule on manufacturer costs. (NAFEM, No. 93 at p. 3)

Additionally, during the October public meeting Coca-Cola and True commented that food safety was of prime importance in the design of their equipment, and should take precedence over energy savings. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 86) (True, Public Meeting Transcript, No. 62 at p. 350) National Restaurant Association (NRA) noted that the proposed standards had the potential to reduce cooling ability and recovery time for equipment subject to constant opening and closing, and that this reduced performance could compromise food safety. (NRA, No. 90 at p. 3) Similarly, NAFEM also noted that the implementation of the proposed standards would have potential negative effects on food safety for end-users. (NAFEM, No. 93 at p. 5)

DOE understands the concerns voiced by stakeholders regarding their future ability to meet standard levels as proposed in the NOPR. Between the NOPR and final rule stages, DOE revised and updated its analysis based on stakeholders comments received at the NOPR public meeting and in written comments. These updates included improvements to the modeling of equipment geometries, design specifications, and design option performance and costs so as to provide a more accurate model of baseline and higher-efficiency designs across the classes analyzed. After applying these updates, DOE amended its TSLs and standard level equations accordingly. With respect to the comments from Zero Zone, Structural Concepts, and Royal Vendors regarding the ability of technologies needed to meet the proposed standard level, DOE analyzed the available technologies in its market and technology assessment and screening analyses, and incorporated appropriate and available technology options in the modeling performed as part of its engineering analysis. Therefore, DOE believes that the technologies and designs included in the analysis accurately reflect what is available to industry for improving equipment efficiency.

In response to the Joint Comment, DOE notes that it evaluated equipment performance independently for each equipment class and thus did not revise standards for any one class solely based upon factors affecting another class. DOE believes that the updates and improvements to the modeling applied between the NOPR and final rule stages of this rulemaking have resulted in standard levels presented in today's final rule which address the concerns voiced by stakeholders after publication of the NOPR.

In response to stakeholder comments comparing the proposed standard levels to ENERGY STAR levels, DOE cautions against direct comparisons between its standards and those set forth by ENERGY STAR due to the different natures of the programs and how the two different sets of standard levels are set. ENERGY STAR is a voluntary program which derives its standard levels from market data based on the performance of certain models of equipment currently available for purchase. ENERGY STAR also does not model performance or include consumer economics in its standard-setting process. DOE sets its standards as applicable to all covered equipment and develops them through specific analyses of equipment performance and modeling of economic impacts and other downstream effects. Due to the different goals and methodologies of these two programs, a direct comparison may not be entirely relevant.

However, during the final rule stage, for relevant equipment classes[25], DOE did compare its engineering results to available ENERGY STAR data as a means of checking the modeled performance levels against empirical test data. With respect to the comparison by the California IOUs of performance of open cases to certified values from the CEC directory, DOE also cautions that this directory is not exhaustive. For example, a search of the directory shows that, for some equipment classes, only equipment from a single manufacturer is included. Therefore, while directory data is helpful in providing a check on DOE's results, DOE has performed independent modeling and analysis to derive its standard levels.

With respect to the concerns about the relative perceived stringencies of proposed standards for different classes, in the NOPR analyses, DOE examined each equipment class independently based on standard geometries and feature sets for representative units within the classes. DOE then conducted the engineering simulations and downstream economic analyses separately for each primary class examined. The results presented at the NOPR stage represent the suggested performance and cost values for each class based on the best available information at the time of that analysis. Therefore, DOE cautions against comparative examination of the relative stringencies of the various standard levels, as each was calculated independently and the performance and economic benefits of individual design options vary specific to each class. DOE also agrees with the California IOUs that previous standard levels should not necessarily be used as a check on current analytical results because the origins of those standards are not completely

[25] ENERGY STAR only maintains standard levels applying to equipment classes VCS.SC.M, VCS.SC.L, VCT.SC.M, VCT.SC.L, HCS.SC.M, HCS.SC.L, HCT.SC.M, and HCT.SC.L. Thus, these were the only classes for which a comparison between the DOE and ENERGY STAR levels could be made.

transparent, meaning that a direct comparison may be inappropriate due to differences between the methodologies used to set those standards and those used by DOE in the current rulemaking. At the final rule stage, DOE continued to examine each class independently based on the merits of the available efficiency-improving features, and has set amended standards for each class based on the results of those analyses.

In response to the assertions that DOE's standard levels were not based upon currently available technologies, but rather were dependent upon future potential technological developments, DOE maintains that all technology options and equipment configurations included in its NOPR reflect technologies currently in use in commercial refrigeration equipment or related equipment types. DOE has observed these design options and features used in current manufacturer models offered for sale. The specific inputs which it used to model these design options, such as compressor efficiency improvements over the market baseline, glass door U-factor, or heat exchanger UA, were provided to the public for comment in the NOPR TSD and engineering analysis spreadsheet, and DOE has updated those inputs according to stakeholder feedback and other information available during the final rule stage.

DOE understands the concerns voiced by Coca-Cola, True, NAFEM, and NRA regarding food safety. DOE realizes that food safety is of the utmost importance to the industry, and is in fact a definitional aspect of the design of equipment for food storage temperatures. In its screening analysis, DOE is compelled by sections 4(b)(4) and 5(b) of the Process Rule[26] to eliminate from consideration any technology that presents unacceptable problems with respect to a specific set of criteria, including impacts on equipment utility. Therefore, DOE removed from consideration technologies and design options which could result in such adverse impacts. Additionally, in its engineering analysis, DOE modeled medium-temperature equipment as having an average product temperature of 38°F, consistent with the rating temperature specified in the DOE test procedure and below the 41°F requirement of the NSF 7[27] food safety rating procedure. Thus, the daily energy consumption values produced in the engineering analysis reflect a level of equipment performance which ensures preservation of the ability to maintain food safety temperatures.

3. Rulemaking Timeline

Some stakeholders felt that in light of the large number of analytical changes that could be required between the NOPR and final rule, DOE should extend the target date for publication of the final rule. Traulsen requested that DOE slow the rulemaking process down due to the aggressiveness of the final rule date. (Traulsen, Public Meeting Transcript, No. 62 at p. 347) Hillphoenix and Lennox also expressed the same concern, noting that a February 2014 deadline for publication of the final rule allowed insufficient time for the reevaluation of DOE's engineering analysis. (Hillphoenix, No. 71 at p. 3) (Lennox, No. 73 at p. 2) In contrast, the New York State Attorney General (NYSAG) commented that the delay in amending these efficiency

[26] Appendix A to subpart C of 10 CFR part 430, "Procedures, Interpretations, and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products" is known as "The Process Rule."
[27] This refers to the NSF/ANSI 7 procedure used to test equipment performance for food safety.

standards not only violated Congressional mandates, but has also prolonged the time that inefficient products stay in the market. NYSAG further commented that these delays have led to avoidable pollution and waste of resources. (NYSAG, No. 92 at p. 1)

While DOE appreciates the input from commenters requesting that the timeline for this rulemaking be extended, none of the commenters has provided any details or specifics with regard to what specifically they believe would require extra time. In reviewing its analyses to date, the inputs received at the NOPR public meeting and in subsequent written comment, DOE believes that the time allotted is sufficient in order to allow for full and proper analysis required in order to develop the final rule. In fact, DOE conducted an efficient and thorough effort to promulgate the final rule within the constraints of the time allotted. With regard to NYSAG's comment, DOE notes that it has moved as efficiently as possible while conducting the thorough analysis required to set appropriate standards.

4. Normalization Metrics

Following publication of the NOPR, DOE received comment on the normalization metrics used to scale allowable daily energy consumption under the standard levels as a function of equipment size. Depending on the design and intended application of each equipment class, DOE proposed energy standard levels using either total display area or volume as a metric. Structural Concepts commented that DOE's metrics for the VCT and HCT families were inconsistent, since some proposed standards for classes within the families were based on total display area (TDA) while others were based on volume, NAFEM stated that industry participants use volume, rather than linear feet, to estimate total market size. (Structural Concepts, No. 85 at p. 3) (NAFEM, No. 93 at p. 6)

DOE understands that the selection of appropriate measures of case size is important to the standards-setting process across all covered equipment classes. For the self-contained equipment with doors for which standards were set in the EPACT 2005 legislation, volume was identified in the statute as the normalization metric. (42 U.S.C. 6313(c)(2)) For the equipment covered by the 2009 final rule, DOE selected the metrics of volume for equipment with solid doors and TDA for display-type equipment. Because radiation and conduction through doors are the primary heat transfer pathways for CRE equipment with transparent doors, DOE concluded that TDA is the metric that best quantifies this effect. Likewise, for equipment without doors, the majority of heat load occurs due to warm air infiltration, and DOE determined that TDA would also be the most appropriate metric for capturing these effects. DOE also stated its conclusion that for these equipment types, where the function is to display merchandise for sale, TDA best quantifies the ability of a piece of equipment to perform that function. On the other hand, equipment with solid doors is designed for storage, and volume was determined to be the most appropriate metric for quantifying the storage capacity of the unit. 72 FR 41177-78 (July 26, 2007).

DOE does not believe, based on its discussions with manufacturers and comments solicited over the course of this rulemaking that the fundamental concepts underlying the choices of TDA or volume as the normalization metric for any given class of equipment have changed.

In line with the reasons stated above, DOE is retaining the current normalization metrics for the respective equipment classes, consisting of both the metrics set forth in the 2009 final rule and those prescribed by the EPACT 2005 standards for self-contained equipment with doors.

In response to the comment from NAFEM regarding the usage of linear feet, DOE wishes to clarify that it did not use linear feet of equipment as a measure of equipment size in its engineering analysis, nor as a metric when estimating total market size in its shipments analysis. Rather, DOE utilized linear feet as a normalization metric in the national impacts and other downstream analyses when accounting for the aggregate costs and benefits of today's final rule. DOE believes that the units used in making representations of equipment market size are accurate, and DOE did not modify them for the final rule analysis.

5. Conformance with Executive Orders and Departmental Policies

At the NOPR public meeting, and in a subsequent written comment, Traulsen opined that the proposed rule violates Executive Order 12866. Specifically, Traulsen stated that the rule failed to identify the failures of private markets or public institutions that warrant new agency action, since the industry had actively embraced voluntary efficiency goals and standards. (Traulsen, No. 65 at p.16) Section 1(b)(1) of Executive Order 12866 requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. In section VI.A of today's document (and also in the NOPR), DOE has identified the problems that it has addressed by amending energy conservation standards for commercial refrigeration equipment. For certain segments of the companies that purchase commercial refrigeration equipment, such as small grocers, these problems may include a lack of consumer information and/or information processing capability about energy efficiency opportunities in the commercial refrigeration equipment market. In addition, the market for commercial refrigeration equipment is affected by electricity prices that do not reflect all of the social and environmental costs associated with electricity use. When such externalities are not included in the decisions made by market actors, this is considered a market failure by economists.

Traulsen asserted that the proposed rule was in violation of Executive Order 13563 and the Information Quality Act since the assumptions in DOE's analysis did not use the best available techniques to quantify the benefits of the rule. (Traulsen, No. 65 at pp.16-17) DOE believes that the analysis described in today's document is based on the best available techniques that were suited to the data available to analyze commercial refrigeration equipment. Further, Traulsen did not point to any specific techniques in its comment that would have been superior to those employed by DOE

NAFEM expressed concern that the proposed rule was in violation of Executive Orders because it had a disproportionate negative impact on small businesses, failed to consider non-regulatory alternatives, and since DOE had made no contact with end-users in order to understand impact on users. (NAFEM, No. 93 at p. 14) Traulsen stated that DOE should consider supplementing regulatory action with other forms of non-regulatory alternatives, such as expanded collaboration with ENERGY STAR, rebates, and incentive programs. (Traulsen, No. 65 at p. 15)

As discussed in section V.B.1.b of this document, DOE believes that today's rule would not have a disproportionate negative impact on small businesses. DOE did consider non-regulatory alternatives to amended standards, as described in detail in chapter 17 of the final rule TSD. Finally, DOE requested comment from the public and held public meetings that were attended by representatives of end-users of commercial refrigeration equipment (e.g., ACCA, Coca-Cola, and NAFEM).

NAFEM also opined that the proposed rule violated the Secretarial Policy Statement of Scientific Integrity, since the analysis was not independently peer-reviewed by qualified experts, underlying assumptions were not clearly explained, and since DOE failed to accurately contextualize uncertainties pertaining to non-regulatory alternatives. (NAFEM, No. 93 at p. 14)

The Secretary's March 23, 2012 "Secretarial Policy Statement of Scientific Integrity"[28] sets forth a policy for DOE employees and states, in relevant part, that "DOE will ensure that data and research used to support policy decisions are of high scientific and technical objectivity. Scientific and technical objectivity will be supported through independent peer review by qualified experts, where feasible and appropriate, and consistent with law." With respect to DOE's analysis underlying this final rule, DOE has solicited and thoroughly considered

[28] https://www.directives.doe.gov/references/secretarial_policy_statement_on_scientific_integrity/view

comment and data from expert CRE manufacturers throughout the rulemaking process. DOE does not believe that any additional expert review of its analysis is either necessary or appropriate.

Further, the assumptions used in DOE's analysis are described in detail in the NOPR TSD and in the final rule TSD. DOE is not aware of the uncertainties pertaining to non-regulatory alternatives mentioned only in a general sense by NAFEM.

6. Offset Factors

In presenting the NOPR standard levels, DOE adopted and modified the offset factors from the 2009 final rule and EPACT 2005 standard levels to define the energy consumption of a unit at zero volume or TDA, thus setting the y-intercepts of the linear standard level equations proposed at levels intended to represent "end effects" inherent in all equipment. Some stakeholders expressed disagreement with DOE's modeling of offset factors. Hillphoenix commented that offset factors were designed to account for factors which remained constant over a range of equipment sizes. Hillphoenix further commented that such factors as conduction end effects typically do not vary with size. (Hillphoenix, No. 71 at p. 2) Traulsen commented that DOE's modeled offset factors were not empirically determined. (Traulsen, No. 65 at p. 19) The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) commented that it was impossible for stakeholders to compare the offset factors within the current rulemaking with the previous rulemaking's values. (AHRI, No. 75 at p. 14)

In developing offset factors for the NOPR, DOE scaled existing offset factors from the EPACT 2005 and 2009 final rule standard levels based on the percentage reduction in energy use modeled at the representative unit size. This allowed the NOPR standard level equations to reflect energy allowances which proposed a standard percentage reduction in allowable consumption across all equipment sizes. While DOE agrees with Traulsen that the offset factors were not empirically determined, the factors were based upon scaling proportional to modeled equipment performance and applied to the existing offset factors which have been well-established and vetted through development of and compliance with the existing standards containing them.

In response to the comment from Hillphoenix, DOE agrees that there are certain fixed effects which will be encountered by any piece of equipment, such as a minimum amount of conduction, or energy consumption attributable to the presence of a minimum of a single fan motor, for example. For the final rule, and in response to the concern of stakeholders, DOE adjusted its offset factors to account for these constant effects. In equipment for which DOE developed offset factors for use in standard level equations in its 2009 final rule, DOE retained the same offset factors in the development of the trial standard levels presented in today's document. DOE believes that the retention of these factors accurately reflects the presence of fixed end-effect behavior in this equipment, which remains independent of the design options elsewise implemented in the equipment. For the equipment for which standard levels were set by EPACT 2005, DOE had no background information as to how those offset factors were developed. Therefore, in developing trial standard levels for today's final rule, DOE adjusted those offset factors based on available data from directories of certified product performance. For more information on the development of offset factors, please see chapter 5 of the final rule TSD.

B. Market and Technology Assessment

When beginning an energy conservation standards rulemaking, DOE develops information that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, and market characteristics. This activity includes both quantitative and qualitative assessments based primarily on publicly available information (e.g., manufacturer specification sheets, industry publications) and data submitted by manufacturers, trade associations, and other stakeholders. The subjects addressed in the market and technology assessment for this rulemaking include: (1) quantities and types of equipment sold and offered for sale; (2) retail market trends; (3) equipment covered by the rulemaking; (4) equipment classes; (5) manufacturers; (6) regulatory requirements and non-regulatory programs (such as rebate programs and tax credits); and (7) technologies that could improve the energy efficiency of the equipment under examination. DOE researched manufacturers of commercial refrigeration equipment and made a particular effort to identify and characterize small business manufacturers. See chapter 3 of the final rule TSD for further discussion of the market and technology assessment.

1. Equipment Classes

In evaluating and establishing energy conservation standards, DOE generally divides covered equipment into classes by the type of energy used, or by capacity or other performance-related feature that justifies a different standard for equipment having such a feature. (42 U.S.C. 6295(q) and 6316(e)(1)) In deciding whether a feature justifies a different standard, DOE must consider factors such as the utility of the feature to users. DOE normally establishes different energy conservation standards for different equipment classes based on these criteria.

Commercial refrigeration equipment can be divided into various equipment classes categorized by specific physical and design characteristics. These characteristics impact equipment efficiency, determine the kind of merchandise that the equipment can be used to display, and affect how the customer can access that merchandise. Key physical and design characteristics of commercial refrigeration equipment are the operating temperature, the presence or absence of doors (i.e., closed cases or open cases), the type of doors used (transparent or solid), the angle of the door or air curtain[29] (horizontal, semivertical, or vertical), and the type of condensing unit (remote condensing or self-contained). The following list shows the key characteristics of commercial refrigeration equipment that DOE developed as part of the January 2009 final rule (74 FR at 1099–1100 (January 9, 2009)), and used during this rulemaking:

1. Operating Temperature
    - Medium temperature (38 °F, refrigerators)
    - Low temperature (0 °F, freezers)
    - Ice-cream temperature (-15 °F, ice-cream freezers)

[29] An air curtain is a continuously moving stream of air, driven by fans, which exits on one side of the opening in an open refrigerated case and re-enters on the other side via an intake grille. The function of the air curtain is to cover the opening in the case with this sheet of air, which minimizes the infiltration of warmer ambient air into the refrigerated space.

2. Door Type
    - Equipment with transparent doors
    - Equipment with solid doors
    - Equipment without doors
3. Orientation (air-curtain or door angle)
    - Horizontal
    - Semivertical
    - Vertical
4. Type of Condensing Unit
    - Remote condensing
    - Self-contained

Additionally, because EPCA specifically sets a separate standard for refrigerators with a self-contained condensing unit designed for pull-down temperature applications and transparent doors, DOE has created a separate equipment class for this equipment. (42 U.S.C. 6313(c)(3)) DOE included this equipment in the form of a separate family with a single class (PD.SC.M). A total of 49 equipment classes were created, and these are listed in chapter 3 of the TSD using the nomenclature developed in the January 2009 final rule. 74 FR at 1100 (January 9, 2009).

During the October 2013 NOPR public meeting and in subsequent written comments, a number of stakeholders addressed issues related to proposed equipment classes and the inclusion of certain types of equipment in the analysis. These topics are discussed in this section.

a. Equipment Subcategories

In their written comments, Continental, NAFEM, True and Traulsen all expressed concern that the equipment classes defined by DOE in the proposed rule did not sufficiently encompass various sub-classifications, especially with regard to pass-through and reach-in cases. (Continental, No. 87 at p. 1) (NAFEM, No. 93 at p. 7) (True, No. 76 at p. 3) (Traulsen, No. 65 at p. 16) Further, Traulsen and True pointed out that a multitude of custom-built and niche equipment exists, which would require further analysis in order to determine a viable standard. (Traulsen, No. 65 at p. 20) (True, No. 76 at p. 1)

In response to the concerns of interested parties, DOE believes that its existing equipment class structure is sufficient to account for the majority of variation in type and combination of equipment geometry, condensing unit configuration, and operating temperature. DOE provides allowances in its standards to account for the energy needs of different equipment sizes through its use of standard level equations constructed in the form of linear equations varying with equipment size (as measured by volume or TDA) and through its use of offset factors to represent energy end-effects. DOE also accommodates variation in operating temperature outside of its three rating temperatures through the use of a lowest application product temperature provision in its test procedure. 77 FR at 10305 (February 21, 2012)

b. Floral Equipment

In the context of niche equipment classes, the Society of American Florists (SAF) noted that the floral industry uses purpose-designed refrigeration equipment, including sliding door floral display coolers (self-contained), open air access floral display coolers (reach-in), countertop floral display coolers and long door floral display coolers (swinging or sliding doors, top-mounted or remote condensing unit). SAF further added that most of these units are custom-built, since floral cooling systems are balanced to keep humidity high, and that special low-velocity coils are utilized to blow air through the unit while maintaining temperature and high humidity levels – features not available in stock equipment. (SAF, No. 74 at p. 3)

DOE believes that its division of covered equipment into numerous classes is sufficiently broad to capture the level of differentiation present within the commercial refrigeration equipment market. The equipment types described in the comment from SAF would fall into a number of existing equipment classes for which DOE has conducted analyses in this rulemaking. Additionally, DOE has recognized the temperature issues which may be present in floral cases, and has accommodated those different operating temperatures by developing and implementing a provision in its test procedure allowing equipment which cannot reach the specified DOE rating temperature to be tested at its lowest application product temperature. 77 FR at 10305 (February 21, 2012)

2. Technology Assessment

As part of the market and technology assessment performed for the final rule analysis, DOE developed a comprehensive list of technologies that would be expected to improve the energy efficiency of commercial refrigeration equipment. Chapter 3 of the TSD contains a detailed description of each technology that DOE identified. Although DOE identified a complete list of technologies that improve efficiency, DOE only considered in its analysis technologies that would impact the efficiency rating of equipment as tested under the DOE test procedure. Therefore, DOE excluded several technologies from the analysis during the technology assessment because they do not improve the rated efficiency of equipment as measured under the specified test procedure. Technologies that DOE determined impact the rated efficiency were carried through to the screening analysis and are discussed in section IV.C.

a. Technologies Applicable to All Equipment

In the NOPR analysis market and technology assessment, DOE listed the following technologies that would be expected to improve the efficiency of all equipment: higher efficiency lighting, higher efficiency lighting ballasts, remote lighting ballast location, higher efficiency expansion valves, higher efficiency evaporator fan motors, variable-speed evaporator fan motors and evaporator fan motor controllers, higher efficiency evaporator fan blades, increased evaporator surface area, low-pressure differential evaporators, increased case insulation or improvements, defrost mechanisms, defrost cycle controls, vacuum insulated panels, and occupancy sensors for lighting controls. These technologies are discussed in depth in chapter 3 of the NOPR TSD. Not all of these technologies were considered in the engineering analysis; some were screened out or removed from consideration on technical grounds. After the publication of the NOPR analysis, DOE received numerous stakeholder comments regarding these technologies, discussed below.

Low Pressure Differential Evaporators

Traulsen commented that low pressure differential evaporators would require larger spaces between fins and tubes, which could in turn reduce overall efficiency by allowing frost build-up. (Traulsen, No. 65 at p. 7) Low-pressure differential evaporators reduce energy consumption by reducing the power of evaporator fan motors, often by increasing the air gap between fins. However, as noted in chapter 5 of the NOPR TSD, in space-constrained equipment such as commercial refrigeration equipment, this reduction usually comes from a decrease in evaporator coil surface area, which generally requires a lower saturated evaporator temperature (SET) to achieve the same discharge air temperature and cooling potential. This, in turn, results in a reduction in compressor efficiency. Therefore, DOE agrees with Traulsen that low pressure differential evaporators are not a viable option for consideration in this rulemaking and did not consider them as a design option.

Defrost Mechanisms

Traulsen commented that in order for DOE to advocate for improved defrost sensors, new designs would need to be implemented, and that the compliance date suggested in the NOPR would not allow for the levels of research and development (R&D) necessary to achieve this improvement. (Traulsen, No. 65 at p. 8) DOE wishes to clarify that it did not consider advanced defrost sensors as a design option within the analyses conducted at the NOPR or final rule stages of this rulemaking. Much equipment currently manufactured already uses partial defrost cycle control in the form of cycle temperature-termination control. However, defrost cycle initiation is still scheduled at regular intervals. Full defrost cycle control would involve a method of detecting frost buildup and initiating defrost. This could be accomplished using an optical sensor or through use of a sensor to detect the temperature differential across the evaporator coil. However, DOE understands that both of these methods are currently unreliable due to fouling of the coil with dust and other surface contaminants, which becomes more of an issue as cases age. Because of these issues, DOE agrees with Traulsen's concerns and did not consider defrost cycle control as a design option at the NOPR or final rule stages. Instead, the defrost lengths modeled in the engineering analysis were based on defrost times gathered through review of manufacturer literature, manufacturer interviews, and data collected through laboratory testing of equipment currently available on the market.

Light Emitting Diode Lighting

After publication of the NOPR, Traulsen commented that DOE's assertion of consumer enthusiasm towards LEDs lacked basis in reality. Further, Traulsen commented that any weight given to this assertion in the calculations was null. (Traulsen, No. 65 at p. 4) During its analysis, DOE considered design options based on their availability on the market and on the screening criteria set forth by the Process Rule. In considering LED lighting as a design option, DOE did so after researching existing product offerings on the market and conferring with manufacturers in confidential interviews. DOE did not factor "consumer enthusiasm" into its decision to include LED lighting as asserted by Traulsen, but instead considered this design option based on the information available from the current equipment market and the technology's ability to reduce the measured energy consumption of covered equipment.

b. Technologies Relevant only to Equipment with Doors

In chapter 3 of the NOPR TSD, DOE mentioned three technologies that could apply only to doored equipment: anti-fog films, anti-sweat heater controllers, and high performance doors. Not all of these technologies were considered in the NOPR engineering analysis, as some were screened out or removed from consideration on technical grounds. The following sections discuss stakeholder comments regarding these technologies.

Anti-fog Films

Traulsen commented that while DOE called for the use of advanced hydrophobic materials in the form of anti-fog films to prevent condensation build-up, there were concerns with regard to the NSF certification of this feature. (Traulsen, No. 65 at p. 11) DOE wishes to clarify that, while it included anti-fog films for consideration in the NOPR market and technology assessment, it did not include them as a design option in the engineering analysis. For a full discussion of why DOE did not consider anti-fog films, please see chapter 5 of the NOPR TSD. DOE agrees with Traulsen's concerns, amongst others, and continued to exclude this technology from it analysis at the final rule stage.

Anti-Sweat Heater Controllers

In its statements at the NOPR public meeting, the California IOUs urged DOE to consider anti-sweat heater controllers as a design option due to their large savings potential. (CA IOUs, Public Meeting Transcript, No. 62 at p. 19) However, in its written comment, Traulsen pointed out that these may be impractical, since sensor technologies had high failure rates in kitchen environments. (Traulsen, No. 65 at p. 11)

DOE addressed consideration of this technology in chapter 4 of the NOPR TSD. Anti-sweat heater controllers modulate the operation of anti-sweat heaters by reducing heater power when humidity is low, and operate most effectively when a constant ambient dew point cannot be maintained. However, in the context of the DOE test procedure, anti-sweat heater controllers solely serve to keep the power to the anti-sweat heaters at the levels necessary for the test conditions. These fixed conditions of 75°F and 55 percent relative humidity are the conditions that ASHRAE has determined to be generally representative of commercial refrigeration equipment operating environments and which DOE has adopted in its test procedure. While anti-sweat heater controllers could modulate the anti-sweat power to a further extent in the field so as to account for more or less extreme ambient conditions, a system equipped with anti-sweat heater controllers will not likely exhibit significantly different performance at test procedure conditions than a unit with anti-sweat heaters tuned for constant 75/55 conditions. Because they would have no impact on measured energy consumption under the DOE test procedure, DOE did not consider anti-sweat heater controllers in the engineering analysis.

c. Technologies Applicable Only to Equipment without Doors

In chapter 3 of the NOPR TSD, DOE mentioned two technologies, air-curtain design and night curtains, that potentially could be used to improve the efficiency of commercial refrigeration equipment without doors. Air curtain design was not considered in the NOPR engineering analysis, as it was screened out and removed from consideration because, according to the information available to DOE, advanced air curtain designs are still in research and development stages and are not yet available for use in the manufacture of commercial refrigeration equipment. The following sections address stakeholder comments regarding technologies applicable to equipment without doors.

Air-Curtain Design

In its written comment, Traulsen expressed concern over the use of advanced air curtain designs. (Traulsen, No. 65 at p. 11) DOE agrees with Traulsen that advanced air curtain designs are not currently a feasible option for use in commercial refrigeration equipment. Sections 4(a) and 5(b) of the Process Rule specifically set "practicability to manufacture, install, and service" as a criterion that should be satisfied for technology to be considered as a design option. In chapter 4 of the NOPR TSD, DOE explained that advanced air curtain designs are only in the research stage and, therefore, that it would be impracticable to manufacture, install, and service this technology on the scale necessary to serve the relevant market at the time an amended standard would become effective. For that reason, DOE screened out improved air curtains as a design option for improving the energy efficiency of commercial refrigeration equipment.

C. Screening Analysis

DOE uses four screening criteria to determine which design options are suitable for further consideration in a standards rulemaking. Namely, design options will be removed from consideration if they are not technologically feasible; are not practicable to manufacture, install, or service; have adverse impacts on product utility or product availability; or have adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, sections (4)(a)(4) and (5)(b).

In comments received after the NOPR publication, Traulsen commented that, while DOE screened out certain technology options due to impacts on end-users, it was unclear why the same technology option was screened out for some equipment classes but not others. (Traulsen, No. 65 at p. 2)

During the screening analysis, DOE considered sections 4(b)(4) and 5(b) of the Process Rule, which provide guidance in determining whether to eliminate from consideration any technology that presents unacceptable problems with respect to certain criteria. These criteria include technological feasibility, practicability to manufacture, install, and service, impacts on equipment utility or equipment availability, and adverse impacts on health or safety. If DOE determines that a technology, or a combination of technologies, meet any of the criteria set forth in section 5(b) of the Process Rule, it will be eliminated from consideration. This screening process is applied to each candidate technology being considered, and is applicable across all equipment classes. Therefore, in response to the comment from Traulsen, DOE does not believe that it screened out any particular technology options for some classes but not others.

Based on all available information, DOE has concluded that: (1) all of the efficiency levels discussed in today's document are technologically feasible; (2) equipment at these efficiency levels could be manufactured, installed, and serviced on a scale needed to serve the relevant markets; (3) these efficiency levels would not force manufacturers to use technologies that would adversely affect product utility or availability; and (4) these efficiency levels would not adversely affect consumer health or safety. Thus, the efficiency levels that DOE analyzed and discusses in this document are all achievable through technology options that were "screened in" during the screening analysis.

D. Engineering Analysis

The engineering analysis determines the manufacturing costs of achieving increased efficiency or decreased energy consumption. DOE historically has used the following three methodologies to generate the manufacturing costs needed for its engineering analyses: (1) the design-option approach, which provides the incremental costs of adding to a baseline model design options that will improve its efficiency; (2) the efficiency-level approach, which provides the relative costs of achieving increases in energy efficiency levels, without regard to the particular design options used to achieve such increases; and (3) the cost-assessment (or reverse engineering) approach, which provides "bottom-up" manufacturing cost assessments for achieving various levels of increased efficiency, based on detailed data as to costs for parts and material, labor, shipping/packaging, and investment for models that operate at particular efficiency levels.

As discussed in the Framework document, preliminary analysis, and NOPR analysis, DOE conducted the engineering analyses for this rulemaking using a design-option approach for commercial refrigeration equipment. The decision to use this approach was made due to several factors, including the wide variety of equipment analyzed, the lack of numerous levels of equipment efficiency currently available in the market, and the prevalence of relatively easily implementable energy-saving technologies applicable to this equipment. More specifically, DOE identified design options for analysis, used a combination of industry research and teardown-based cost modeling to determine manufacturing costs, and employed numerical modeling to determine the energy consumption for each combination of design options used to increase equipment efficiency. DOE selected a set of 25 high-shipment classes, referred to as "primary" classes, to analyze directly in the engineering analysis. Additional details of the engineering analysis are available in chapter 5 of the final rule TSD.

1. Representative Equipment for Analysis

a. Representative Unit Selection

In performing its engineering analysis, DOE selected representative units for each primary equipment class to serve as analysis points in the development of cost-efficiency curves. In selecting these units, DOE researched the offerings of major manufacturers to select models that were generally representative of the typical offerings produced within the given equipment class. Unit sizes, configurations, and features were based on high-shipment-volume designs prevalent in the market. Using this data, a set of specifications was developed defining a representative unit for each primary equipment class. These specifications include geometric dimensions, quantities of components (such as fans), operating temperatures, and other case features that are necessary to calculate energy consumption. Modifications to the units modeled were made as needed to ensure that those units were representative of typical models from industry, rather than a specific unit offered by one manufacturer. This process created a representative unit for each equipment class with typical characteristics for physical parameters (e.g., volume, TDA), and minimum performance of energy-consuming components (e.g., fans, lighting).

b. Baseline Models

DOE created a set of baseline design specifications for each equipment class analyzed directly in the engineering model. Each set of representative baseline unit specifications, when combined with the lowest technological level of each design option applicable to the given equipment class, defines the energy consumption and cost of the lowest efficiency equipment analyzed for that class. Chapter 5 of the final rule TSD sets forth the specifications that DOE chose for each equipment class and discusses baseline models in greater detail.

One complexity involved in developing an engineering baseline was due to the variety of designs and technology options that manufacturers could utilize in order to meet the recently-implemented standards arising from EPACT 2005 and the 2009 final rule. Through its analyses, DOE determined that manufacturers were utilizing a wide variety of design paths in order to meet the necessary performance level. Therefore, in order to develop its engineering results for the current rule, DOE retained the engineering baseline and associated technologies used in its January 2009 final rule engineering analysis and expanded them to accommodate the new equipment classes covered by the standards initially established by EPCA. (42 U.S.C.

6313(c)(2)–(3)) DOE then added technologies to this baseline to develop its cost-efficiency curves, and ordered the technology options from lowest to highest payback period. The result was a set of cost-efficiency curves reflecting what DOE believes to be the most cost-effective means of meeting the existing standards, as well as that of attaining the higher levels of performance reflected in today's rule.

As a result, some of the engineering results represent levels of unit performance that are below the standard levels for equipment currently on the market and subject to DOE's existing standards. (10 CFR 431.66). However, in its LCC and other downstream analyses, DOE accounted for this fact by utilizing a standards baseline as the minimum efficiency level examined, thereby truncating the engineering design option levels so that the lowest efficiency point analyzed corresponded to the current standard level with which that particular model of equipment would have to comply. The exact procedure is described in section IV.F and additional details are provided in chapter 8 of the final rule TSD.

After publication of the NOPR and the NOPR public meeting, DOE received a number of comments from interested parties regarding its establishment of baseline models, and the features and design specifications included in those baseline models. The subsequent sections contain those comments and DOE's responses.

Composition of Baseline

Southern Store Fixtures Inc. (Southern Store Fixtures), AHRI, Hussmann and Structural Concepts expressed concern that, by keeping the baseline consistent between the previous rule and the proposed rule, DOE had failed to account for the efficiency improvement brought about by the previous standard, thereby overestimating the potential for energy savings. (Southern Store Fixtures, No. 67 at p. 2) (AHRI, No. 75 at p. 2) (Hussmann, No. 77 at p. 9) (Structural Concepts, No. 85 at p. 1) Additionally, AHRI noted that although the current rulemaking retains the baseline specifications and some related technologies from the previous rulemaking, there are differences in the baseline energy consumption across the two rulemakings. (AHRI, No. 75 at p. 4)

The Joint Comment pointed out that, for some equipment classes, many ENERGY STAR-qualified products were rated as being less efficient than the modeled baseline. Further, the Joint Comment urged DOE to re-evaluate the baseline levels for equipment classes for which the current standards were established by EPACT 2005. (Joint Comment, No. 91 at p. 5)

In response to the comments raised by interested parties regarding the modeled equipment baseline, DOE points out that there is currently no prescriptive requirement that commercial refrigeration equipment use any specific combination of features to meet the existing EPACT 2005 or 2009 final rule standard levels. For this reason, and in order to ensure a proper ordering of the implementation of efficiency-improving technologies in its engineering analysis, DOE started with an engineering baseline which was, in many cases, below the performance level mandated by the current standards. DOE then modeled equipment with increasingly higher levels of performance by implementing the applicable design options in order of ascending payback period. The result of this was a modeled configuration reflecting, based on the information available to DOE, the most cost-effective way to build a model which complies with the existing standards. Then, DOE continued to add the remaining design options until it reached the max-tech level. It was these additional efficiency levels above the performance level required by the existing standard that were considered as offering incremental efficiency improvements beyond the level required at the time of the analysis.

Energy savings and downstream impacts (such as life-cycle cost and national net present value results) were calculated based on a base case efficiency distribution in which minimum-efficiency products available today are assumed to comply with existing standards. Therefore the modeled design options up to the level of performance required by existing standards did not have any impact on the energy or cost savings attributed to the amended standards prescribed today, but rather, served only to align the engineering cost-efficiency curve with the technologies which present the shortest-payback options for reducing energy consumption. As a result, DOE believes that the assertion of some stakeholders that its methodology overstates the energy savings attributable to today's rule is inaccurate.

With regard to the specific technology modeling that was discussed by AHRI, DOE updated modeling of some baseline design options and components from the 2009 final rule to the current rulemaking to ensure the most accurate possible depiction of components currently available on the market. In the final rule stage, DOE revisited these design option parameters based on stakeholder comments and further revised them where appropriate so as to ensure a greater degree of accuracy in the engineering model inputs. Therefore, DOE understands that there may be adjustments to the numerical outputs of the modeling of baseline units between rulemakings and rulemaking stages.

In response to the issue raised in the Joint Comment, DOE wishes to point out that the ENERGY STAR-qualified directory[30] is, by design, not necessarily an exhaustive source of information for all models available on the market. However, DOE has adjusted its modeling of baseline units in the final rule stage of the analysis and, in conducting comparisons between its engineering results and market data such as the ENERGY STAR directory, has found agreement between the performance results obtained from its engineering analysis and the data points contained in the ENERGY STAR directory.

Condensate Pan Heaters

In their written comments, manufacturers provided input on the modeling of condensate pan heaters in baseline and higher-performance units. Traulsen noted that closed door refrigerators were modeled in the NOPR engineering analysis as not requiring electric condensate pan heaters, while freezers were modeled as using this component, even though refrigerators face the same physical limitations as freezers. Further, Traulsen commented that DOE should consider the power required to bring condensate pan heaters to operating

[30] Available http://www.energystar.gov/certified-products/certified-products

temperature and the idle power consumption of empty condensate pans when reviewing energy conservation strategies. Further, Traulsen expressed the belief that electric condensate pan heaters are an important feature which cannot be ignored. (Traulsen, No. 65 at p. 1) Similarly, Hussmann also commented that in self-contained medium-temperature units, manufacturers are required to use condensate evaporator pans, the lack of which would reduce utility to end-users. (Hussmann, No. 77 at p. 7)

In response to the comments provided by Traulsen and Hussmann, DOE revisited its engineering analysis and added condensate pan heaters for medium-temperature vertical closed-door cases to its analytical model. Additionally, in response to Traulsen's suggestion, DOE added a factor of an additional 10% pan energy consumption to its modeling of condensate pan energy use in order to account for the energy needed to bring the pan up to temperature. However, DOE did not add further energy in its engineering simulation to account for idle consumption of empty condensate pans, as DOE understands that most condensate pan heaters use float switches or other sensor devices to activate the pan heater only when the water level is sufficiently high to require it, minimizing operation of heaters with empty pans.

Defrost

In its written comment, Traulsen provided additional information to assist in DOE's modeling of defrost systems. Traulsen commented that while the DOE model assumed that all VCT.SC.M and VCS.SC.M units employ off-cycle defrost systems, this is not true in real-life applications. Traulsen further commented that, for most refrigerator models, it uses an electric defrost element. Traulsen further noted that if electric defrost were included, all theoretical models would fail to meet the proposed standard. Additionally, Traulsen commented that DOE's model seems to ignore desired features such as hot-gas defrost and electric defrost systems, even though they are widely available in the market.

Traulsen commented that defrost cycles tend to terminate when the evaporator coil reaches a predetermined temperature, but the time period required for melting all accumulated frost varies with the mass of the evaporator coil and surrounding components. Further, Traulsen noted that the DOE spreadsheet appears not to account for these accommodations, and fails to account for increased defrost length when using enhanced evaporator coils, which have a 50% higher mass than the baseline coil designs. Traulsen commented that, in the DOE NOPR engineering model, defrost heater wattage only varied in proportion to the length of the cabinet, and not with the cabinet height or volume. Furthermore, Traulsen noted that the heater wattage calculated for full-height closed door cabinets appear to be too high. (Traulsen, No. 65 at p. 11) Structural Concepts commented that the multipliers used to model defrost cycles should differ between open and closed type cases. (Structural Concepts, No. 85 at p. 3)

After the NOPR public meeting and upon receipt of comments, DOE researched defrost mechanisms applied in medium-temperature applications. Specifically, DOE investigated this subject through review of manufacturer literature such as manuals and replacement parts catalogs, as well as through testing and teardown of selected units. The results of this investigation contradicted Traulsen's assertion that electric defrost is commonly used in medium-temperature units, as DOE did not find evidence of this. Additionally, examination of public certification databases such as the ENERGY STAR directory showed equipment performance levels inconsistent with the use of substantial amounts of electric defrost. Therefore, DOE did not find sufficient evidence to warrant adding the modeling of electric defrost to its engineering analysis. With respect to the discussion of hot gas defrost, DOE understands that this feature is currently used by some manufacturers in the market, but did not explicitly model it due to concerns raised through comments and in manufacturer interviews regarding reliability issues with this feature.

In response to the comments from Traulsen and Structural Concepts regarding defrost cycle lengths, DOE based its modeling of defrost cycles for various equipment classes based on a number of sources, including manufacturer literature, manufacturer interviews, and testing of equipment currently on the market. Thus DOE agrees that the defrost length values should vary by equipment class, and has modeled them as such in its engineering analysis. With respect to Traulsen's comment on additional defrost power being needed for larger evaporator coils, DOE constrained the size of the evaporator coils modeled in the final rule analysis, thus mitigating concern over this issue. Additionally, in the final rule engineering analysis, for vertical freezers, DOE adjusted the modeled defrost heater wattages based on inputs from Traulsen's comment and other sources. DOE believes that these changes better reflects the actuality of defrost mechanisms utilized in these equipment classes.

Lighting Configurations

Hillphoenix commented that the number of shelves, and therefore shelf lights, varies greatly for SVO cases depending on the height of the case. Hillphoenix further commented that there exist "extreme configuration differences" among cases within the same class. (Hillphoenix, No. 71 at p. 4)

In developing its engineering analysis for this rulemaking, DOE collected data on common designs within the industry. This information included specifications on lighting configurations and formed the basis for the representative units modeled within the engineering analysis. Based on input collected over the course of the current rulemaking and in the development of the 2009 final rule, DOE believes that its design specifications, including lighting configurations, are accurate and representative of the various covered classes, including SVO cases. Additionally, DOE notes that for SVO cases, the allowable energy consumption under the existing and amended standards is a function of TDA. Cases with greater height, such as those suggested by Hillphoenix, would have a greater measured total display area and thus would be allowed a proportionally larger amount of energy. Therefore, DOE believes that its existing analytical methodology accounts for the concerns raised by Hillphoenix.

Infiltration Loads

Manufacturers opined that DOE's modeling of air infiltration caused by door openings could be improved. Continental Refrigerator (Continental), Hussmann, and Traulsen all commented that air exchange during door openings significantly affects system energy consumption. (Hussmann, No. 77 at p. 3) (Traulsen, No. 65 at p. 10) (Continental, No. 87 at p. 2) Specifically, True commented that door openings and the resultant air exchange could account for between 15% and 25% of a unit's energy consumption. (True, Public Meeting Transcript, No. 62 at p. 151)

Traulsen commented that the energy consumption formulas for closed door models fail to account for gasket losses (heat gain or added load), and that it was concerned with the use of the air infiltration load models applied, especially with respect to closed door units, since real world conditions can vary from those experienced during the ASHRAE test procedure. (Traulsen, No. 65 at p. 10) Moreover, Continental noted that the percentage of air that is exchanged varies greatly with the configuration and type of cabinet. Continental further commented that the DOE model did not provide sufficient explanation of how air infiltration loads were calculated for different cabinet types. (Continental, Public Meeting Transcript, No. 62 at p. 123) Structural Concepts commented that the multipliers used to model infiltration should differ between open and closed type cases. (Structural Concepts, No. 85 at p. 3) ACEEE commented that tracer gas analysis, a well-established technology, could be used to analyze the actual air exchange that occurs during door openings. (ACEEE, Public Meeting Transcript, No. 62 at p. 154)

DOE understands the significance of air infiltration and is aware of its impact on the modeled energy consumption of commercial refrigeration equipment. In response to these comments, DOE reviewed its modeled infiltrated air mass values between the NOPR and final rule stages of the rulemaking. Specifically, DOE adjusted the values for a variety of classes to better align with new information presented in stakeholder comments and other sources. This included adjustments to account for the impacts of the respective air densities at the three DOE rating temperatures, and scaling to better simulate the impacts of case geometry. For full details on the infiltration levels modeled, please refer to chapter 5 and appendix 5A of the final rule TSD.

With respect to the comment from True regarding the percentage of case heat load attributable to infiltration, DOE's engineering model provides a specific breakdown of the constituent components of the case heat loads modeled in its simulation. A review of the DOE engineering model shows the contribution of infiltration to case heat load for closed-door units to be in line with the figures provided by True. In response to the comment from Traulsen, DOE believes that gasket losses are accounted for in its infiltrated air mass values. These values were derived from manufacturer literature based upon test performance under ASHRAE conditions, and thus would encapsulate all phenomena, including gasket losses, encountered by the unit which contribute to the infiltration load during operation. The engineering model simulates performance under the DOE test procedure, and thus changes which may be encountered in the field such as those noted by Traulsen are not specifically relevant to the calculated daily energy consumption values used for standards setting purposes. Therefore, DOE does not see a need to change its methodology to account for this attribute.

DOE agrees with Continental and Structural Concepts that wide variation in infiltration is observed among different equipment classes, particularly between open and closed cases. DOE believes that its updated air infiltration values better account for differences that exist in infiltration loads among cases of different configurations, geometries, sizes, and operating temperatures.

With respect to the comment from ACEEE, DOE understands that tracer gas analysis could be used in a controlled laboratory environment to possibly determine infiltration rates into commercial refrigeration equipment. However, within the scope, time frame, and resources of this rulemaking process, DOE did not pursue that method to further investigate infiltration effects. Instead, DOE continued to base its approach on infiltration load values calculated from manufacturer literature, and adjusted those values based upon comments received after publication of the NOPR. DOE believes that this is an accurate approach, consistent with methodologies employed in other past and current rulemakings, which is substantiated by the best available data as of the time of this analysis.

2. Design Options

After conducting the screening analysis and removing from consideration technologies that did not warrant inclusion on technical grounds, DOE included the remaining technologies as design options in the energy consumption model for its engineering analysis:

- higher efficiency lighting and occupancy sensors for VOP, SVO, and SOC equipment families (horizontal fixtures);
- higher efficiency lighting and occupancy sensors for VCT and PD equipment families (vertical fixtures);

- improved evaporator coil design;
- higher efficiency evaporator fan motors;
- improved case insulation;
- improved doors for VCT equipment family, low temperature and ice-cream temperature (hinged);
- improved doors for VCT and PD equipment families, medium temperature (hinged);
- improved doors for HCT equipment family, low temperature and ice-cream temperature (sliding);
- improved doors for HCT equipment family, medium temperature (sliding);
- improved doors for SOC equipment family, medium temperature (sliding);
- improved condenser coil design (for self-contained equipment only);
- higher efficiency condenser fan motors (for self-contained equipment only);
- higher efficiency compressors (for self-contained equipment only); and
- night curtains (equipment without doors only).

After publication of the NOPR, DOE received a number of comments on its choice and implementation of certain design options within the engineering analysis. The following sections address these stakeholder comments.

a. Fluorescent Lamp Ballasts

Traulsen commented that markets have already trended towards electronic (solid-state) ballasts to modulate power provided by T8 lights. Traulsen raised concern that DOE analysis might therefore be unfairly overstating savings from the adoption of TSL4 by including electronic ballasts as a design option in its analysis. (Traulsen, No. 65 at p. 4)

DOE understands that electronic ballasts are ubiquitous in the commercial refrigeration equipment market within cases that use fluorescent lighting and agrees with the comment presented by Traulsen. In its NOPR engineering analysis, DOE modeled the baseline design option in cases with lighting as comprised of T8 fluorescent fixtures with electronic ballasts. At improved levels of efficiency, DOE implemented super-T8 fluorescent lighting, LED lighting, and LED lighting with occupancy sensors. DOE did not model magnetic ballasts within its NOPR engineering analysis. Given the comments received at the NOPR stage, DOE retained this stance in its final rule engineering analysis.

With regard to Traulsen's assertion that DOE might be overstating savings, DOE wishes to clarify that energy savings and downstream impacts (such as life-cycle cost and national net present value results) were calculated using a base case efficiency distribution in which minimum-efficiency products available today are assumed to comply with existing standards. Therefore, the modeled design options up to the level of performance required by existing standards did not have any impact on the energy or cost savings attributed to the amended standards set forth today, but rather, served only to align the engineering cost-efficiency curve with the technologies which present the shortest-payback options for reducing energy consumption.

b. Condenser Fans

Southern Store Fixtures and AHRI commented that the modeling of electronically commutated motors (ECMs) in condenser fan applications was redundant, since they believe that all equipment in compliance with the 2009 final rule are already using ECMs. (Southern Store Fixtures, No. 67 at p. 4) (AHRI, No. 75 at p. 7)

DOE understands that manufacturers may currently be choosing to utilize ECM fan motors as part of their designs on the market. However, the 2009 final rule and EPACT 2005 standards do not include prescriptive requirements, so DOE is unable to assume that manufacturers have all used any one single design path in order to achieve the necessary performance levels. Instead, DOE started its analysis with an engineering baseline representing designs less sophisticated than needed to meet the current standard levels, and added all available design options, including some previously considered in the 2009 final rule, until reaching the max tech efficiency level. This method allowed DOE to order all design options in the most cost-effective manner. However, only those modeled efficiency levels having performance above the level required by existing standards were considered as contributing to the energy and cost savings attributable to this rule. For a further explanation of this methodology, please see section IV.D.1.b, "Baseline Models."

c. Evaporator Fans

Southern Store Fixtures and AHRI commented that the modeling of ECM fan motors in evaporators was redundant, since they believe that all equipment in compliance with the 2009 final rule is already using ECMs. (Southern Store Fixtures, No. 67 at p. 4) (AHRI, No. 75 at p. 7) Continental commented that shutting off the fans during door-opening could cause the evaporator coil to freeze up, and thus that this should not be considered as an option. (Continental, Public Meeting Transcript, No. 62 at p. 153)

DOE understands that many manufacturers may currently be choosing to utilize ECM fan motors as part of their designs on the market at this time. However, the 2009 final rule and EPACT 2005 standards do not include prescriptive requirements, so DOE was unable to assume that manufacturers all chose any one single design path in order to achieve the necessary performance levels. Instead, DOE started with a simpler engineering baseline representing equipment performance at a lower level than that permitted by current standards, and added all design options, including some previously considered in the 2009 final rule, until reaching the max tech level. This method allowed DOE to order all design options in the most cost-effective manner. However, only those modeled efficiency levels performance above the level required by existing standards were considered as contributing to the energy and cost savings attributable to this rule. For a further explanation of this methodology, please see section IV.D.1.b, “Baseline Models.”

DOE agrees with the concerns of Continental regarding turning off evaporator fans, and did not model evaporator fan controls as a design option in this rulemaking due to a number of issues including the integrity of the air curtain on open cases and food safety issues due to lack of air circulation arising from stopping the evaporator fans. For a full discussion of this issue, please see chapter 5 of the final rule TSD.

d. Design Options Impacting Equipment Form Factor

Some manufacturers and consumer groups urged DOE to screen out any design options which would even marginally affect the geometry of a model, either by increasing its total footprint or reducing the cooled internal space. Specifically, these comments referred to DOE's consideration of added insulation thickness as a design option. True commented that it was impractical to increase the total footprint of equipment since almost all commercial kitchen equipment has a fixed footprint and replacement units must fit into the same space as old units. (True, No. 76 at p. 1) Continental commented that a ½" increase in insulation of walls could have a significant impact on end-users and manufacturers, since equipment is often designed for very specific footprints and layouts. Continental further commented that while an inch less inside space or an inch larger cabinet may seem insignificant, it may be important to end-users. (Continental, Public Meeting Transcript, No. 62 at p. 103) Traulsen, too, noted that both internal capacity and footprint of a unit were its key selling points. (Traulsen, No. 65 at p. 7) Hoshizaki, True, AHRI, NAFEM, SAF, Continental, Structural Concepts and Hillphoenix all opined that increasing the case insulation requirement by even ½", would lead to a significant increase in footprint, or decrease in internal volume – both of which would detrimentally affect consumer utility, since many commercial environments have very limited floor space. (Hoshizaki, No. 84 at p. 2) (True, No. 76 at p. 3) (AHRI, No. 75 at p. 6) (NAFEM, No. 93 at p. 5) (SAF, No. 74 at p. 6) (Continental, No. 87 at p. 3) (Structural Concepts, No. 85 at p. 2) (Hillphoenix, No. 71 at p. 3)

DOE understands stakeholder concerns over unit form factor, and discussed these concerns thoroughly in its manufacturer interviews conducted at the NOPR stage of the rulemaking. At that time, manufacturers agreed that the addition of ½" of insulation above the baseline thicknesses modeled (1.5", 2", and 2.5" for refrigerators, freezers, and ice cream freezers, respectively) was feasible, albeit at the expense of equipment redesign and replacement of foaming fixtures. DOE incorporated cost figures for these factors into the engineering and manufacturer impact analyses so as to account for the costs of additional foam as a design option. With respect to the concerns over additional foam thickness having an impact on the usefulness of the product to consumers, DOE notes that in its teardown analyses it encountered a number of models currently on the market utilizing the increased foam wall thicknesses which it modeled. Since manufacturers are already employing these wall thicknesses in currently-available models, DOE believes that this serves as a proof of concept and that the resulting changes to form factor would be of minimal impact to end users. DOE also would like to remind stakeholders that it is not setting prescriptive standards, and should manufacturers value some features over others, they are free to use different design paths in order to attain the performance levels required by today's rule.

e. Vacuum Insulated Panels (VIPs)

True, Structural Concepts, and Traulsen commented that the use of VIPs is very cost-prohibitive and can reduce the structural strength of the unit. Additionally, Traulsen recommended further discussion on the use of vacuum insulated panels, specifically on the structural integrity and associated trade-offs of this technology. (Traulsen, No. 65 at p. 10) (True, No. 76 at p. 3) (Structural Concepts, No. 85 at p. 2)

DOE considered vacuum insulated panels as a design option in its engineering analysis because they have the potential to improve equipment efficiency, are available on the market today, are currently used in refrigeration equipment, and pass the screening criteria set forth in sections 4(b)(4) and 5(b) of the Process Rule. However, DOE understands that there is a high level of cost required to implement this design option, including redesign costs, and sought to reflect that fact through appropriate cost values obtained from manufacturer interviews and other sources and included in its analyses. As a result, vacuum insulated panels appear only in max-tech designs for each equipment class, and are not included in any of the modeled configurations selected in setting the standard levels put forth in today's document.

f. Variable-Speed Fan Motors

Traulsen commented that while DOE suggested varying condenser and evaporator fan speeds to improve performance, Traulsen equipment is used in applications in which food safety concerns make this option infeasible. Traulsen further commented that NSF issues related to food safety and sanitation must be a primary consideration over energy savings. (Traulsen, No.

65 at p. 5) However, ebm-papst, Inc. (ebm-papst) noted that variable speed condenser fans have successfully been deployed in the European market. (ebm-papst, No. 70 at p. 3)

DOE agrees with Traulsen's concerns over food safety issues arising from possible implementation of evaporator fan control schemes. DOE noted in chapter 5 of its NOPR TSD that the effectiveness of the air curtain in equipment without doors is very sensitive to changes in airflow, and fan motor controllers could disrupt the air curtain. The potential of disturbance to the air curtain, which could lead to higher infiltration loads, does not warrant the use of evaporator fan motor controllers in equipment without doors, even if there were some reduction in fan energy use. With respect to equipment with doors, DOE, in its discussions with manufacturers, found that there are concerns in industry about the implementation of variable-speed fan technology due to the need to meet food safety and maximum temperature requirements. Varying the fan speed would reduce the movement of air within the case, potentially leading to the development of "hot spots" in some areas of the case, where temperatures could exceed the desired value. This finding aligns with the concerns raised by Traulsen. Some industry representatives also stated during interviews that the use of such controllers could have unintended consequences, in which fans would be inadvertently run at full power to attempt to overcome a frosted or dirty coil, resulting in wasted energy. Due to the uncertainties that exist with respect to these technologies, DOE did not consider variable-speed evaporator fan motors or evaporator fan motor controllers as a design option in its NOPR or final rule analyses.

In response to the comment from ebm-papst, DOE points out that it discussed condenser fan controls in chapter 4 of its NOPR TSD. Because testing under the ANSI/ASHRAE Standard 72 test procedure is conducted at a constant ambient temperature, there is little opportunity to account for the adaptive technology of varying condenser fan motor speed to reduce daily energy consumption of a given model. Moreover, DOE understands that condenser fan motor controllers function best when paired with a variable-speed modulating compressor, a technology that DOE understands to be only in the early stages of implementation in this industry. Therefore, DOE did not consider variable-speed condenser fan motors or condenser fan motor controllers as design options in its engineering analysis.

g. Improved Transparent Door Designs

In the NOPR, DOE modeled triple pane, low-e coated glass in the configuration of an advanced design option for vertical medium-temperature cases with transparent doors. Hussmann commented that low-e coatings have an inherent tint to them, which reduces the visibility of merchandise through a triple-paned, low-e coated glass door. (Hussmann, Public Meeting Transcript, No. 62 at p. 99) SAF, AHRI and NRA also expressed concern over product visibility associated with this technology. (SAF, No. 74 at p. 6) (AHRI, No. 75 at p. 6) (NRA, No. 90 at p. 5) Traulsen, NAFEM, Continental, Royal Vendors, and True noted that triple-pane glass doors are much heavier than double-paned doors, and increase the risk of the unit tipping over, especially when it is near empty. Additionally, True pointed out that triple-paned glass led to reduced thermo-break in hinge areas, reduction in internal volume of sliding doors, failure to clear the Underwriters Laboratories (UL) 471 tip-test,[31] door opening difficulties due to added mass and easier breakage. Traulsen also noted that an enhanced door would require design changes including heavier hinges, and a complete redesign of sliding doors with applications in narrow aisles. (Continental, No. 87 at p. 3) (NAFEM, No. 93 at p. 7) (True, No. 76 at p. 2) (Traulsen, No. 65 at p. 10)

Additionally, AHRI commented that, for HCT equipment, the NOPR TSD considered two extra panes of glass for high-performance doors that were used in low and ice-cream temperatures, whereas only a single extra pane of glass was used for medium temperature high-performance doors. (AHRI, No. 75 at p. 7)

The CA IOUs disagreed with the comments from many manufacturers and trade associations, and in a written comment opined that triple-pane, low-e transparent doors were feasible in medium temperature applications and were already found in existing equipment. (CA IOUs, No. 63 at p. 6) The Joint Comment suggested that if the use of triple-pane, low-e doors were to reduce product visibility, then increased lighting levels may be more energy-efficient than reverting to double-pane glass. (Joint Comment, No. 91 at p. 4)

DOE understands the concern of manufacturers and other interested parties regarding the applicability and appropriateness of triple-pane, low-e doors in medium temperature equipment.

[31] UL standard 471, "Commercial Refrigerators and Freezers," is a safety standard applicable to this equipment. Part of this procedure includes a test of the ability of the unit to avoid tipping over under certain conditions. This is the "tip test" referenced by the commenter.

The range of concerns suggests that manufacturers may encounter significant issues of redesign, recertification, consumer choice, and possible loss of some functionality were this feature to be implemented across all medium-temperature glass-door units. Therefore, in its final rule modeling of glass doors, DOE restricted its high-performance design to consider only two panes of glass for medium-temperature cases.

In response to AHRI's comments regarding HCT doors, DOE asserts that HCT doors as modeled in its engineering analysis for the NOPR featured the same number of panes of glass in both low/ice cream and medium temperature designs. For these equipment types, the baseline door featured a single pane of glass, while the high-performance door featured a second pane of glass. These designs are consistent with what DOE has observed on the market and in the design of similar equipment. Therefore, DOE retained these designs, with respect to the number of panes of glass modeled, in its final rule engineering analysis.

DOE agrees with the CA IOUs that some equipment currently on the market for medium-temperature applications does feature triple-pane, low-e glass doors. However, this is not a standard design and DOE understands the concerns of manufacturers in applying this feature to the entirety of their product lines. Due to concerns over applicability and implementation of triple-pane, low-e doors in all medium-temperature products, DOE retained a double-pane design in its final rule engineering analysis simulation of improved glass door performance. However, DOE wishes to point out again that it is not setting prescriptive design requirements, and thus manufacturers are free to use only those designs and technologies they see fit in order to attain the level of performance specified in today's final rule.

h. High-Performance Coil Designs

In order to model improved performance, DOE considered the use of improved evaporator and condenser coils as design options. However, many manufacturers felt that while these design options provided theoretical efficiency gain, there are several practical issues which mitigated these gains in the field. Heatcraft commented that the phrase "improved evaporator coil design" was a very generic term, and that coils that can be designed for high efficiency in a laboratory environment may not serve the purpose of the equipment functionally in the field. (Heatcraft, Public Meeting Transcript, No. 62 at p. 77) Danfoss, Traulsen, Southern Store Fixtures, Royal Vendors and True commented that higher fin density for evaporators and condensers would lead to frequent clogging and freezing, which could not only cause an increase in energy use, but also cause the unit to not maintain temperature levels required for safe storage of food. (Danfoss, No. 61 at p. 4) (Traulsen, No. 65 at p. 6) (Southern Store Fixtures, No. 67 at p. 3) (Royal, No. 68 at p. 1) (True, Public Meeting Transcript, No. 62 at p. 67)

At the NOPR stage, DOE modeled an improved evaporator coil with a larger number of tube passes than the baseline design; however, Traulsen commented that if an evaporator with a larger number of tube passes is selected, there is an increased risk of refrigerant pressure drop through the coils. Traulsen further commented that, with multiple tubing circuits, this drop could be so substantial that the refrigerant could fail to make its way back to the compressor. (Traulsen, No. 65 at p. 6)

DOE also modeled rifled evaporator tubes to improve coil performance in its NOPR analyses. Southern Store Fixtures commented that the use of rifled tubing for evaporator coils may have no significant improvement in coil performance for commercial refrigeration systems. (Southern Store Fixtures, No. 67 at p. 3) AHRI commented that rifling of evaporator coil tubes is common in the industry, but that in practical applications, lower evaporation temperatures and lower flow rates result in no significant efficiency improvement attributable to internally enhanced tubing. (AHRI, No. 75 at p. 3) Continental commented that rifled tubing for evaporator coils causes turbulence in refrigerant flow, leading to slugging and stress concentrations, which lead to increased maintenance costs and failure possibilities. (Continental, No. 87 at p. 2)

Another concern amongst manufacturers was the effect of incorporating larger evaporator and condenser coils into a unit. AHRI noted that there had been drastic reductions in the overall width and depth of the modeled evaporator coils since the last rulemaking. Further, AHRI noted that while DOE relied on its contractors for details on coil construction, it did not provide any references to studies that justify changes in coil dimensions. (AHRI, No. 75 at p. 5) Traulsen commented that larger coils would require equipment redesign, resulting in possible obsolescence of smaller lines and custom applications. (Traulsen, No. 65 at p. 6) Hillphoenix commented that the use of taller coils would decrease the amount of product that could be put in the case, or would move the product further away from consumers, and that this would be unacceptable to retailers. (Hillphoenix, No. 71 at p. 4) Hussmann commented that increasing evaporator and condenser coil dimensions would involve engineering costs associated with redesigning parts of the case that interface with the coil. (Hussmann, No. 77 at p. 2) Structural Concepts commented that changing the overall height of heat exchangers would require that either the display capacity to be reduced, or the overall height of a unit be increased, which would impact utility negatively. (Structural Concepts, No. 85 at p. 2) Continental commented that in under-counter and worktop units, limited space is available for a condensing unit, and increasing the size of the condenser coil is not practical. (Continental, No. 87 at p 2)

In response to the comment from Heatcraft regarding DOE's reference to "improved evaporator coil design," DOE points to chapter 5 of its TSD, where it specifically outlines the geometries and features included in this coil design. With respect to the concerns of Heatcraft, Danfoss, Traulsen, Southern Store Fixtures, Royal Vendors, and True that coil designs must remain functional in the field, DOE only considered features which were proven through field use in current coil designs. In a review of the coil designs at the final rule stage, DOE removed from consideration designs featuring increased fin pitch, and instead retained the modeled fin pitches at levels seen in teardown units. DOE believes that this action addresses the concerns of these stakeholders over the issues of clogging and freezing that could be encountered with higher-fin-pitch coils.

When modeling coil configurations at baseline and improved levels of efficiency, DOE evaluated the overall performance of the coils within the context of specific refrigeration systems in which they would be used. This included numerical simulation of coil performance accounting for pressure drops. DOE excluded from consideration coil designs which proved impractical, or which had negative energy impacts. Therefore, DOE believes Traulsen's concern regarding pressure drops over larger numbers of tube passes to be unsubstantiated. Additionally, DOE re-evaluated its coil designs at the final rule stage based on stakeholder comments and additional data from teardowns, incorporating many of the concerns expressed in these comments during coil modeling at the final rule stage.

Based on stakeholder comments including those of Southern Store Fixtures, AHRI, and Continental, DOE removed consideration of coil tube rifling from its analysis of improved heat exchanger performance at the final rule stage of this rulemaking. DOE believes that this action addresses the concerns voiced by stakeholders over the inapplicability of rifled tubing to some commercial refrigeration designs and issues with reduced refrigerant flow, slugging, and other negative effects.

During the final rule stage, DOE revised its modeling of evaporator and condenser coils based on new information gained through stakeholder comments and additional teardowns. In this analysis, it addressed the concerns expressed by manufacturers and other parties regarding the size constraints imposed upon heat exchangers in commercial refrigeration applications. With respect to the comments from AHRI, DOE notes that it did re-evaluate its coil designs from the 2009 rulemaking to produce designs that better approximate the configurations and performance attributes of coils found in the market. In response to the concerns of Hillphoenix, Hussmann, Structural Concepts, and Continental, during its final rule engineering modeling, DOE kept the size of modeled evaporator coils constant based on geometries seen in teardown units, and instead modified only features which could improve coil performance without growing the footprint of the coil. When modeling condenser coils, DOE allowed for a modest inclusion of an additional coil row in the direction of airflow. This was consistent with advanced designs seen in production units today, and DOE believes that this added coil size would not be sufficient to cause major impacts on unit form factor.

i. Higher-Efficiency Fan Blades

Traulsen commented that DOE modeling of higher efficiency fan blades did include specific details pertaining to the implementation of this design option, including energy savings, method of cost modeling, and other attributes. (Traulsen, No. 65 at p. 5) ebm-papst commented that fan selection should be based on airflow at the operating point and should not be limited to axial and tangential fans. (ebm-papst, No. 70 at p. 3)

In response to Traulsen's comment, DOE wishes to clarify that DOE did not consider higher-efficiency fan blades as a design option within its NOPR or final rule engineering analyses. Most commercial refrigeration equipment currently uses stamped sheet metal or plastic axial fan blades. DOE was not able to identify any axial fan blade technology that is significantly more efficient than what is currently used, but did identify tangential fan blades as an alternative fan blade technology that might improve efficiency. However, tangential fan blades in small sizes are themselves less efficient at moving air, and thus require greater motor shaft power.

Because of these competing effects, DOE did not consider tangential fan blades as a design option in its analyses. Additionally, with regard to ebm-papst's comment, DOE did not encounter any other fan blade technologies aside from axial and tangential fans which were available for application in commercial refrigeration equipment. Consistent with the comment from ebm-papst, DOE modeled fan motor and blade combinations so as to provide needed airflow across the heat exchangers consistent with what is used in designs currently available on the market.

j. ECM Fan Motors

ebm-papst, in its written comment, noted that a variety of fans with electronically commutated (EC) motors (ECMs) were available on the market which provided wire-to-air efficiency of 65-70%. ebm-papst further commented that EC motors are compact and easily integrated into all levels of refrigeration systems. Also, ebm-papst commented that EC fans compatible with alternative refrigerants are now available on the market. (ebm-papst, No. 70 at p. 4)

DOE agrees with ebm-papst regarding the performance and availability of ECM fan motors for commercial refrigeration applications. In its preliminary and NOPR analyses, DOE considered EC motors as a design option for evaporator and condenser fan applications in all equipment classes where such fans were present. Additionally, DOE modeled an overall efficiency of 66% for EC motors, which is consistent with the figure provided by ebm-papst. DOE retained this modeling of EC motors in the final rule analyses.

k. Lighting Occupancy Sensors and Controls

In its analysis, DOE considered lighting occupancy sensors as a design option with the potential to reduce unit energy consumption. However, Traulsen commented that the study of occupancy sensors which DOE cited did not account for different traffic patterns, and only covered 30 days of data collection with LEDs at full power and 60 days with LEDs dimmed. Traulsen expressed concern that this analysis used insufficient data to support the savings assumed by TSL4. (Traulsen, No. 65 at p. 12) Hillphoenix commented that the occupancy sensor credit for VOP.RC.L was higher than for all other classes. (Hillphoenix, No. 71 at p. 7)

Some manufacturers questioned the need for occupancy sensors. AHRI commented that since manual night curtains are modeled, it could be assumed that when the curtains are deployed, the CRE lighting systems can also be manually turned off during periods of inactivity. (AHRI, No. 75 at p. 4) Structural Concepts commented that requiring occupancy sensors on cases that will be going to twenty-four hour stores would be a cost-burden with no associated energy savings. (Structural Concepts, No. 85 at p. 2) However, the Joint Comment suggested that the use of lighting sensors could further reduce the energy consumption of max-tech options for self-contained vertical closed transparent door units. (Joint Comment, No. 91 at p. 4)

DOE based its modeling of lighting occupancy sensors and scheduled controls on the provisions of the DOE test procedure as amended by the 2012 final rule. 77 FR at 10292 (February 21, 2012). These provisions allow for cases featuring these technologies to be tested with the lights turned off for a fixed period of time. DOE applied these provisions specifically across all classes in which occupancy sensors and scheduled controls were considered as a design option. Therefore, DOE believes Traulsen's assertions regarding DOE's modeled savings levels to be incorrect, as DOE did not model savings potential based on field studies, but rather on the specific provisions of the DOE test procedure. In response to the comment from Hillphoenix, DOE wishes to clarify that occupancy sensors were not given an absolute credit in the form of a kWh/day reduction, but instead were modeled as they are treated under the DOE test procedure, where they are given an allowance for lighting off time. This modified lighting run time was incorporated into DOE's engineering analysis model for cases including lighting occupancy sensors, and the model was run for the particular case configuration being examined. Therefore, due to differences in case geometries, features, and design options, DOE cautions against direct comparisons of the absolute merits of specific technologies across different equipment classes, as such comparisons may be misleading.

With respect to the comment from AHRI, DOE does not consider a manual light switch to be a lighting controller under the provisions of its test procedure, since this device does not have the inherent ability to reduce energy consumption and since the method of test included in the procedure requires that all lighting be activated during the test. In its 2012 test procedure final rule, DOE added a provision specifically to allow for the testing of units including occupancy sensors and scheduled controls, but this does not include manual light switches. 77 FR at 10292 (February 21, 2012). Therefore, DOE maintains that a manual light switch is not a lighting control and shall not be treated as such during the conduct of the DOE test procedure.

In response to the concerns of Structural Concepts, occupancy sensors have the potential to operate at all times, turning off lighting to save energy during periods of inactivity, then reactivating the lights when shoppers are present. DOE understands that, even in 24-hour stores, there are periods when a high density of shoppers may not be present, and thus when lighting occupancy sensors would present the potential to save energy. DOE agrees with the Joint Comment that lighting occupancy sensors offer the potential to reduce the energy consumption of equipment in classes to which they are applicable, including the particular class noted in the comment. Therefore, DOE retained its modeling of this design option in its final rule engineering analysis.

l. Night Curtains

DOE analyzed night curtains as a design option with the potential to reduce equipment energy consumption. However, Southern Store Fixtures commented that, while DOE modeled a reduction in heat load when night curtains were employed, there was no cost analysis presented to justify this option. Furthermore, Southern Store Fixtures referred to a Pacific Gas and Electric Company (PG&E) report which asserted that night curtains were not cost effective due to poor economics, and a study funded by the California Energy Commission which reported a minimum 6.63 year and maximum 21.56 year payback period on night curtains. (Southern Store Fixtures, No. 67 at p. 6) Structural Concepts commented that night curtains should be excluded from the analysis since they were deemed by DOE as not “required.” Structural Concepts further commented that twenty-four-hour stores would not be able to use night curtains. (Structural Concepts, No. 85 at p. 2)

Regarding the types of night curtains that were modeled by DOE, AHRI commented that DOE did not explore automatic night curtains and Southern Store Fixtures commented that there were no night curtains currently available that are suited for curved display cases. (Southern Store Fixtures, No. 67 at p. 5) (AHRI, No. 75 at p. 3)

In response to the comment from Southern Store Fixtures on cost analysis, DOE wishes to clarify that it did include a cost analysis of night curtains in its engineering analysis. Costs per foot of night curtain were included in DOE's engineering spreadsheet model as released to the public, and served as the basis of DOE's placement of night curtains in the engineering cost-efficiency curves, as design options were ordered from lowest to highest calculated payback period. Regarding the mention of the PG&E report as presented to CEC, DOE understands that that report focused largely on time-variant economic factors such as the savings at peak-load conditions, rather than the overall life cycle cost savings and payback periods calculated by DOE. Therefore, due to a different focus and methodology, that organization may have reached a different conclusion than that attained by DOE. DOE plans to retain its analytical methodology as used across a variety of rulemaking efforts and believes that that methodology is appropriate and soundly evaluates the economic and energy savings benefits of design options including night curtains.

With respect to the comments from Structural Concepts, DOE agrees that use of night curtains is not required since DOE is setting a performance standard based on daily energy consumption under the DOE test procedure, rather than a prescriptive standard mandating the use of specific features. However, DOE is charged with exploring all avenues of reducing measured energy consumption, and the ability of the DOE test procedure to quantify savings attributed to night curtains justifies DOE's inclusion of this technology in its analysis. In addition, DOE notes that night curtains may be used in 24-hour stores during periods of low customer traffic, and that consideration of this feature in equipment offered for sale would provide store operators with the availability of an additional mechanism for attaining energy savings.

DOE agrees with AHRI that it did not explore automatic night curtains, as it did not find a readily available automatic night curtain technology that was applicable to the relevant case designs, including vertical and semivertical open cases. With respect to the comment from Southern Store Fixtures on case geometries, DOE believes that night curtains are available that apply to the vast majority of open case designs. Further, DOE is not setting a prescriptive standard; night curtains are one design option, but not required under the amended standard.

3. Refrigerants

For the preliminary and NOPR analyses, DOE considered two refrigerants, hydrofluorocarbons (HFCs) R-134a and R-404a, because these are the industry-standard choices for use in the vast majority of commercial refrigeration equipment covered by this rulemaking. This selection was consistent with the modeling performed in the January 2009 final rule, which was based on industry research and stakeholder feedback at that time. After the publication of the

NOPR, DOE received a number of comments on potential future issues relating to refrigerants for this equipment.

ACEEE commented that the DOE had not taken into consideration the use of propane and other hydrocarbon refrigerants, which are in use internationally and are now allowed in limited quantities by the U.S. Environmental Protection Agency (EPA). ACEEE further commented that it has manufacturer statements to show that these refrigerants considerably improve equipment efficiency. (ACEEE, Public Meeting Transcript, No. 62 at p. 40) Danfoss commented that Montreal Protocol[32] amendments requiring the phasing out of HFCs would likely come into effect before this standard's compliance date. Additionally, Danfoss commented that this action would make DOE's "refrigerant neutral" stance flawed, and that DOE must consider the increased uncertainty and regulatory burden from the use of low-global warming potential (GWP) refrigerants in its analysis. (Danfoss, No. 61 at p. 2) Coca-Cola, too, opined that by not directly analyzing alternative refrigerants, DOE was showing a bias towards HFCs. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 121) The CA IOUs commented that alternative refrigerants are being used both internationally and in the United States. The CA IOUs further commented that, given the potential for EPA regulations on HFC usage, DOE should be prepared to adopt the levels of performance included in its proposed standards to reflect the performance abilities of other refrigerants. (CA IOUs, No. 63 at p. 8)

[32] The Montreal Protocol is an international agreement, first signed in 1987, in which signatories pledged to phase out the production and use of ozone depleting substances.

AHRI commented that the potential for changes in Federal refrigerant policy over the next few years will require the industry to use refrigerants with low GWP, putting into question the applicability of the proposed standard over extended time periods. AHRI further stated that there was a possibility of refrigerant switching having adverse impacts on equipment performance. (AHRI, No. 75 at p. 10) True commented that the refrigerants modeled in the analysis, R404 and R134a, are both currently being reviewed by the EPA Significant New Alternatives Policy (SNAP) program[33] for possible removal from commercial refrigeration applications. (True, Public Meeting Transcript, No. 62 at p. 123) Lennox, too, noted that non-HFC refrigerants might become a growing part of the CRE market in the foreseeable future. (Lennox, No. 73 at p. 5) Additionally, Hillphoenix commented that manufacturers are being pushed towards low GWP refrigerants which will have an impact on coil and evaporator designs, as well as efficiency curves for compressors. (Hillphoenix, No. 71 at p. 2)

ACEEE asserted that the market already has begun to move away from HFC refrigerants. (ACEEE, Public Meeting Transcript, No. 62 at p. 185) Coca-Cola commented that it was seeking to stop using HFCs and switch over to R744, R290 and R600A, not only to improve energy efficiency, but also to make the units environmentally benign. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 88) Further, Coca-Cola commented that it is already purchasing a large number (28% in the United States) of R744 cabinets, and aim to be using only R744 within three years. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 128) Continental commented that

[33] EPA SNAP is the U.S. government regulatory program responsible for maintaining the list of alternatives to ozone depleting substances allowed for use within specific applications, including refrigeration, in the United States.

refrigerants such as propane and CO2 have been approved by EPA and are actively being evaluated and tested in products. Continental further commented that alternative refrigerants have the potential to affect the performance of equipment. (Continental, No. 87 at p. 1) AHRI also commented that a change in refrigerant policy would impact refrigerants which are used as blowing agents for foams, possibly resulting in lower insulation performance values. (AHRI, No. 75 at p. 10) Providing an additional view, the Joint Comment noted that the use of propane as a refrigerant could improve efficiency of units by 7-11%. Additionally, the Joint Comment pointed out that while DOE did not model non-HFC refrigerants, manufacturers have the option of using more efficient refrigerants. (Joint Comment, No. 91 at p. 4)

Specifically, many stakeholders wished for DOE to consider propane (R290) as a viable alternative refrigerant. Danfoss commented that the inclusion of natural refrigerants in the analysis was a critical issue, since, unlike higher-efficiency compressors, the technology is already available. Danfoss urged DOE to consider propane, isobutane and carbon dioxide as viable refrigerants. (Danfoss, Public Meeting Transcript, No. 62 at p. 126) ACEEE commented that DOE's decision to screen out propane refrigerant as a design option had seriously impacted the downstream analyses. (ACEEE, Public Meeting Transcript, No. 62 at p. 127) However, both Structural Concepts and True noted that they could consider propane as a refrigerant for some, but not all, of their products, since the 150 gram SNAP limit restricted total compressor capacity. (Structural Concepts, Public Meeting Transcript, No. 62 at p. 127) (True, Public Meeting Transcript, No. 62 at p. 127)

In its written comment, however, Traulsen commented that, while alternative refrigerants were discussed in the public meeting, DOE should remain technology neutral with regard to those refrigerants at this time, since there was a risk of conflict with other programs such as EPA SNAP and UL, and since the costs to switch over to alternative refrigerants is high. (Traulsen, No. 65 at p. 18)

While DOE appreciates the input from stakeholders at the public meeting and in subsequent written comment, DOE does not believe that there is sufficient specific, actionable data presented at this juncture to warrant a change in its analysis and assumptions regarding the refrigerants used in commercial refrigeration applications. As of now, there is inadequate publicly-available data on the design, construction, and operation of equipment featuring alternative refrigerants to facilitate the level of analysis of equipment performance which would be needed for standard-setting purposes. DOE is aware that many low-GWP refrigerants are being introduced to the market, and wishes to ensure that this rule is consistent with the phase-down of HFCs proposed by the United States under the Montreal Protocol. DOE continues to welcome comments on experience within the industry with the use of low-GWP alternative refrigerants. Moreover, there are currently no mandatory initiatives such as refrigerant phase-outs driving a change to alternative refrigerants. Absent such action, DOE will continue to analyze the most commonly-used, industry-standard refrigerants in its analysis.

DOE wishes to clarify that it will continue to consider CRE models meeting the definition of commercial refrigeration equipment to be part of their applicable covered equipment class, regardless of the refrigerant that the equipment uses. If a manufacturer believes that its design is subjected to undue hardship by regulations, the manufacturer may petition DOE's Office of Hearing and Appeals (OHA) for exception relief or exemption from the standard pursuant to OHA's authority under section 504 of the DOE Organization Act (42 U.S.C. 7194), as implemented at subpart B of 10 CFR part 1003. OHA has the authority to grant such relief on a case-by-case basis if it determines that a manufacturer has demonstrated that meeting the standard would cause hardship, inequity, or unfair distribution of burdens.

4. Cost Assessment Methodology

During the preliminary analysis, DOE developed costs for the core case structure of the representative units it modeled, based on cost estimates performed in the analysis for the January 2009 final rule. For more information, see chapter 5 of the preliminary analysis TSD, pp. 5-3 to 5-8. DOE also developed costs for the design option levels implemented, based on publicly available information and price quotes provided during manufacturer interviews. These costs were combined in the engineering cost model based on the specifications of a given modeled unit in order to yield manufacturer production cost (MPC) estimates for each representative unit at each configuration modeled. At the preliminary analysis rulemaking stage, DOE's component cost estimates were based on data developed from manufacturer interviews, estimates from the January 2009 final rule, and publicly available cost information. During the NOPR analysis, DOE augmented this information with data from physical teardowns of commercial refrigeration equipment currently on the market.

During the development of the engineering analysis for the NOPR, DOE interviewed manufacturers to gain insight into the commercial refrigeration industry, and to request feedback on the engineering analysis methodology, data, and assumptions that DOE used. Based on the information gathered from these interviews, along with the information obtained through a teardown analysis and public comments, DOE refined the engineering cost model. Next, DOE derived manufacturer markups using publicly available commercial refrigeration industry financial data, in conjunction with manufacturer feedback. The markups were used to convert the MPCs into MSPs. These results were used as the basis for the downstream calculations at the NOPR stage of the rulemaking.

At the NOPR public meeting and in subsequent written comments, DOE received further input from stakeholders regarding the methodologies and inputs used in DOE's cost assessment. DOE incorporated this input in updating its modeling at the final rule stage. Further discussion of the comments received and the analytical methodology used is presented in the following subsections. For additional detail, see chapter 5 of the final rule TSD.

a. Teardown Analysis

In the preliminary analysis TSD, DOE expressed its intent to update its core case cost estimates, which were at that time developed based on estimates from the January 2009 final rule, through performing physical teardowns of selected units. These core case costs consist of the costs to manufacture the structural members, insulation, shelving, wiring, etc., but not the costs associated with the components that could directly affect energy consumption, which were considered collectively as design options and served as one of many inputs to the engineering cost model. DOE first selected representative units for physical teardown based on available offerings from the catalogs of major manufacturers. DOE selected units that had sizes and feature sets similar to those of the representative units modeled in the engineering analytical model. DOE selected units for teardown representing each of the equipment families, with the exception of the HZO family[34]. The units were then disassembled into their base components, and DOE estimated the materials, processes, and labor required for the manufacture of each individual component. This process is referred to as a "physical teardown." Using the data gathered from the physical teardowns, DOE characterized each component according to its weight, dimensions, material, quantity, and the manufacturing processes used to fabricate and assemble it. These component data were then entered into a spreadsheet and organized by system and subsystem levels to produce a comprehensive bill of materials (BOM) for each unit analyzed through the physical teardown process.

The physical teardowns allowed DOE to identify the technologies, designs, and manufacturing techniques that manufacturers incorporated into the equipment that DOE analyzed. The result of each teardown was a structured BOM, incorporating all materials, components, and fasteners, classified as either raw materials or purchased parts and assemblies, and characterizing the materials and components by weight, manufacturing processes used, dimensions, material, and quantity. The BOMs from the teardown analysis were then modified,

[34] The reason why no HZO units were torn down was that the HZO family is the least complex of the equipment classes with respect to its construction. DOE felt that there was no additional data which could be gained from teardown of this equipment which would not have already been captured by the teardowns of other units.

and the results used as one of the inputs to the cost model to calculate the MPC for each representative unit modeled. The MPCs resulting from the teardowns were then used to develop an industry average MPC for each equipment class analyzed.

At the final rule stage of the rulemaking, in response to comments regarding the technologies incorporated into commercial refrigeration equipment at various levels of performance, DOE procured additional models of equipment on the market and performed further teardown assessment of the construction and componentry featured in these models. The data from these supplemental teardowns, coupled with known performance of the purchased units from independent testing or ENERGY STAR certification, allowed DOE to compare the performance of models currently on the market to the results of modeling of the same equipment configurations using its engineering simulation. This comparison provided a validation check on the results of the simulations. See chapter 5 of the final rule TSD for more details on the teardown analysis.

b. Cost Model

The cost model for this rulemaking was divided into two parts. The first of these was a standalone core case cost model, based on physical teardowns, that was used for developing the core case costs for the 25 directly analyzed equipment classes. This cost model is a spreadsheet that converts the materials and components in the BOMs from the teardowns units into MPC dollar values based on the price of materials, average labor rates associated with manufacturing and assembling, and the cost of overhead and depreciation, as determined based on manufacturer interviews and DOE expertise. To convert the information in the BOMs to dollar values, DOE collected information on labor rates, tooling costs, raw material prices, and other factors. For purchased parts, the cost model estimates 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 (e.g., tube, sheet metal) are estimated based on 5-year averages calculated from cost estimates obtained from sources including the American Metal Market and manufacturer interviews. The cost of transforming the intermediate materials into finished parts is estimated based on current industry pricing.

The function of the cost model described above is solely to convert the results of the physical teardown analysis into core case costs. To achieve this, components immaterial to the core case cost (lighting, compressors, fans, etc.) were removed from the BOMs, leaving the cost model to generate values for the core case costs for each of the teardown points. Then, these teardown-based core case BOMs were used to develop a "parameterized" computational cost model, which allows a user to virtually manipulate case parameters such as height, length, insulation thickness, and number of doors by inputting different numerical values for these features to produce new cost estimates. For example, a user could start with the teardown data for a two-door case and expand the model of the case computationally to produce a cost estimate for a three-door case by changing the parameter representing the number of doors, which would in turn cause the model to scale other geometric and cost parameters defining the overall size of the case. This parameterized model, coupled with the design specifications chosen for each representative unit modeled in the engineering analysis, was used to develop core case MPC cost estimates for each of the 25 directly analyzed representative units. These values served as one of several inputs to the engineering cost model.

The engineering analytical model, as implemented by DOE in a Microsoft Excel spreadsheet, also incorporated the engineering cost model, the second cost modeling tool used in this analysis. In the engineering cost model, core case costs developed based on physical teardowns were one input, and costs of the additional components required for a complete piece of equipment (those components treated as design options) were another input. The two inputs were added together to arrive at an overall MPC value for each equipment class. Based on the configuration of the system at a given design option level, the appropriate design option costs were added to the core case cost to reflect the cost of the entire system. Costs for design options were calculated based on price quotes from publicly available sources and discussions with commercial refrigeration equipment manufacturers. Chapter 5 of the final rule TSD describes DOE's cost model and definitions, assumptions, data sources, and estimates.

c. Manufacturer Production Cost

Once the cost estimates for all the components of each representative unit, including the core case cost and design option costs, were finalized, DOE totaled the costs in the engineering cost model to calculate the MPC. DOE estimated the MPC at each efficiency level considered for each directly analyzed equipment class, from the baseline through the max-tech. After incorporating all of the assumptions into the cost model, DOE calculated the percentages attributable to each element of total production cost (i.e., materials, labor, depreciation, and overhead). DOE used these production cost percentages in the MIA (see section IV.J). At the NOPR stage of the rulemaking, DOE revised the cost model assumptions used for the preliminary analysis based on teardown analysis, updated pricing, and additional manufacturer feedback, which resulted in refined MPCs and production cost percentages. DOE once again updated the analysis at the final rule stage based on input from the NOPR public meeting and subsequent written comments. DOE calculated the average equipment cost percentages by equipment class. Chapter 5 of the TSD presents DOE's estimates of the MPCs for this rulemaking, along with the different percentages attributable to each element of the production costs that comprise the total MPC.

d. Cost-Efficiency Relationship

The result of the engineering analysis is a cost-efficiency relationship. DOE created a separate relationship for each input capacity associated with each commercial refrigeration equipment class examined for this rule. DOE also created 25 cost-efficiency curves, representing the cost-efficiency relationship for each commercial refrigeration equipment class.

To develop cost-efficiency relationships for commercial refrigeration equipment, DOE examined the cost differential to move from one design option to the next for manufacturers. DOE used the results of teardowns to develop core case costs for the equipment classes modeled, and added those results to costs for design options developed from publicly available pricing information and manufacturer interviews. Additional details on how DOE developed the cost-efficiency relationships and related results are available in the chapter 5 of the final rule TSD.

Chapter 5 of the final rule TSD also presents these cost-efficiency curves in the form of energy efficiency versus MPC. After the publication of the NOPR analysis, several stakeholders provided input and feedback regarding DOE's cost modeling methodology and costs used for specific components and design options. Specifically, DOE received comments regarding core case costs, LED cost specifications, component sourcing and cost information, and coil costs. The following sections address these stakeholder comments and concerns.

Core Case Costs

Traulsen commented that DOE's assumption of core costs not changing for more efficient design option levels is flawed. Traulsen further pointed out that costs for shelving, wiring, air curtain grills, trim, etc. do change in all cases when internal or external product footprint is altered. (Traulsen, No. 65 at p. 15)

DOE understands that changes to design requiring adjustment to a unit's form factor would have an impact on the cost of production of the unit, and would result in the manufacturer incurring redesign costs. Of the design options considered, most would not have a significant impact in these areas, as they consist largely of component swaps or bolt-on component additions. However, for the design options which would affect unit format, DOE considered incremental materials costs and redesign costs, as well as capital expenditures, in its engineering and MIA analyses. Therefore, DOE believes that it has sufficiently addressed the concerns raised by Traulsen.

Light-Emitting Diode Cost Specifications

Several stakeholders expressed reservations over DOE's use of LED price projections, opining that DOE had likely underestimated the price of LEDs. Traulsen commented that according to DOE's Solid State Lighting Multi-Year Program Plan (MYPP), there is a breakthrough in LED performance required in 2015 that would decrease the life-cycle energy of LED lamps. Traulsen asserted that these projections were based on the assumption of continued governmental R&D support, and that there is evidence of declining R&D support for LEDs. Traulsen further commented that this lack of certainty made some assumptions in DOE analysis questionable. (Traulsen, No. 65 at p. 3) Hussmann noted that, typically, LED fixtures cost twice as much as T8 fluorescent ballasts. (Hussmann, No. 77 at p. 2) Structural Concepts commented that the prices of LED fixtures would likely be 37-40% higher than DOE predictions for 2017. (Structural Concepts, No. 85 at p. 2) Similarly, Hillphoenix commented that DOE had modeled a zero cost for drivers and that current LED prices are on the order of three times that estimated in the model. (Hillphoenix, No. 71 at p. 1) Traulsen noted that for VCT.SC systems, the added cost of using LED systems was greater than $120 per unit. (Traulsen, No. 65 at p. 3) True commented that it was unlikely for LED prices to continue to drop. (True, No. 76 at p. 1) Hillphoenix commented that LED lighting for the VCT.RC.M and VCT.RC.L classes had experienced an 83% reduction in cost from the previous rulemaking to the current rulemaking analysis. (Hillphoenix, No. 71 at p. 7) Conversely, the Joint Comment concurred with DOE's analysis, noting that the incorporation of LED price projections significantly improved the analysis by reflecting a realistic estimate of LED costs. (Joint Comment, No. 91 at p. 5)

In its NOPR analysis, DOE incorporated price projections from its Solid-State Lighting Program[35] into its MPC values for the primary equipment classes. The price projections for LED case lighting were developed from projections developed for the DOE Solid-State Lighting Program 2012 report, Energy Savings Potential of Solid-State Lighting in General Illumination Applications ("the energy savings report").[36] In the appendix to this report, price projections from 2010 to 2030 were provided in ($/klm) for LED lamps and LED luminaires. DOE analyzed the models used in the Solid-State Lighting Program work and determined that the LED luminaire projection would serve as an appropriate proxy for a cost projection to apply to refrigerated case LEDs. The price projections presented in the Solid-State Lighting Program's energy savings report are based on the DOE's 2011 Multi-Year Program Plan (MYPP). The MYPP is developed based on input from manufacturers, researchers, and other industry experts. Table IV.1 shows the normalized LED price deflators used in the final rule analysis.

Table IV.1 LED price deflators used in the final rule analysis

Year	Normalized to 2013	Normalized to 2017	Year	Normalized to 2013	Normalized to 2017
2010	2.998	5.652	2021	0.361	0.681
2011	1.799	3.392	2022	0.335	0.631
2012	1.285	2.423	2023	0.312	0.588
2013	1.000	1.885	2024	0.292	0.550
2014	0.819	1.543	2025	0.274	0.517
2015	0.693	1.306	2026	0.259	0.488
2016	0.601	1.133	2027	0.245	0.462
2017	0.530	1.000	2028	0.232	0.438

[35] The DOE Solid-State Lighting Program is a program within DOE's Office of Energy Efficiency & Renewable Energy. More information on the program is available at http://www1.eere.energy.gov/buildings/ssl/

[36] Navigant Consulting, Inc., Energy Savings Potential for Solid-State Lighting in General Illumination Applications. 2012. Prepared for the U.S. Department of Energy - Office of Energy Efficiency and Renewable Energy Building Technologies Office, Washington, D.C.

2018	0.475	0.895	2029	0.221	0.417
2019	0.430	0.810	2030	0.211	0.398
2020	0.393	0.740	2031-2046*	0.211	0.398

During the NOPR stage, DOE incorporated the price projection trends from the energy savings report into its engineering analysis by using the data to develop a curve of decreasing LED prices normalized to a base year. That base year corresponded to the year when LED price data was collected for the NOPR analyses of this rulemaking from catalogs, manufacturer interviews, and other sources. DOE started with this commercial refrigeration equipment-specific LED cost data and then applied the anticipated trend from the energy savings report to forecast the projected cost of LED fixtures for commercial refrigeration equipment at the time of required compliance with the proposed rule (2017). These 2017 cost figures were incorporated into the engineering analysis as comprising the LED cost portions of the MPCs for the primary equipment classes.

The LCC analysis (section IV.F) was carried out with the engineering numbers that account for the 2017 prices of LED luminaires. The reduction in price of LED luminaires from 2018 through 2030 was taken into account in the NIA (section IV.H). The cost reductions were calculated for each year from 2018 through 2030 and subtracted from the equipment costs in the NIA. The reduction in lighting maintenance costs[37] due to reduction in LED prices for equipment

[37] Discussion related to lighting maintenance costs for commercial refrigeration equipment can be found in section 0, and a more detailed explanation can be found in chapter 8 of the final rule TSD.

installed in 2018 to 2030 were also calculated and appropriately deducted from the lighting maintenance costs.

While DOE understands the concerns of manufacturers over projections of LED prices in the future, DOE made the decision to incorporate these projections based on stakeholder input, past market trends, and DOE research within the lighting field, which includes regular interaction with manufacturers and suppliers of LED lighting technologies. With respect to the comments from Traulsen, DOE does not see any specific hurdles in the market that indicate that levels predicted in the MYPP will fail to be realized. DOE appreciates the comments from Hussmann, Structural Concepts, Hillphoenix, Traulsen, and True regarding present and future LED prices. However, based on past market trends and the current research supporting the MYPP, DOE continued to utilize these LED price projections in the modeling underlying today's final rule. As a point of clarification to the comment presented by Hillphoenix, DOE wishes to mention that the modeled costs include all components of the LED fixture, including drivers, emitters, housing, and wiring. DOE agrees with the assertion of the Joint Comment that incorporation of LED price projections allow the analysis to better depict market conditions which will be encountered by manufacturers at the time of their compliance with the amended standard set forth in today's rule.

Component Sourcing and Cost Information

In its written comment following publication of the NOPR, Hoshizaki commented that the engineering cost analysis was unrealistic and incomplete since specific parts suppliers, part numbers, and parts costs were not listed. (Hoshizaki, No. 84 at p. 1)

In developing its engineering cost model, DOE gathered a wide variety of input information, including component and material costs, to serve as the basis for this model. Much of this information was collected under nondisclosure agreement by DOE's contractors, or from sources which are not publicly available. Therefore, in order to protect the sensitive nature of this information, DOE is unable to disclose the information in its notice or technical support document. However, in developing its engineering performance and cost models, DOE ensured that the components and features being modeled did not present any intellectual property issues with respect to sourcing or implementation. That is, DOE ensured that the features modeled were consistent with designs and components available on the open market to the entire range of CRE manufacturers.

Coil Costs

Some manufacturers opined that DOE had underestimated the cost of manufacturing improved evaporator and condenser coils. Southern Store Fixtures commented that using smaller tubes in a fixed size evaporator was found through their internal studies to allow for only 8% performance improvement, while incurring a 290% cost increase. Southern Store Fixtures noted that making changes to a condensing unit would make the cost 80% higher than the standard catalog price. (Southern Store Fixtures, No. 67 at p. 3) AHRI commented that DOE had underestimated the added costs associated with the implementation of higher efficiency evaporator coils. (AHRI, No. 75 at p. 5) Traulsen, too, commented that DOE estimated values of the cost to manufacture improved coils was much lower than a cost figure provided to it by the largest provider of CRE coils in the US. (Traulsen, No. 65 at p. 6) Hillphoenix concurred with DOE on the modeled price of condenser coils, but noted that evaporator coils cost nearly three to four times as much as condenser coils. Hillphoenix qualified this assertion by pointing out that the necessary customization, as well as the increased assembly cost (labor) of a lower fin density and longer width coil, contributed to the increased price of the evaporator coil. (Hillphoenix, No. 71 at p. 1)

In response to the comment from Southern Store Fixtures, DOE did not consider smaller-diameter tubes in its evaporator coil designs as modeled in the final rule engineering analysis. Additionally, DOE modeled the components of the condensing unit – coil, fans, compressor, and cost to assemble – independently, rather than modeling the cost of a single prepackaged assembly. DOE believes that this modeling accurately reflects the costs incurred by manufacturers when producing the condensing units of self-contained equipment.

Regarding the concerns of AHRI, Traulsen and Hillphoenix on the modeled costs of condenser and evaporator coils, DOE revisited this modeling for the final rule. DOE based its modeling of coil costs on information gathered from teardowns of coils present in units currently available on the market, and then used these inputs in conjunction with an internal cost model to develop costs to manufacture for these components. These costs factor in the prices of raw materials, the costs of processing, forming, and assembly operations, and other key costs integral to the development of the components. DOE updated its coil costs for the final rule taking into account the design changes to the form factors of its modeled coils and the information provided in stakeholder comments regarding the relative costs of different coil types. DOE is confident in its use of this methodology, which has been implemented and vetted through use in a number of other past and ongoing rulemaking analyses. For further information regarding coil modeling, please see chapter 5 of the final rule TSD.

e. Manufacturer Markup

To account for manufacturers' non-production costs and profit margin, DOE applies a non-production cost multiplier (the manufacturer markup) to the full MPC. The resulting MSP is the price at which the manufacturer can recover all production and non-production costs and earn a profit. To meet new or amended energy conservation standards, manufacturers often introduce design changes to their product lines that result in increased MPCs. Depending on the competitive environment for this equipment, some or all of the increased production costs may be passed from manufacturers to retailers and eventually to customers in the form of higher purchase prices. The MSP should be high enough to recover the full cost of the equipment (i.e., full production and non-production costs) and yield a profit. The manufacturer markup has an important bearing on profitability. A high markup under a standards scenario suggests manufacturers can readily pass along the increased variable costs and some of the capital and equipment conversion costs (one-time expenditures) to customers. A low markup suggests that manufacturers will not be able to recover as much of the necessary investment in plant and equipment.

To calculate the manufacturer markups, DOE used 10-K reports submitted to the SEC by the six publicly owned commercial refrigeration equipment companies in the United States. (SEC 10-K reports can be found using the search database available at www.sec.gov/edgar/searchedgar/webusers.htm.) The financial figures necessary for calculating the manufacturer markup are net sales, costs of sales, and gross profit. DOE averaged the financial figures spanning the years from 2004 to 2010[38] to calculate the markups. For commercial refrigeration equipment, to calculate the average gross profit margin for the periods analyzed for each firm, DOE summed the gross profit earned during all of the aforementioned years and then divided the result by the sum of the net sales for those years. DOE presented the calculated markups to manufacturers during the manufacturer interviews for the NOPR (see section IV.D.4.g). DOE considered manufacturer feedback to supplement the calculated markup, and refined the markup to better reflect the commercial refrigeration market. DOE developed the manufacturer markup by weighting the feedback from manufacturers on a market share basis because manufacturers with larger market shares more significantly affect the market average. DOE used a constant markup to reflect the MSPs of both the baseline equipment and higher efficiency equipment. DOE used this approach because amended standards may transform high-efficiency equipment, which currently is considered to be premium equipment, into baseline

[38] Typically, DOE uses the data for the 5 years preceding the year of analysis. However, in this case additional data were available up to 2004. Hence, data from 2004 to 2010 were used for these calculations.

equipment. See chapter 5 of the final rule TSD for more details about the manufacturer markup calculation.

f. Shipping Costs

The final component of the MSP after the MPC and manufacturer markup is the shipping cost associated with moving the equipment from the factory to the first point on the distribution chain. During interviews, manufacturers stated that the specific party (manufacturer or buyer) that incurs that cost for a given shipment may vary based on the terms of the sale, the type of account, the manufacturer's own business practices, and other factors. However, for consistency, DOE includes shipping costs as a component of MSP. In calculating the shipping costs for use in its analysis, DOE first gathered estimates of the cost to ship a full trailer of manufactured equipment an average distance in the United States, generally representative of the distance from a typical manufacturing facility to the first point on the distribution chain. DOE then used representative unit sizes to calculate a volume for each unit. Along with the dimensions of a shipping trailer and a loading factor to account for inefficiencies in packing, DOE used this cost and volume information to develop an average shipping cost for each equipment class directly analyzed.

g. Manufacturer Interviews

Throughout the rulemaking process, DOE has sought and continues to seek feedback and insight from interested parties that would improve the information used in its analyses. DOE interviewed manufacturers as a part of the NOPR MIA (see section IV.J). During the interviews, DOE sought feedback on all aspects of its analyses for commercial refrigeration equipment. For the engineering analysis, DOE discussed the analytical assumptions and estimates, cost model, and cost-efficiency curves with manufacturers. DOE considered all of the information learned from manufacturers when refining the cost model and assumptions. However, DOE incorporated equipment and manufacturing process figures into the analysis as averages to avoid disclosing sensitive information about individual manufacturers' equipment or manufacturing processes. The results of the manufacturer interview process conducted before the release of the NOPR were augmented with additional information provided in written comments after the NOPR and at the NOPR public meeting. More details about the manufacturer interviews are contained in chapter 12 of the final rule TSD.

5. Energy Consumption Model

The energy consumption model is the second key analytical model used in constructing cost-efficiency curves. This model estimates the daily energy consumption, calculated using the DOE test procedure, of commercial refrigeration equipment in kilowatt-hours at various performance levels using a design-option approach. In this methodology, a unit is initially modeled at a baseline level of performance, and higher-efficiency technologies, referred to as design options, are then implemented and modeled to produce incrementally more-efficient equipment designs. The model is specific to the types of equipment covered under this rulemaking, but is sufficiently generalized to model the energy consumption of all covered equipment classes. DOE developed the energy consumption model as a Microsoft Excel spreadsheet.[39]

For a given equipment class, the model estimates the daily energy consumption for the baseline, as well as the energy consumption of subsequent levels of performance above the baseline. The model calculates each performance level separately. For the baseline level, a corresponding cost is calculated using the cost model, which is described in section IV.D.4.b. For each level above the baseline, the changes in system cost due to the implementation of various design options are used to recalculate the cost. Collectively, the data from the energy consumption model are paired with the cost model data to produce points on cost-efficiency curves corresponding to specific equipment configurations. After the publication of the NOPR analysis, DOE received numerous stakeholder comments regarding the methodology and results of the energy consumption model.

a. Release of Engineering Model for Review

At the NOPR public meeting, Zero Zone and ACEEE urged DOE to make its engineering spreadsheet model publicly available. (Zero Zone, Public Meeting Transcript, No. 62 at p. 70) (ACEEE, Public Meeting Transcript, No. 62 at p. 125) DOE agreed with Zero Zone and ACEEE and released the engineering spreadsheet model for public review shortly after the NOPR public meeting. Stakeholder review of the model served as the basis for many of the specific comments and suggestions discussed in today's document and incorporated into DOE's final rule analysis.

[39] Available http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/27

b. Anti-Sweat Heater Power

Some stakeholders opined that the DOE model did not fully consider some equipment classes and components which used anti-sweat heat. Traulsen noted that, due to gasket and breaker strip inefficiencies, VCS.SC.L and VCS.SC.M equipment will require some auxiliary heat around door perimeters to prevent condensation, even at ambient conditions of 75F and 55% RH. (Traulsen, No. 65 at p. 11) Hussmann noted that no-heat doors for VCT.RC.M were not suitable in high-humidity conditions, since they could lead to condensation on the doors and the risk of water dripping onto the floor. (Hussmann, No. 77 at p. 9) AHRI commented that there was no clear justification provided for why certain doors were modeled with anti-sweat heat power and others were modeled without it, further pointing out, that anti-sweat heat is not limited only to doors, but often also applies to frames and mullions too. (AHRI, No. 75 at p. 8)

DOE appreciates the input from commenters regarding the use of anti-sweat heat and has updated its engineering model for the final rule stage to better reflect the needs of different equipment classes in this respect. In response to the comment from Traulsen and based on additional investigational teardowns performed at the final rule stage, DOE added anti-sweat heater power to some solid-door classes in order to account for inefficiencies in gasketing which could otherwise result in condensation or frost issues. The magnitude of the power of these heaters was developed based on figures included in stakeholder comments applicable to classes VCS.SC.M and VCS.SC.L, as well as from measurements taken during teardown analysis performed at the final rule stage.

During manufacturer interviews and in investigations of the current offerings of commercial refrigeration equipment manufacturers and door suppliers, DOE encountered a number of "energy-free" transparent door designs for medium-temperature applications. This served as the basis for the modeling of some doors without anti-sweat heat in the NOPR analysis, as referenced by AHRI and Hussmann. However, in response to the concerns of stakeholders over an assumption of zero energy doors being too strict for field applications, DOE added a modest amount of anti-sweat heat to its modeling of transparent doors for medium-temperature applications in the final rule engineering analysis. DOE believes that this modeled design provides energy savings benefits over standard designs while maintaining the ability to utilize some anti-sweat heat to prevent condensation issues during use.

In response to the concerns of AHRI, DOE wishes to clarify that for transparent door classes, the modeled "door" anti-sweat heat includes all anti-sweat heat on the face of the unit, including frame, mullion, and glass heat. This anti-sweat heat is included with the modeling of the door because generally, the display case manufacturer purchases the doors and frames as a single item, inclusive of the anti-sweat heaters, which is then installed in an opening in the case body. For cases with solid doors, as well as open cases, the perimeter, gasket, mullion, and/or face heater power is included under the category of "non-door anti-sweat power" in the design specifications tab of the engineering analysis spreadsheet model. Therefore, while the needed power may be accounted for differently among the different classes, the appropriate heater types are modeled for each class. DOE believes that its efforts in updating anti-sweat heater powers modeled in the engineering analysis for the final rule sufficiently and directly address the concerns voiced by stakeholders at the NOPR stage.

c. Coil Performance Modeling

Stakeholders offered feedback to DOE on how the simulation of coil performance could be improved to better reflect the performance of evaporator and condenser coils in the field. Traulsen commented that while DOE states that evaporators can be designed to have a discharge air temperature that is a minimum of 10 degrees F colder than the product temperature, the baseline model in the analysis shows a product-to-refrigerant temperature difference of 11 degrees F. Traulsen further sought clarification on where the improvement in evaporator performance could be attained since the temperature differential at the baseline was already low. (Traulsen, No. 65 at p. 5) Hussmann commented that the gap between discharge air temperature and saturated evaporator temperature was unrealistically low for certain equipment classes. (Hussmann, No. 77 at p. 10)

Hillphoenix and AHRI noted that, conventionally, coil UA[40] is calculated using log-mean temperature difference (LMTD) and inlet temperature. Further, Hillphoenix commented that the use of what it perceived to be incorrect formulae had led to over-estimation of UA for condensers and evaporators, and that different methods were used to calculate UA for condensers than were used for evaporators. (AHRI, No. 75 at p. 5) (Hillphoenix, No. 71 at p. 5).

[40] Coil UA is a lumped parameter describing the heat transfer capability of a heat exchanger, accounting for the thermal transmittance (U) and surface area (A) of the specific heat exchanger design.

AHRI commented that since both the previous and current rulemakings included rifled tubing and increased fin pitch, the total prototype energy consumption should have been the same across rulemakings. Further, AHRI commented that the prototype condenser coil scenario is not fully representative of all condensers for SC equipment. (AHRI, No. 75 at p. 8)

In response to the concerns of Traulsen and Hussmann, DOE re-evaluated its parameters for modeling of coil temperature performance. Specifically, it adjusted the temperature differential between product temperature and saturated evaporator temperature to be 15 °F for certain classes under the baseline configuration. DOE believes that this is a more accurate representation of evaporator performance based on the feedback that it has received from comments and data from testing and equipment literature. The result is that the temperature differential at the baseline and high-performance level is higher, reflecting the adjustments to this parameter suggested by stakeholders.

In the engineering model, evaporator coil UA is calculated as a function of case heat load and a log mean temperature difference based on the saturated evaporator temperature, discharge air temperature, and return air temperature. This is the same methodology that was used in the 2009 final rule engineering analysis, which underwent rigorous examination by stakeholders. Therefore, DOE believes that Hillphoenix and AHRI are misinterpreting DOE's methodology when discussing evaporator performance. Additionally, with respect to the comment that different formulae were applied to the modeling of evaporators and condensers, DOE agrees with this fact, but does not believe that this is an incorrect methodology. The modeling of the evaporator reflects the fact that chilled case air is being recirculated, whereas modeling of the condenser reflects the fact that the condenser is rejecting heat to an ambient environment which functions as an effectively infinite thermal sink. Therefore, DOE believes that these different performance environments warrant different modeling, and maintains its methodology for conducting this modeling in the final rule.

With regard to the concern of AHRI over disparities between the coil performance levels modeled in the 2009 final rule and the current rulemaking, DOE performed new analysis for the current rulemaking based on teardowns and simulation conducted at the NOPR stage. At the final rule stage, based on further input from stakeholder comments, DOE again updated this performance and cost modeling. Therefore, due to the fact that the analysis was conducted anew at each of these stages and is not directly related to the analysis conducted for the 2009 final rule, DOE believes that the differences in modeled performance are reasonable and reflect improvements to DOE's understanding of baseline and high-performance coil designs.

In reference to AHRI's mention of the applicability of DOE's condenser coil design to a variety of commercial refrigeration equipment, DOE modeled a baseline coil based upon geometries and features measured from teardowns of representative models for sale on the market today, and then implemented further design improvements based on the inputs of outside subject matter experts and within the guidance provided by stakeholder comments and feedback. The engineering model then expands the cost and capacity of the modeled coil to adjust to the needs of different equipment sizes being simulated. Thus, DOE believes that the modeled coil design accurately reflects the real-world needs of condenser heat exchangers for this equipment.

d. Compressor Performance Modeling

Manufacturers and consumers expressed concern over DOE's assumptions regarding the advances in compressor technology anticipated before the compliance date. Danfoss, Traulsen, AHRI, True, Structural Concepts, Continental, NAFEM and Hoshizaki commented that if a 10% compressor efficiency improvement were possible for a 5% cost increase, then it is most likely that manufacturers would have already adopted this technology. (Traulsen, No. 65 at p. 12) (AHRI, No. 75 at p. 9) (True, No. 76 at p. 2) (Structural Concepts, No. 85 at p. 2) (Continental, No. 87 at p. 2) (NAFEM, No. 93 at p. 3) (Hoshizaki, No. 84 at p. 2) Further, Danfoss stated that, at most, a 1-2% increase in efficiency could be gained for a 5% cost increase. (Danfoss, No. 61 at p. 2)

DOE appreciates the specific and detailed input which it received from manufacturers and suppliers regarding its previous assumptions of potential improvements in compressor efficiency and the corresponding costs to attain these performance increases. In light of these comments, DOE updated its performance and cost modeling of compressors for the final rule analysis. Specifically, DOE implemented the suggestion of Danfoss, a major supplier, which stated that a 2% increase in performance over today's standard offerings, with a corresponding cost increase of 5%, is attainable. DOE believes that these parameters better reflect the options available to manufacturers of commercial refrigeration equipment.

e. Insulation Modeling

Some stakeholders felt that DOE's analytical model of case insulation had failed to sufficiently capture its effect on manufacturing processes and field performance. Continental and Structural Concepts commented that the actual R-value of urethane foam insulation is significantly lower than the value modeled. (Structural Concepts, No. 85 at p. 2) (Continental, No. 87 at p. 3) AHRI and True suggested that an R-Value of 6 per inch was more realistic for insulation than the currently modeled 8 per inch. (AHRI, No. 75 at p. 5) (True, No. 76 at p. 3) Concurrently, NAFEM commented that 1.25 inches of added insulation would actually be required to meet the level of insulating performance included in the proposed standard. (NAFEM, No. 93 at p. 5) True commented that there was a loss of insulation value over time using urethane insulation and plastic liners. (True, No. 76 at p. 3)

Traulsen commented that the DOE assumption that increased insulation would not affect cabinet structure was incorrect. Traulsen further noted that some aspects of cabinet geometry and features where the highest level of heat leakage occur appear to be beyond the scope of DOE's model. (Traulsen, No. 65 at p. 7) Continental, too, commented that cabinet geometry would lead to low in-place insulation values, requiring much thicker insulation in some areas than others, to achieve the proposed standards. (Continental, No. 87 at p. 3)

Traulsen commented that since the 2009 rule noted that a 1/2" insulation increase was not viable for some classes, and since no significant changes in technology have occurred, DOE should exclude this design option from a proposed standard level. (Traulsen, No. 65 at p. 8)

In response to the comments from Structural Concepts, Continental, AHRI, True, and NAFEM, DOE believes that an R-value of 8 per inch is accurate for foamed-in-place polyurethane insulation as used in commercial refrigeration equipment. DOE has corroborated this value in past and ongoing rulemakings against product literature, supplier and academic studies, and discussions in manufacturer interviews. Therefore DOE believes that this is an accurate value and has maintained it for the modeling of foam performance in its final rule engineering analysis. With regard to the comment from True on changes in insulative value of foam over time, DOE notes that certification of equipment is conducted at or shortly after the time of manufacture, and thus equipment in that state is modeled in DOE's engineering analysis. DOE did not model the performance of equipment at points long after the time of manufacture.

DOE based its modeling of case heat loads on measured geometries as seen in units purchased and torn down over the course of the rulemaking, as well as on product literature for designs currently on the market. DOE notes that these geometries in some cases included the level of increased foam thicknesses modeled as a design option, meaning that manufacturers were already including these increases and accounting for their effects. Thus, since proof of concept is already being presented in today's equipment market, DOE does not believe that there are inaccuracies in its levels of modeled foam thickness. In response to the comment from

Traulsen, DOE believes that its model sufficiently accounts for the thermal effects of conduction, infiltration, and other heat loads incident upon the refrigerated case. With respect to Continental's concerns, DOE has examined a wide variety of case designs on the market, but generally has not encountered instances in which low in-place insulation thicknesses have been observed. In most instances that DOE has examined, manufacturers have maintained a standard thickness throughout the body of the case. Therefore, DOE believes that its insulation modeling is accurate and consistent with designs currently produced by the industry.

DOE conducted its current analysis based on the latest available information regarding equipment designs, cost and performance of design options and components, and downstream factors such as electricity price forecasts. This information was updated entirely from the 2009 rule. Therefore, in response to Traulsen's comment that DOE should not consider a design option in this analysis just because it was not included in the analytical levels corresponding to standards set for some classes in 2009, DOE cautions that a direct comparison between the two rulemakings may not be accurate. Changes in prices, market factors, and other inputs since 2009 mean that outcomes between the two analyses could be different. Therefore, DOE has conducted the current analysis in isolation based on the best currently available data, and has set the standard levels included in today's rule using the results of that analysis.

f. Lighting Performance

Several manufacturers opined that DOE had modeled LED performance too aggressively. Southern Store Fixtures commented that even with more directional light from LED systems, higher wattage LEDs with higher number of diodes than those modeled by DOE would be required to provide illumination comparable to a fluorescent system. (Southern Store Fixtures, No. 67 at p. 2) Traulsen, in agreement with other commenters, noted that LEDs require more watts per lumen than high efficiency T8 lighting which uses reflectors. (Traulsen, No. 65 at p. 3) Continental commented that, while LEDs are significantly more directional than fluorescent lights, the efficacy modeled by DOE was overestimated. (Continental, No. 87 at p. 2) More specifically, AHRI commented that although LEDs are directional, the DOE assumption that the output of 4-ft & 5-ft LEDs is only 29% of that associated with T8 lighting is flawed, since the directional nature of LEDs cannot fully compensate for such a large differential. (AHRI, No. 75 at p. 3) Additionally, True commented that due to the varied nature of illumination needs across products, many models require higher wattages if LEDs are used. (True, No. 76 at p. 1) AHRI added that reducing the light output into cases through use of LEDs would affect consumer utility. (AHRI, No. 75 at p. 4) Traulsen commented that CRE applications, especially those requiring low temperature settings, could experience degradation in LED color quality and shorter lifespans. Traulsen further commented that the variety of displayed packaging or product types may need special light colors, and that one size fits all approach to LED lighting could lead to loss of utility. (Traulsen, No. 65 at p. 4)

Providing an additional viewpoint, the CA IOUs commented that the assumed level of efficacy for LED technology (54 lumens per watt) was very conservative. The CA IOUs further noted that using the DesignLights Consortium online database, the current simple average for all vertical refrigerated case lighting was 59 lumens per watt, with the average for products added in 2013 being 66 lumens per watt. (CA IOUs, No. 63 at p. 7)

AHRI commented that comparisons between T8, super T8, and LED lighting systems as modeled in the previous and current rulemakings suggest that no significant improvements have been made in lighting since the last rulemaking cycle. (AHRI, No. 75 at p. 2)

With regard to specific equipment classes, Hillphoenix commented that the savings from SVO.RC.M due to LED lighting was the same as for VOP.RC.M even though the semi-vertical cases would have fewer shelf lights than the vertical open cases. (Hillphoenix, No. 71 at p. 6) Further, AHRI commented that in the case of VCT.RC.M and VCT.RC.L equipment, the LED lighting design option provides about an 80-83% increased energy consumption reduction for the current rulemaking as compared to the previous rulemaking. (AHRI, No. 75 at p. 9)

DOE agrees with the comments from Southern Store Fixtures, Continental, and Traulsen that, in absolute terms, LED lighting produces fewer output lumens per watt than T8 fluorescent lighting. However, DOE understands that due to the directionality of LED lighting, a much greater percentage of the lighting is incident upon the product, rather than being diffused into the cabinet. With respect to the concerns of AHRI and Continental that this directionality is still not sufficient to compensate for the levels of lighting modeled in the engineering analysis, DOE asserts that it based its modeling directly on the specific configurations of equipment being shipped on the market at the time of the analysis. When selecting LED lighting specifications to model, DOE performed research through manufacturer literature and catalogs, studies of lighting manufacturer product literature, and physical teardowns of existing units on the market. Developed based on this data, DOE believes that its lighting specifications reflect the current needs of customers and designs produced by manufacturers to satisfy those needs.

In addition, based on new information provided by stakeholder comments at the final rule stage, DOE has increased the modeled lumen output of its LED fixtures by roughly 20% across all classes. DOE believes that this added modeled light output serves to address the concerns presented by stakeholders in their comments. Additionally, DOE understands that manufacturers have concerns over the applicability of LED lighting to the wide variety of models merchandised within commercial refrigeration equipment. During its manufacturer interviews, DOE specifically addressed this subject, speaking to manufacturers of a broad range of equipment about their use of LEDs. Generally, manufacturers stated that LED technology has advanced sufficiently that issues with color matching and product color illumination are no longer as significant as in the past. DOE's research into current manufacturer designs aligns with this finding, as manufacturers are using LED lighting in all applicable equipment families. With respect to concerns over LED lifetimes, based on its discussions with manufacturers, DOE does understand that there still remain variations in quality and durability of LED products based on the chosen supplier, but that LED reliability has improved significantly to its current state. Additionally, DOE has accounted for the need for replacement of LED lighting fixtures as part of the maintenance costs analyzed in its life-cycle cost and payback period analysis.

After receiving the comment from the CA IOUs regarding standard efficacies of LED fixtures produced today, DOE researched the referenced DesignLights Consortium online database and found that the listed data agreed with the performance levels stated in the comment from the CA IOUs. In response to this new data, DOE updated its efficacy figures for the modeled LED fixtures in line with those levels depicted for models currently on the market per the database. This resulted in an approximate 20% increase in modeled lumen output for all LED fixtures modeled. DOE believes that this adjustment allows its LED modeling to better reflect the level of technology currently available on the market, while simultaneously addressing concerns from manufacturers and other stakeholder about low levels of product illumination using LED lighting.

DOE agrees with AHRI that no major new lighting technologies have come onto the market since the conduct of the 2009 rulemaking; that is, that the options currently available to manufacturers consist largely of T8 fluorescent and LED lighting. Therefore, in building up engineering cost-efficiency curves depicting the price and performance of equipment from baseline to max-tech levels, DOE included these technologies in the baseline and higher-efficiency scenarios and implemented energy-saving lighting features alongside other design options in order of ascending payback period. With respect to AHRI's assertion of significant new improvements to lighting technologies since the modeling for the 2009 final rule was performed, DOE points out that it updated the prices and performance levels of the various lighting technologies to reflect new information since the 2009 rulemaking, and reordered its design options and cost-efficiency curves correspondingly.

In response to the comments from AHRI and Hillphoenix comparing the perceived relative efficacies of specific design options in the engineering analysis to the incremental performance changes associated with them in the 2009 rule, DOE cautions against making such comparisons since many other factors were not held constant. Updates to the baseline configuration, improved pricing and performance modeling, inclusion of new design options, and updated design option ordering all mean that the modeled order of implementation of design options, and the effects of those design options being implemented, has in many instances changed since the 2009 final rule analysis. Therefore, a direct comparison would be inaccurate and unfair. Similarly, DOE cautions against direct comparisons of specific incremental results across different equipment classes. Engineering results for each equipment class were calculated independently based upon the best available data on equipment configuration, design option performance, and costs. Therefore, the results of each class should be examined independently, and there was no interrelation to other classes built into the model.

g. Transparent Door Performance

Stakeholders expressed concern over the modeled improvements in transparent door performance between the current and previous rulemaking analyses. AHRI commented that there was a decrease of over 60% in the U-factors for transparent doors between the previous final rule and the current NOPR, even though both results were arrived at using the Lawrence Berkeley

National Laboratory (LBNL) WINDOW[41] software. Further, AHRI noted that the U-factor associated with high-performance doors for VCT.M equipment in 2009 did not even meet the level of performance suggested by the U-factor that is listed in the current TSD for standard doors. (AHRI, No. 75 at p. 9) Similarly, Hussmann commented that the U-factors and anti-sweat heat values for transparent doors in various classes were significantly lower than in the 2009 final rule, and that base cases in the current NOPR analysis did not meet the definition of high-performance from the previous analysis. (Hussmann, No. 77 at p. 2) Hillphoenix commented that the U-factor and heater power varied for identical classes from the previous rulemaking to the current. (Hillphoenix, No. 71 at p. 7) AHRI commented that for HCT.M equipment, while the overall U-Factor specified for standard doors seems appropriate, the U-factor for high-performance doors seems very low. (AHRI, No. 75 at p. 10)

In response to the stakeholder concerns regarding the modeled performance of transparent doors, DOE revisited its modeling of this feature as part of its final rule engineering analysis. In doing so, it incorporated comments and suggestions from stakeholders received during the NOPR public meeting and in written comments after the publication of the NOPR regarding design attributes such as the number of panes of glass modeled, the use of low-e coatings, and appropriate levels of anti-sweat heat. DOE also gathered additional information through physical inspection and teardown of several additional glass-door models procured during the final rule stage. Based on these inputs, DOE modeled the various types of glass doors

[41] This software is an industry-accepted, publicly-available software tool used to model the performance of various fenestration components such as windows. More information is available at http://windows.lbl.gov/software/window/window.html

using the latest version of the LBL WINDOW software to develop new, more accurate whole-door U-factors. In response to the comments on alignment of the previous and current baseline door designs, DOE did in some cases, where appropriate, retain the U-factors and anti-sweat powers used at the baseline in the 2009 final rule. However, in other instances where DOE found evidence that the market baseline and features included in standard door offerings had evolved since that time, DOE sought to include in its baseline designs features which reflect the current offerings of major door manufacturers. For full details on the modeled performance attributes of transparent doors, please see chapter 5 of the final rule TSD.

h. Validation of Engineering Results

DOE’s engineering results as presented in the NOPR were based on the results of analytical modeling. Several stakeholders, however, felt that the analysis was purely theoretical and did not account for factors affecting field performance. Hoshizaki commented that DOE's engineering analysis considers a theoretical base case with no experimental or physical data to support the model. (Hoshizaki, No. 84 at p. 1) Traulsen commented that the MDEC targets were evaluated by using a theoretical prototype based on market trends and assumptions, and contrasted that with DOE’s statement in the NOPR TSD that design options comprising the maximum technologically feasible level must have been physically demonstrated. Further, Traulsen noted that the engineering analysis was only an academic exercise based on computer simulations rather than physical results. (Traulsen, No. 65 at p. 2)

Hoshizaki, ACEEE and Lennox urged DOE to perform validation testing and physically demonstrate the achievement of the proposed efficiency improvement levels. (Hoshizaki, No. 84 at p. 2) (ACEEE, Public Meeting Transcript, No. 62 at p. 351) (Lennox, No. 73 at p. 2) Similarly, NAFEM noted that the modeled maximum-technology designs were not backed by tests or prototypes. (NAFEM, No. 93 at p. 3) The CA IOUs strongly urged DOE to calibrate and validate its model with test and prototype data, asserting that while many of the assumptions made by DOE might hold true in theory, they may not be physically possible to realize. (CA IOUs, No. 63 at p. 6)

Traulsen commented that the success of the 2009 final rule standard could have been reviewed using voluntary databases containing empirical data of commonly-produced units. Traulsen further commented that DOE should base its future MDEC targets on data regarding best practices and technologies available in the market, as indicated by these databases. (Traulsen, No. 65 at p. 2)

The Joint Comment noted that DOE utilized a theoretical engineering model approach for the 2011 residential refrigerators final rule. 76 FR 57516 (Sept. 15, 2011) Further, the Joint Comment noted that the 2011 residential refrigeration model's max-tech levels were 59% more efficient than the existing standard, even though the most efficient model available at the time was only 27% more efficient. (Joint Comment, No. 91 at p. 2)

DOE agrees that its results are based on analytical modeling, but disagrees with the assertions from Hoshizaki and Traulsen that the simulation and modeling were purely theoretical in nature. DOE based its analysis on a model which was developed for the 2009 final rule and updated to accommodate the needs of this current rulemaking. Inputs to the model included data from tangible sources such as manufacturer literature, manufacturer interviews, production facility tours, reverse engineering and teardown of existing products on the market, and tests of commercial refrigeration equipment and components. DOE maintains its assertion, contrary to Traulsen's comment, that all design options modeled have been physically demonstrated in the commercial refrigeration market or in comparable products.

In agreement with the Joint Comment, DOE points to the 2011 residential refrigerators final rule, the 2009 commercial refrigeration equipment final rule, and the 2009 refrigerated beverage vending machine final rule as examples of cases where analytical tools and simulation have been used to develop effective energy efficiency standards. 76 FR 57516 (Sept. 15, 2011); 74 FR 1092 (Jan. 9, 2009); 74 FR 44914 (Aug. 31, 2009) Additionally, DOE notes that it recently issued a rule, strongly supported by industry, which will allow manufacturers to use alternative energy determination methods (AEDMs), which are non-testing methodologies and analytical tools, to certify the performance of their equipment. 78 FR 79579 (December 31, 2013)

In response to the comments from Traulsen, Hoshizaki, ACEEE, the CA IOUs, Lennox, and NAFEM that DOE perform validation testing to confirm the veracity of its model, at the final rule stage DOE procured a number of commercial refrigeration units currently on the market, including high-performance units featuring advanced designs. It gathered physical test data on each unit from certification directories and, in some cases, from independent laboratory tests conducted by DOE on the units. DOE then performed physical teardowns and inspection of the units to quantify the features and design attributes included in each model. Then, DOE used this empirically-determined data as inputs into its engineering model, allowing the model to simulate these specific manufacturer models as closely as possible. The results showed good alignment between the model outputs and the physical test results across a range of equipment classes and efficiencies, validating the abilities of the model. For further information on this validation exercise, please see chapter 5 of the final rule TSD.

With regard to the suggestion from Traulsen that DOE reference existing equipment performance databases, at the final rule stage of this rulemaking, DOE utilized information from the ENERGY STAR[42] and California Energy Commission[43] appliance databases as a point of comparison to its engineering analysis results. This allowed DOE to compare its analytical results to existing directories of certified data and ensure that the results fell within a reasonable range of performance values. However, DOE notes that neither of these databases is necessarily comprehensive and exhaustive of all models offered for sale in the United States, and that market data only capture those designs which are currently being built, not all of those which may be feasible. For these reasons, while DOE compared its results against those databases as a check, it

[42] http://www.energystar.gov/certified-products/certified-products
[43] http://www.appliances.energy.ca.gov/Default.aspx

continued to use a design option approach and simulation as the basis for developing its engineering analysis results, rather than developing standard levels solely from existing market data.

E. Markups Analysis

DOE applies multipliers called "markups" to the MSP to calculate the customer purchase price of the analyzed equipment. These markups are in addition to the manufacturer markup (discussed in section IV.D.4.e) and are intended to reflect the cost and profit margins associated with the distribution and sales of the equipment. DOE identified three major distribution channels for commercial refrigeration equipment, and markup values were calculated for each distribution channel based on industry financial data. The overall markup values were then calculated by weighted-averaging the individual markups with market share values of the distribution channels.

In estimating markups for CRE and other products, DOE develops separate markups for the cost of baseline equipment and the incremental cost of higher-efficiency equipment. Incremental markups are applied as multipliers only to the MSP increments of higher-efficiency equipment compared to baseline, and not to the entire MSP.

Traulsen stated that, in its experience, the initial markup on equipment will be consistent with production costs, and that the incremental markups will increase with higher levels of product efficiency due to product differentiation. (Traulsen, No. 65 at p. 18) DOE agrees that manufacturer markups are often larger on higher-efficiency equipment due to product differentiation strategies. However, DOE's approach considers a situation in which products at any given efficiency level may be the baseline products under new or amended standards (i.e., they just meet the standard). In that situation, a typical markup would apply. DOE uses average values for manufacturer markups.

Traulsen also stated that it did not believe that wholesalers differentiate markups based on the technologies inherently present in this equipment and that, in its experience, wholesalers/resellers will use traditional markup rates regardless of equipment's energy efficiency. (Traulsen, No. 65 at p. 18)

DOE's approach for wholesaler markups does not imply that wholesalers differentiate markups based on the technologies inherently present in the equipment. It assumes that the average markup declines as the wholesalers' cost of goods sold increases due to the higher cost of more-efficient equipment. If the markup remains constant while the cost of goods sold increases, as Traulsen's comment suggests, the wholesalers' profits would also increase. While this might happen in the short run, DOE believes that the wholesale market is sufficiently competitive such that there would be pressure on margins. DOE recognizes that attempting to capture the market response to changing cost conditions is difficult. However, DOE's approach is consistent with the mainstream understanding of firm behavior in competitive markets.

See chapter 6 of the final rule TSD for more details on DOE's markups analysis.

F. Life-Cycle Cost and Payback Period Analysis

DOE conducts LCC analysis to evaluate the economic impacts of potential amended energy conservation standards on individual commercial customers—that is, buyers of the equipment. LCC is defined as the total customer cost over the life of the equipment, and consists of purchase price, installation costs, and operating costs (maintenance, repair, and energy costs). DOE discounts future operating costs to the time of purchase and sums them over the expected lifetime of the piece of equipment. PBP is defined as the estimated amount of time it takes customers to recover the higher installed costs of more-efficient equipment through savings in operating costs. DOE calculates the PBP by dividing the increase in installed costs by the average savings in annual operating costs.

As part of the engineering analysis, design option levels were ordered based on increasing efficiency (i.e., decreasing energy consumption) and increasing MSP. For the LCC analysis, DOE chose a maximum of eight levels, henceforth referred to as “efficiency levels,” from the list of engineering design option levels. For equipment classes for which fewer than eight design option levels were defined in the engineering analysis, all design option levels were used. However, for equipment classes where more than eight design option levels were defined, DOE selected specific levels to analyze in the following manner:

1. The lowest and highest energy consumption levels provided in the engineering analysis were preserved.
2. If the difference in reported energy consumptions and reported manufacturer price between sequential levels was minimal, only the higher efficiency level was selected.

3. If the energy consumption savings benefit between efficiency levels relative to the increased cost was very similar across multiple sequential levels, an intermediate level was not selected as an efficiency level.

The first efficiency level (Level 0) in each equipment class is the least efficient and the least expensive equipment configuration in that class. The higher efficiency levels (Level 1 and higher) exhibit progressive increases in efficiency and cost from Level 0. The highest efficiency level in each equipment class corresponds to the max-tech level. Each higher efficiency level represents a potential new standard level.

The installed cost of equipment to a customer is the sum of the equipment purchase price and installation costs. The purchase price includes MPC, to which a manufacturer markup and outbound freight cost are applied to obtain the MSP. This value is calculated as part of the engineering analysis (chapter 5 of the final rule TSD). DOE then applies additional markups to the equipment to account for the markups associated with the distribution channels for the particular type of equipment (chapter 6 of the final rule TSD). Installation costs were varied by state, depending on the prevailing labor rates.

Operating costs for commercial refrigeration equipment are the sum of maintenance costs, repair costs, and energy costs. These costs are incurred over the life of the equipment and therefore are discounted to the base year (2017, which is the compliance date of any amended standards that are established as part of this rulemaking).

The sum of the installed cost and the operating cost, discounted to reflect the present value, is termed the life-cycle cost or LCC. Generally, customers incur higher installed costs when they purchase higher efficiency equipment, and these cost increments will be partially or wholly offset by savings in the operating costs over the lifetime of the equipment. LCC savings are calculated for each efficiency level of each equipment class.

The PBP of higher efficiency equipment is obtained by dividing the increase in the installed cost by the decrease in annual operating cost. In addition to energy costs (calculated using the electricity price forecast for the first year), the annual operating cost includes annualized maintenance and repair costs. PBP is calculated for each efficiency level of each equipment class.

Apart from MSP, installation costs, and maintenance and repair costs, other important inputs for the LCC analysis are markups and sales tax, equipment energy consumption, electricity prices and future price trends, expected equipment lifetime, and discount rates.

Many inputs for the LCC analysis are estimated from the best available data in the market, and in some cases the inputs are generally accepted values within the industry. In general, each input value has a range of values associated with it. While single representative values for each input may yield an output that is the most probable value for that output, such an analysis does not provide the general range of values that can be attributed to a particular output value. Therefore, DOE carried out the LCC analysis in the form of Monte Carlo simulations,[44] in which certain inputs were expressed as a range of values and probability distributions to account for the ranges of values that may be typically associated with the respective input values. The results, or outputs, of the LCC analysis are presented in the form of mean and median LCC savings; percentages of customers experiencing net savings, net cost and no impact in LCC; and median PBP. For each equipment class, 10,000 Monte Carlo simulations were carried out. The simulations were conducted using Microsoft Excel and Crystal Ball, a commercially available Excel add-in used to carry out Monte Carlo simulations.

LCC savings and PBP are calculated by comparing the installed costs and LCC values of standards-case scenarios against those of base-case scenarios. The base-case scenario is the scenario in which equipment is assumed to be purchased by customers in the absence of the amended energy conservation standards. Standards-case scenarios are scenarios in which equipment is assumed to be purchased by customers after the amended energy conservation standards, determined as part of the current rulemaking, go into effect. The number of standards-case scenarios for an equipment class is equal to one less than the total number of efficiency levels in that equipment class, since each efficiency level above Efficiency Level 0 represents a potential amended standard. Usually, the equipment available in the market will have a

[44] Monte Carlo simulation is, generally, a computerized mathematical technique that allows for computation of the outputs from a mathematical model based on multiple simulations using different input values. The input values are varied based on the uncertainties inherent to those inputs. The combination of the input values of different inputs is carried out in a random fashion to simulate the different probable input combinations. The outputs of the Monte Carlo simulations reflect the various outputs that are possible due to the variations in the inputs.

distribution of efficiencies. Therefore, for both base-case and standards-case scenarios, in the LCC analysis, DOE assumed a distribution of efficiencies in the market (see section IV.F.10).

Recognizing that each building that uses commercial refrigeration equipment is unique, DOE analyzed variability in the LCC and PBP results by performing the LCC and PBP calculations for seven types of businesses: (1) supermarkets; (2) wholesaler/multi-line retail stores, such as “big-box stores,” “warehouses,” and “supercenters”; (3) convenience and small specialty stores, such as meat markets and wine, beer, and liquor stores; (4) convenience stores associated with gasoline stations; (5) full-service restaurants; (6) limited service restaurants; and (7) other foodservice businesses, such as caterers and cafeterias. Different types of businesses face different energy prices and also exhibit differing discount rates that they apply to purchase decisions.

Expected equipment lifetime is another input whose value varies over a range. Therefore, DOE assumed a distribution of equipment lifetimes that are defined by Weibull survival functions.[45]

Another important factor influencing the LCC analysis is the State in which the commercial refrigeration equipment is installed. Inputs that vary based on this factor include energy prices and sales tax. At the national level, the spreadsheets explicitly modeled variability

[45] A Weibull survival function is a continuous probability distribution function that is used to approximate the distribution of equipment lifetimes of commercial refrigeration equipment.

in the inputs for electricity price and markups, using probability distributions based on the relative shipments of units to different States and business types.

Detailed descriptions of the methodology used for the LCC analysis, along with a discussion of inputs and results, are presented in chapter 8 and appendices 8A and 8B of the final rule TSD.

1. Equipment Cost

To calculate customer equipment costs, DOE multiplied the MSPs developed in the engineering analysis by the distribution channel markups, described in section IV.D.5. DOE applied baseline markups to baseline MSPs, and incremental markups to the MSP increments associated with higher efficiency levels.

DOE developed an equipment price trend for CRE based on the inflation-adjusted index of the producer price index (PPI) for air conditioning, refrigeration, and forced air heating from 1978 to 2012.[46] A linear regression of the inflation-adjusted PPI shows a slight downward trend (see appendix 10D of the final rule TSD). To project a future trend, DOE extrapolated the historic trend using the regression results. For the LCC and PBP analysis, this default trend was applied between the present and the first year of compliance with amended standards, 2017.

[46] Bureau of Labor Statistics, Producer Price Index Industry Data, Series: PCU3334153334153

2. Installation Costs

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. The installation costs may vary from one equipment class to another, but they do not vary with efficiency levels within an equipment class. DOE retained the nationally representative installation cost values from the January 2009 final rule and simply escalated the values from 2007$ to 2012$, resulting in installation costs of $2,299 for all remote condensing equipment and $862 for all self-contained equipment.

Hussmann opined that as equipment becomes more expensive, it will also become more difficult to install, which will result in higher installation labor costs. (Hussmann, No. 77 at p. 5) DOE has found no evidence to support the notion that higher-efficiency (and more expensive) commercial refrigeration equipment lead to an increase in installations costs. The installation costs derived for the NOPR and final rule are based on a detailed list of installation and commissioning procedures, which DOE believes to be representative of current industry practice. These installation and commissioning details can be found in chapter 8 of the final rule TSD.

NAFEM asserted that DOE failed to take into account the ramifications of the proposed standard on a variety of end-uses, such as restaurants, grocery stores, and convenience stores. For these end-users floor space is limited, and increasing efficiency may increase the equipment size to store the same amount of goods. NAFEM suggests that increasing the thickness of foam insulation would decrease storage and display capacity of equipment and will likely result in a limitation of the products offered for sale by these users. (NAFEM, No. 93 at pp. 3-4)

As described in detail in section IV.D.2.d of today's rule, DOE, in its teardown analyses, encountered a number of models currently on the market utilizing the increased foam wall thicknesses which it modeled. Since manufacturers are already employing these wall thicknesses in currently-available models, DOE believes that this serves as a proof of concept and that the resulting changes to form factor would be of minimal impact to end users. DOE also would like to remind stakeholders that it is not setting prescriptive standards, and should manufacturers value some features over others, they are free to use different design paths in order to attain the performance levels required by today's rule.

3. Maintenance and Repair Costs

Maintenance costs are associated with maintaining the operation of the equipment. DOE split the maintenance costs into regular maintenance costs and lighting maintenance costs. Regular maintenance activities, which include cleaning evaporator and condenser coils, drain pans, fans, and intake screens; inspecting door gaskets and seals; lubricating hinges; and checking starter panel, control, and defrost system operation, were considered to be equivalent for equipment at all efficiency levels. Lighting maintenance costs are the costs incurred to replace display case lighting at regular intervals in a preventative fashion. Because lights and lighting configuration change with efficiency levels, lighting maintenance costs vary with efficiency levels. As stated in chapter 5 of the TSD, for efficiency levels that incorporate LED lights as a design option, the expected reduction in LED costs beyond 2017 was taken into account when calculating the lighting maintenance costs.

Repair cost is the cost to the customer of replacing or repairing failed components. DOE calculated repair costs based on the typical failure rate of refrigeration system components, original equipment manufacturer (OEM) cost of the components, and an assumed markup value to account for labor cost.

Several stakeholders stated that DOE's estimated repair and maintenance costs were too low. The National Restaurant Association commented that, in general, maintenance costs would be much higher. (NRA, No. 90 at p. 3) Hussmann asserted that the condensate evaporator pan, which is often present in self-contained equipment, must be periodically cleaned and serviced, which increases the maintenance costs for such equipment, and that self-contained equipment that utilizes enhanced condenser coils needs to be cleaned more frequently due to the greater density of fins on the condenser. (Hussmann, No. 77 at p. 4) Hussmann further commented that equipment using ECM has higher repair costs. (Hussmann, No. 77 at p. 5) True commented that fluorescent lamps in low temperature applications fail more commonly, so there is a substantial increase in the cost of lighting for freezers compared to refrigerators. LEDs do not have this problem. (True, Public Meeting Transcript, No. 62 at p. 186) Continental commented that smaller refrigeration systems have higher maintenance costs due to tighter tolerances. (Continental, Public Meeting Transcript, No. 62 at p. 186)

DOE requested information from stakeholders regarding maintenance and repair costs specifically related to any of the design options used for this rulemaking. DOE believes its maintenance costs per linear foot are consistent with current industry practices and are sufficient to account for the additional time required to clean closely placed condenser coils and other considerations related to tight space. DOE does not believe that any design option used in the higher efficiency equipment considered in this rulemaking would lead to higher costs for regular maintenance activities. Therefore, DOE retained its approach of using the same costs for regular maintenance for all efficiency levels. However, repair costs have been modeled to be proportional to the OEM cost of the components and, consequently, are higher for higher efficiency equipment.

4. Annual Energy Consumption

Typical annual energy consumption of commercial refrigeration equipment at each considered efficiency level is obtained from the engineering analysis results (see chapter 5 of the final rule TSD).

5. Energy Prices

DOE calculated state average commercial electricity prices using the U.S. Energy Information Administration's (EIA's) "Database of Monthly Electric Utility Sales and Revenue Data."[47] DOE calculated an average national commercial price by (1) estimating an average commercial price for each utility company by dividing the commercial revenues by commercial sales; and (2) weighting each utility by the number of commercial customers it served by state.

[47] U.S. Energy Information Administration. EIA-826 Sales and Revenue Spreadsheets. (Last accessed May 16, 2012). www.eia.doe.gov/cneaf/electricity/page/eia826.html

6. Energy Price Projections

To estimate energy prices in future years, DOE extrapolated the average state electricity prices described above using the forecast of annual average commercial electricity prices developed in the Reference Case from AEO2013.[48] AEO2013 forecasted prices through 2040. To estimate the price trends after 2040, DOE assumed the same average annual rate of change in prices as from 2031 to 2040.

7. Equipment Lifetime

DOE defines lifetime as the age at which a commercial refrigeration equipment unit is retired from service. DOE based expected equipment lifetime on discussions with industry experts, and concluded that a typical lifetime of 10 years is appropriate for most commercial refrigeration equipment in large grocery/multi-line stores and restaurants. Industry experts believe that operators of small food retail stores, on the other hand, tend to use CRE longer. In the NOPR, DOE used 15 years as the average equipment lifetime for remote condensing equipment in small food retail stores. DOE reflects the uncertainty of equipment lifetimes in the LCC analysis for both equipment markets as probability distributions, as discussed in section 8.2.3.5 of the final rule TSD.

[48] The spreadsheet tool that DOE used to conduct the LCC and PBP analyses allows users to select price forecasts from either AEO's High Economic Growth or Low Economic Growth Cases. Users can thereby estimate the sensitivity of the LCC and PBP results to different energy price forecasts.

Several commenters responded on the subject of equipment lifetimes. NAFEM asserted that DOE had overestimated the lifetime of commercial refrigeration equipment, and suggested that DOE reach out to end-users and manufacturers for a more accurate estimate. (NAFEM, No. 93 at p. 7) Traulsen commented that commercial refrigeration equipment is too diverse to be lumped into categories of different lifetimes, as the lifetime of a unit depends on how it is used by a customer in each environment. Traulsen added that without including the time spent in the used equipment market, the estimate of equipment life is too low. (Traulsen, No. 65 at p. 21) The National Restaurant Association also commented that DOE's assumption of a 10 to 15 year lifetime is too low. (NRA, No. 90 at p. 3) Hussmann and Hoshizaki both commented that DOE's equipment lifetime estimates are reasonable at 10 and 15 years. (Hussmann, No. 77 at p. 7) (Hoshizaki, No. 84 at p. 1)

DOE recognizes that the lifetime of commercial refrigeration equipment is dependent on customer type and usage environment. In the NOPR, DOE used an average lifetime of 15 years for remote condensing equipment for small retail stores, and 10 years for all other business types. These lifetimes are the averages of distributions with a maximum lifetime of 20 and 15 years, respectively, for remote condensing equipment for small retail stores, and all other business types. DOE received comments indicating that the lifetimes for small businesses aside from small retail were too low in the NOPR, and that equipment used in small businesses of other types were likely to have increased lifetimes as well. DOE agrees with these statements, and adopted figures for the average and maximum lifetime of 15 and 20 years, respectively, for equipment operated by small businesses of all types. The equipment lifetimes for all other business types remains unchanged from the NOPR with an average and maximum lifetime of 10 and 15 years, respectively. Equipment lifetimes are described in detail in chapter 8 of the TSD.

8. Discount Rates

In calculating the LCC, DOE applies discount rates to estimate the present value of future operating costs to the customers of commercial refrigeration equipment.[49] DOE derived the discount rates for the commercial refrigeration equipment analysis by estimating the average cost of capital for a large number of companies similar to those that could purchase commercial refrigeration equipment. This resulted in a distribution of potential customer discount rates from which DOE sampled in the LCC analysis. 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 company of equity and debt financing.

DOE estimated the cost of equity financing by using the Capital Asset Pricing Model (CAPM).[50] The CAPM assumes that the cost of equity is proportional to the amount of systematic risk associated with a company.

Mercatus Center, George Mason University (Mercatus) commented that the CAPM includes the risk associated with a firm's failure, but it does not estimate the risk associated with

[49] The LCC analysis estimates the economic impact on the individual customer from that customer's own economic perspective in the year of purchase and therefore needs to reflect that individual's own perceived cost of capital. By way of contrast DOE's analysis of national impact requires a societal discount rate. These rates used in that analysis are 7 percent and 3 percent, as required by OMB Circular A-4, September 17, 2003.
[50] Harris, R.S. Applying the Capital Asset Pricing Model. UVA-F-1456. Available at SSRN: http://ssrn.com/abstract=909893.

any individual item used in by the firm, nor does it estimate the failure risk associated with a particular site of operation. (Mercatus, No. 72 at p. 3)

The cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment, and the CAPM is among the most widely used models to estimate the cost of equity financing. The types of risk mentioned by Mercatus may exist, but the cost of equity financing tends to be high when a company faces a large degree of systematic risk, and it tends to be low when the company faces a small degree of systematic risk. DOE's approach estimates this risk for the set of companies that could purchase commercial refrigeration equipment. See chapter 8 of the final rule TSD for further discussion.

9. Compliance Date of Standards

EPCA requires that any amended standards established in this rulemaking must apply to equipment that is manufactured on or after 3 years after the final rule is published in the Federal Register unless DOE determines, by rule, that a 3-year period is inadequate, in which case DOE may extend the compliance date for that standard by an additional 2 years. (42 U.S.C. 6313(c)(6)(C)) Based on these criteria, DOE assumed that the most likely compliance date for standards set by this rulemaking would be in 2017. Therefore, DOE calculated the LCC and PBP for commercial refrigeration equipment under the assumption that compliant equipment would be purchased in 2017.

Continental and Lennox commented that an extension of compliance dates of the amended standards may not be required so long as the standards are based on whatever technology was currently available. (Continental, Public Meeting Transcript, No. 62 at p. 334; Lennox, No. 73 at p. 2) Traulsen noted that, should the compliance date be extended by a further three years, then it was possible, albeit unlikely, that the proposed standards could be realized. (Traulsen, No. 65 at p. 24) Providing a contrary view, the Joint Comment asserted that a three year compliance time period appeared feasible for the proposed standard. In addition, the Joint Comment pointed out that the initial statutory deadline for the final rule was January 2013. (Joint Comment, No. 91 at p. 13) Earthjustice noted that if the compliance date were extended, this may have an impact on how alternative refrigerants feature in the next round of analysis. (Earthjustice, Public Meeting Transcript, No. 62 at p. 334)

In response to the inputs of stakeholders during the NOPR public meeting and in written comment, DOE believes that a compliance date three years after issuance of the final rule is reasonable and appropriate. A three-year period is the standard length of time given between final rule issuance and required compliance, with exceptions generally being made only in circumstances specifically warranting them. Additionally, the commercial refrigeration industry and related industries have proven in the past that a three-year period is adequate to produce equipment meeting updated standards. Therefore, DOE is not including an extension of the period to comply with standards in today's final rule document.

In their written and verbal comments after publication of the NOPR, stakeholders noted that in ascertaining the compliance date for the CRE standards rule, DOE should take into account other, currently open rulemakings, which could affect or be affected by the proposed rule. True commented that the new timeline for this rulemaking, alongside the recent negotiated settlements regarding the certification of commercial equipment, could lead to a situation where the new standards could be enforced, but not the certification requirement. (True, Public Meeting Transcript, No. 62 at p. 28) Traulsen requested that DOE refrain from issuing new CRE standards until the CRE test procedure is finalized. (Traulsen, No. 65 at p. 16) The final rule for the CRE test procedure was issued prior to today's rule for CRE standards. Therefore, DOE sees no conflict between the issuance of the two rules.

Additionally, Structural Concepts commented that in order to have a product line ready by 2017, the design phase would need to start at least three years prior, and therefore new standards should only be based on existing technologies. (Structural Concepts, Public Meeting Transcript, No. 62 at p. 72)

DOE agrees with Structural Concepts that existing technologies should be the basis of its engineering analysis, and has considered only currently-available technologies in that analysis. Additionally, the three-year compliance period required by EPCA in most circumstances is consistent with the required length of design time suggested by Structural Concepts.

10. Base-Case Efficiency Distributions

To accurately estimate the share of affected customers who would likely be impacted by a standard at a particular efficiency level, DOE's LCC analysis considers the projected distribution of efficiencies of equipment that customers purchase under the base case (that is, the case without new or amended energy efficiency standards). DOE refers to this distribution of equipment efficiencies as a base-case efficiency distribution.

In the NOPR, DOE's methodology to estimate market shares of each efficiency level within each equipment class is a cost-based method consistent with the approaches that were used in the EIA's National Energy Modeling System (NEMS)[51] and in the Canadian Integrated Modeling System (CIMS)[52,53] for estimating efficiency choices within each equipment class.

At the NOPR public meeting, True stated that 62 percent of the commercial refrigeration equipment sold in the United States is certified under ENERGY STAR. (True, Public Meeting Transcript, No. 62 at p. 302)

For today's final rule, DOE revised its approach for determining the base case efficiency distribution to better account for market data from the ENERGY STAR program. DOE's

[51] U.S. Energy Information Administration. National Energy Modeling System Commercial Model (2004 Version). 2004. Washington, DC.

[52] The CIMS Model was originally known as the Canadian Integrated Modeling System, but as the model is now being applied to other countries, the acronym is now used as its proper name.

[53] Energy Research Group / M.K. Jaccard & Associates. Integration of GHG Emission Reduction Options using CIMS. 2000. Vancouver, B.C. www.emrg.sfu.ca/media/publications/Reports%20for%20Natural%20Resources%20Canada/Rollup.pdf

understanding of the CRE market is that consumers of commercial refrigeration equipment fall into two categories: those that purchase equipment at the lowest available first cost (also lowest efficiency) and those that purchase equipment at a somewhat higher first cost with higher efficiency. Thus, for the final rule DOE developed a base case efficiency distribution consisting of two categories: purchases at the baseline and purchases at higher efficiency.

For equipment classes that are covered by ENERGY STAR,[54] DOE assumed that baseline equipment accounts for all products that are not ENERGY STAR certified. The ENERGY STAR share is divided between the ENERGY STAR 2.1 level and the more recent ENERGY STAR 3.0 level, which will become effective in October 2014. For CRE classes that are not covered by ENERGY STAR, DOE estimated the share of equipment at the baseline based on the output from the customer choice model for commercial refrigeration used for EIA's Annual Energy Outlook 2013 (AEO 2013).[55] For the higher efficiency equipment, DOE included all efficiency levels for which the retail price is not more than 10 percent above the baseline price, and divided the equipment between the baseline and the higher-efficiency market. Table IV.2 shows the shipment-weighted market shares by efficiency level in the base-case scenario. The method for developing the base-case efficiency distribution is explained in detail in chapter 8 of the final rule TSD.

[54] These classes consist of VCT.SC.M, VCT.SC.L, VCS.SC.M, VCS.SC.L, HCT.SC.M, HCT.SC.L, HCS.SC.M., and HCS.SC.L

[55] U.S. Energy Information Administration. Annual Energy Outlook 2013. 2013. Washington, DC. DOE/EIA-0383(2013).

Table IV.2 Market Shares by Efficiency Level, Base Case in 2017

Equipment Class	Base-case Efficiency Distribution (%)							
	Base	**EL 1**	**EL 2**	**EL 3**	**EL 4**	**EL 5**	**EL 6**	**EL 7**
VOP.RC.M	60	40	0	0	0	0	0	0
VOP.RC.L	60	20	20	0	0	0	0	0
VOP.SC.M	60	40	0	0	0	0	0	0
VCT.RC.M	60	14	13	13	0	0	0	0
VCT.RC.L	60	20	20	0	0	0	0	0
VCT.SC.M	90	0	10	0	0	0	0	0
VCT.SC.L	90	0	10	0	0	0	0	0
VCT.SC.I	60	8	8	8	8	8	0	0
VCS.SC.M	60	0	30	0	0	0	10	0
VCS.SC.L	60	30	0	0	10	0	0	0
VCS.SC.I	60	8	8	8	8	8	0	0
SVO.RC.M	60	40	0	0	0	0	0	0
SVO.SC.M	60	40	0	0	0	0	0	0
SOC.RC.M	60	40	0	0	0	0	0	0
SOC.SC.M	60	40	0	0	0	0	0	0
HZO.RC.M	60	40	0	0	0	0	0	0
HZO.RC.L	60	20	20	0	0	0	0	0
HZO.SC.M	60	20	20	0	0	0	0	0
HZO.SC.L	60	20	20	0	0	0	0	0
HCT.SC.M	60	0	0	40	0	0	0	0
HCT.SC.L	60	0	0	30	0	0	0	10
HCT.SC.I	60	40	0	0	0	0	0	0
HCS.SC.M	90	0	0	0	0	0	10	0
HCS.SC.L	90	0	0	0	0	0	10	0
PD.SC.M	60	40	0	0	0	0	0	0

11. Inputs to Payback Period Analysis

Payback period is the amount of time it takes the customer to recover the higher purchase cost of more energy efficient equipment as a result of lower operating costs. Numerically, the PBP is the ratio of the increase in purchase cost to the decrease in annual operating expenditures. This type of calculation is known as a “simple” PBP because it does not take into account changes in operating cost over time or the time value of money; that is, the calculation is done at an effective discount rate of zero percent. PBPs are expressed in years. PBPs greater than the life of the equipment mean that the increased total installed cost of the more-efficient equipment is not recovered in reduced operating costs over the life of the equipment.

The inputs to the PBP calculation are the total installed cost to the customer of the equipment for each efficiency level and the average annual operating expenditures for each efficiency level in the first year. The PBP calculation uses the same inputs as the LCC analysis, except that electricity price trends and discount rates are not used.

12. Rebuttable-Presumption Payback Period

Sections 325(o)(2)(B)(iii) and 345(e)(1)(A) of EPCA, (42 U.S.C. 6295(o)(2)(B)(iii) and 42 U.S.C. 6316(e)(1)(A)), establish a rebuttable presumption applicable to commercial refrigeration equipment. The rebuttable presumption states that a new or amended 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. This rebuttable presumption test is an alternative way of establishing economic justification.

To evaluate the rebuttable presumption, DOE estimated the additional cost of purchasing more-efficient, standards-compliant equipment, and compared this cost to the value of the energy saved during the first year of operation of the equipment. DOE interprets that the increased cost of purchasing standards-compliant equipment includes the cost of installing the equipment for use by the purchaser. DOE calculated the rebuttable presumption PBP, or the ratio of the value of the increased installed price above the baseline efficiency level to the first year's energy cost savings. When the rebuttable presumption PBP is less than 3 years, the rebuttable presumption is satisfied; when the rebuttable presumption PBP is equal to or more than 3 years, the rebuttable presumption is not satisfied. Note that this PBP calculation does not include other components of the annual operating cost of the equipment (i.e., maintenance costs and repair costs).

While DOE examined the rebuttable presumption, it also considered whether the standard levels considered are economically justified through a more detailed analysis of the economic impacts of these levels pursuant to 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis served as the basis for DOE to evaluate the economic justification for a potential standard level definitively (thereby supporting or rebutting the results of any preliminary determination of economic justification).

G. Shipments

Complete historical shipments data for commercial refrigeration equipment could not be obtained from any one single source. Therefore, for the NOPR DOE used data from multiple sources to estimate historical shipments. The major sources were 2005 shipments data provided by ARI as part of its comments submitted in response to the January 2009 final rule Framework document, ARI 2005 Report (Docket No. EERE-2006-BT-STD-0126, ARI, No. 7, Exhibit B at

p. 1); Commercial Refrigeration Equipment to 2014 by Freedonia Group, Inc.[56]; 2008, and 2012 Size and Shape of Industry by the North American Association of Food Equipment Manufacturers;[57, 58] and Energy Savings Potential and R&D Opportunities for Commercial Refrigeration prepared by Navigant Consulting, Inc. for DOE.[59]

Historical linear feet of shipped units is the figure used to depict the annual amount of commercial refrigeration equipment capacity shipped, and is an alternative way to express shipments data. DOE determined the linear feet shipped for any given year by multiplying each unit shipped by its associated average length, and then summing all the linear footage values. Chapter 9 of the final rule TSD presents the representative equipment class lengths used for the conversion of per-unit shipments to linear footage within each equipment class.

DOE divided historical annual shipments into new and replacement categories by building type. First, equipment types were identified by the type of business they generally serve. For example, vertical open cases with remote condensing units are associated with large grocers and multi-line retail stores. When there was no strong association between the building type and equipment class, equipment was distributed across broader building types. Second, a ratio of new versus replacement equipment was developed based on commercial floor space estimates. Using

[56] Freedonia Group, Inc. Commercial Refrigeration Equipment to 2014. 2010. Cleveland, OH. Study 2261. www.freedoniagroup.com/Commercial-Refrigeration-Equipment.html

[57] North American Association of Food Equipment Manufacturers. 2008 Size and Shape of Industry. 2008. Chicago, IL.

[58] North American Association of Food Equipment Manufacturers. 20012 Size and Shape of Industry. 2012. Chicago, IL.

[59] Navigant Consulting, Inc. Energy Savings Potential and R&D Opportunities for Commercial Refrigeration. 2009. Prepared by Navigant Consulting, Inc. for the U.S. Department of Energy, Washington, DC.

the expected useful life of commercial refrigeration equipment and commercial floor space stock, additions, and retirements, ratios were developed of new versus replacement stock. Using these and related factors (e.g., the division of foodservice into the three building types—limited service restaurants, full-service restaurants, and other), DOE distributed commercial refrigeration equipment shipments among building types and new versus replacement shipments.

DOE then estimated the annual linear footage shipped for each of the 25 primary equipment classes used to represent the commercial refrigeration equipment market. The fractions shown in Table IV.3 were held constant over the analysis period.

Table IV.3 Percent of Shipped Linear Feet of Commercial Refrigeration Equipment

Equipment Class	Percentage of Linear Feet Shipped*
VOP.RC.M	10.3%
VOP.RC.L	0.5%
VOP.SC.M	1.3%
VCT.RC.M	0.8%
VCT.RC.L	10.7%
VCT.SC.M	4.8%
VCT.SC.L	0.2%
VCT.SC.I	0.3%
VCS.SC.M	25.4%
VCS.SC.L	15.0%
VCS.SC.I	0.1%
SVO.RC.M	8.2%
SVO.SC.M	1.1%
SOC.RC.M	2.1%
SOC.SC.M	0.2%
HZO.RC.M	1.3%
HZO.RC.L	4.0%
HZO.SC.M	0.1%
HZO.SC.L	0.2%
HCT.SC.M	0.1%
HCT.SC.L	0.4%
HCT.SC.I	0.4%

HCS.SC.M	4.4%
HCS.SC.L	0.6%
PD.SC.M	7.6%

* The percentages in this column do not sum to 100 percent because shipments of secondary equipment classes and certain other equipment classes that were not analyzed in this rulemaking were not included.

The amount of new and existing commercial floor space is the main driver for future commercial refrigeration equipment shipments. The model divides commercial floor space into new construction floor space and existing floor space.

DOE projected square footage of new construction as a driver of CRE demand to scale annual new commercial refrigeration equipment shipments. DOE took the projected floor space construction after the year 2009 from the NEMS projection underlying AEO 2013. The new construction growth rates over the last 10 years of the AEO 2013 forecast (2031 through 2040) were used to extend the AEO forecast out until 2046 to develop the full 30-year forecast needed for the NIA.

True stated during the NOPR public meeting that DOE's shipments estimates for the VCT.SC.M equipment class were 20 to 30 percent of actual shipments. (True, Public Meeting Transcript, No. 62 at pp. 240-242) This statement was supported by Coca-Cola, which asserted that it alone purchased 180,000 linear feet of VCT.SC.M equipment domestically compared to the 155,000 linear feet of VCT.SC.M equipment presented in the NOPR. (Coca-Cola, Public Meeting Transcript, No. 62 at p. 242) True followed up its public meeting statements with written comment stating that its estimate of the self-contained market was four to six times larger than what was stated in the proposed rule. (True, No. 76 at p. 1) Traulsen suggested that DOE use newer data, such as those in the NAFEM 2012 "Size and Shape of the Industry" study to improve the accuracy of its shipments analysis. (Traulsen, No. 65 at p. 15)

Although neither True nor Coca-Cola provided DOE with shipments data to support their assertions, the magnitude of the discrepancy in shipments identified by these comments led DOE to revise its shipments estimates for the final rule. DOE reviewed three sources of data in developing the revision. First, DOE reviewed the most recent data published by the EPA's ENERGY STAR Program.[60] These EPA data include both an estimate of total units shipped, and an estimate of the fraction that are ENERGY STAR compliant, from 2003 to 2012. The ENERGY STAR estimates of total unit shipments show somewhat slow growth from 2003 to 2010, and a significant increase between 2010 and 2011, with shipments increasing by a factor of two. Second, DOE reviewed the most recent North American Association of Food Equipment Manufacturers Size and Shape of the Industry[61] report published in 2012. This report provides industry total estimates of sales in dollar values. These data show an increase of approximately 60 percent in sales of the relevant covered equipment between 2008 and 2011. Third, DOE reviewed equipment saturation estimates calculated from data in the Energy Information Agency's (EIA) Commercial Buildings Energy Consumption Survey (CBECS) for 1999 and 2003. The CBECS surveys include a count of the number of refrigerated cases in a building,

[60] Energy Star. Unit Shipment and Sales Data Archives. Available at: http://www.energystar.gov/index.cfm?c=partners.unit_shipment_data_archives (Last accessed 12/5/2013).
[61] North American Association of Food Equipment Manufacturers. 2012 Size and Shape of Industry. 2012. Chicago, IL.

which was be converted to a saturation value that represents the average number of cases per building. These data indicate a growth in saturation between 1999 and 2003, particularly for closed refrigeration cases. The existence of a trend in equipment saturations was not accounted for in the NOPR analyses. Taken together, all three data sources support the claims made by stakeholders that DOE's shipments published in the NOPR were substantially underestimated.

For the final rule, DOE modified the shipments analysis to include a trend in equipment saturations between 2003 and 2012. The trend was calculated by (1) smoothing the growth in shipments in the ENERGY STAR data to a constant annual growth rate, (2) correcting to account for the growth in total new and existing commercial floor space, and (3) applying the resulting trend in saturations for the years 2004 to 2012. Before 2003 and after 2012 equipment saturations are held constant. The net result is a doubling of equipment saturations between 2003 and 2012, with corresponding increases in the shipments estimates, which are generally consistent in magnitude with stakeholder comments. These corrections were applied uniformly to all equipment types and applications, and thus do not affect the distribution of equipment by building type or by equipment class.

Detailed description of the procedure to calculate future shipments is presented in chapter 9 of the final rule TSD.

1. Impact of Standards on Shipments

Several stakeholders stated that customer purchase behavior would change in response to an increase in equipment prices due to more stringent standards. At the NOPR public meeting, Hussmann commented that it had noticed a shift from the open VOP.RC.M to the closed VCT.RC.M equipment class, possibly due to energy savings being valued by customers (primarily supermarkets). (Hussmann, Public Meeting Transcript, No. 62 at pp. 236 -37) However, Hussmann noted that the shift could be reversed if closed equipment diminished in its utility as a merchandising platform. (Hussmann, Public Meeting Transcript, No. 62 at p. 237) Hillphoenix and Danfoss stated that if standards require the use of triple-pane coated glass, reduction in visibility will result in users shifting back to less-efficient open cases. (Danfoss, No. 61 at p. 4; Hillphoenix, No. 71 at p. 2) Hussmann noted that it had not observed a reversal of the trend toward closed units in response to previous efficiency standards. (Hussmann, Public Meeting Transcript, No. 62 at p. 235)

DOE recognizes that increased cost for closed equipment meeting the amended standards in today's final rule has the potential to influence a shift from more efficient closed equipment to open equipment. However, DOE did not have sufficient information on customer behavior to model the degree of such equipment switching as part of the NIA. Further, DOE has concluded that the amended standards in today's final rule will not diminish the utility of commercial refrigeration equipment, and they do not require triple-pane coated glass.

Several stakeholders commented that, in response to a possible price increase due to standards, CRE customers may prolong the life of existing equipment through refurbishment. Danfoss asserted that a 15 to 20 percent increase in prices will reduce demand for new units and increase sales of used of refurbished units. (Danfoss, No. 61 at p. 3) NAFEM commented that any standard where the payback on new equipment is longer than 2 years will likely steer users into the refurbished market. (NAFEM, No. 93 at pp. 7 - 8) Traulsen commented that the impact of refurbishing equipment was not fully represented by DOE, especially in the small business environment where customers are likely to hold onto equipment longer. (Traulsen, No. 65 at p. 19) Hussmann stated that due to price increases resulting from higher efficiency, the refurbishment of old equipment will reduce the market for new equipment. (Hussmann, No. 77 at p. 5)

DOE acknowledges that increases in price due to amended standards could lead to more refurbishing of equipment (or purchase of used equipment), which would have the effect of deferring the shipment of new equipment for a period of time. DOE did not have enough information on CRE customer behavior to explicitly model the extent of refurbishing at each TSL. However, DOE believes that the extent of refurbishing would not be so significant as to change the ranking of the TSLs considered for today's rule.

<u>H. National Impact Analysis – National Energy Savings and Net Present Value</u>

The NIA assesses the NES and the NPV of total customer costs and savings that would be expected as a result of amended energy conservation standards. The NES and NPV are analyzed at specific efficiency levels for each equipment class of commercial refrigeration equipment. DOE calculates the NES and NPV based on projections of annual equipment shipments, along with the annual energy consumption and total installed cost data from the LCC analysis. For the final rule analysis, DOE forecasted the energy savings, operating cost savings, equipment costs, and NPV of customer benefits over the lifetime of equipment sold from 2017 through 2046.

DOE evaluated the impacts of the amended standards by comparing base-case projections with standards-case projections. The base-case projections characterize energy use and customer costs for each equipment class in the absence of any amended energy conservation standards. DOE compares these projections with projections characterizing the market for each equipment class if DOE were to adopt an amended standard at specific energy efficiency levels for that equipment class.

DOE uses a Microsoft Excel spreadsheet model to calculate the energy savings and the national customer costs and savings from each TSL. The final rule TSD and other documentation that DOE provides during the rulemaking help explain the models and how to use them, and interested parties can review DOE's analyses by interacting with these spreadsheets. The NIA spreadsheet model uses average values as inputs (as opposed to probability distributions of key input parameters from a set of possible values).

For the final rule analysis, the NIA used projections of energy prices and commercial building starts from the AEO2013 Reference Case. In addition, DOE analyzed scenarios that used inputs from the AEO2013 Low Economic Growth and High Economic Growth Cases. These cases have lower and higher energy price trends, respectively, compared to the Reference Case. NIA results based on these cases are presented in appendix 10D of the final rule TSD.

A detailed description of the procedure to calculate NES and NPV, and inputs for this analysis are provided in chapter 10 of the final rule TSD.

1. Forecasted Efficiency in the Base Case and Standards Cases

The method for estimating the market share distribution of efficiency levels is presented in section IV.F.10, and a detailed description can be found in chapter 8 of the final rule TSD.

As discussed in section IV.F.10 of today's rule, DOE revised the distribution of equipment efficiencies in the base case to better account for data from ENERGY STAR. For equipment covered by ENERGY STAR, for the NIA DOE estimated that the market will move over time to adopt higher efficiency ENERGY STAR rated equipment. DOE estimated that for equipment not covered by ENERGY STAR, there is limited market demand for higher efficiency equipment, and the base case efficiency distribution would not change over time.

To estimate market behavior in the standards cases, DOE uses a "roll-up" scenario. Under the roll-up scenario, DOE assumes that equipment efficiencies in the base case that do not meet the standard level under consideration would "roll up" to meet the new standard level, and equipment efficiencies above the standard level under consideration would be unaffected.

To project trends in standards-case efficiency after the initial shift in the compliance year, DOE used the same assumptions as in the base case for equipment covered or not covered by ENERGY STAR.

The estimated efficiency trends in the base case and standards cases are further described in chapter 8 of the final rule TSD.

2. National Energy Savings

For each year in the forecast period, DOE calculates the NES for each potential standard level by multiplying the stock of equipment affected by the energy conservation standards by the estimated per-unit annual energy savings. DOE typically considers the impact of a rebound effect in its calculation of NES for a given product. A rebound effect occurs when users operate higher efficiency equipment more frequently and/or for longer durations, thus offsetting estimated energy savings. DOE did not incorporate a rebound factor for commercial refrigeration equipment because it is operated 24 hours a day, and therefore there is no potential for a rebound effect.

Major inputs to the calculation of NES are annual unit energy consumption, shipments, equipment stock, a site-to-primary energy conversion factor, and a full fuel cycle factor.

The annual unit energy consumption is the site energy consumed by a commercial refrigeration unit in a given year. Because the equipment classes analyzed represent equipment sold across a range of sizes, DOE's "unit" in the NES is actually expressed as a linear foot of equipment in an equipment class, and not an individual unit of commercial refrigeration equipment of a specific size. DOE determined annual forecasted shipment-weighted average equipment efficiencies that, in turn, enabled determination of shipment-weighted annual energy consumption values.

The NES spreadsheet model keeps track of the total linear footage of commercial refrigeration units shipped each year. The commercial refrigeration equipment stock in a given year is the total linear footage of commercial refrigeration equipment shipped from earlier years that is still in use in that year, based on the equipment lifetime.

To estimate the national energy savings expected from energy conservation standards, DOE uses a multiplicative factor to convert site energy consumption (energy use at the location where the appliance is operated) into primary or source energy consumption (the energy required to deliver the site energy). For today's final rule, DOE used conversion factors based on AEO 2013. For electricity, the conversion factors vary over time because of projected changes in generation sources (i.e., the types of power plants projected to provide electricity to the country). Because the AEO does not provide energy forecasts beyond 2040, DOE used conversion factors that remain constant at the 2040 values throughout the rest of the forecast.

DOE has historically presented NES in terms of primary energy savings. 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 Science, DOE announced its intention to use full-fuel-cycle (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) While DOE stated in that document that it intended to use the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model to conduct the analysis, it also said it would review alternative methods, including the use of NEMS. After evaluating both models and the approaches discussed in the August 18, 2011 document, DOE published a statement of amended policy in the Federal Register in which DOE explained its determination that NEMS is a more appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012).

The approach used for today's final rule, and the FFC multipliers that were applied, are described in appendix 10D of the final rule TSD. NES results are presented in both primary energy and FFC savings in section V.B.3.a.

3. Net Present Value of Customer Benefit

The inputs for determining the NPV of the total costs and benefits experienced by customers of the commercial refrigeration equipment are: (1) total annual installed cost; (2) total annual savings in operating costs; and (3) a discount factor. DOE calculated net national customer savings for each year as the difference between the base-case scenario and standards-case scenarios in terms of installation and operating costs. DOE calculated operating cost savings over the life of each piece of equipment shipped in the forecast period.

As discussed in section IV.F.1, DOE developed an equipment price trend for commercial refrigeration equipment based on the inflation-adjusted index of the PPI for air conditioning, refrigeration, and forced air heating from 1978 to 2012. A linear regression of the inflation-adjusted PPI shows a slight downward trend (see appendix 10D of the final rule TSD). To project a future trend over the analysis period, DOE extrapolated the historic trend using the regression results.

DOE multiplied monetary values in future years by the discount factor to determine the present value of costs and savings. DOE estimated national impacts using both a 3-percent and a 7-percent real discount rate as the average real rate of return on private investment in the U.S. economy. These discount rates are used in accordance with the Office of Management and Budget (OMB) guidance to Federal agencies on the development of regulatory analysis (OMB Circular A-4, September 17, 2003), and section E, "Identifying and Measuring Benefits and Costs," therein. The 7-percent rate is an estimate of the average before-tax rate of return on private capital in the U.S. economy, and reflects the returns on real estate and small business capital, including corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector because recent OMB analysis has found the average rate of return on capital to be near this rate. In addition, DOE used the 3-percent rate to capture the potential effects of amended standards on private consumption. This rate represents the rate at which society discounts future consumption flows to their present value. It can be approximated by the real rate of return on long-term government debt (i.e., yield on Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the last 30 years. DOE defined the present year as 2014 for the analysis.

I. Customer Subgroup Analysis

In analyzing the potential impact of new or amended standards on commercial customers, DOE evaluates the impact on identifiable groups (i.e., subgroups) of customers, such as different types of businesses that may be disproportionately affected. Small businesses typically face higher cost of capital. In general, the higher the cost of capital, the more likely it is that an entity would be disadvantaged by a requirement to purchase higher efficiency equipment. Based on data from the 2007 U.S. Economic Census and size standards set by the U.S. Small Business Administration (SBA), DOE determined that a majority of small grocery and convenience stores and restaurants fall under the definition of small businesses.

Comparing the small grocery and convenience store category to the convenience store with gas station category, both face the same cost of capital, but convenience stores with gas stations generally incur lower electricity prices, which would tend to render higher-efficiency equipment not cost-effective. To examine a "worst case" situation, convenience stores with gas stations were chosen for the subgroup analysis. Limited -service restaurants and full-service restaurants have similar electricity price and discount rates. DOE chose to study full-service restaurants for the subgroup analysis because a higher percentage of full-service restaurants tend to be operated by independent small businesses, as compared to limited -service (fast-food) restaurants. DOE believes that these two subgroups are broadly representative of small businesses that use CRE.

DOE estimated the impact on the identified customer subgroups using the LCC spreadsheet model. The input for business type was fixed to the identified subgroup, which ensured that the discount rates and electricity prices associated with only that subgroup were selected in the Monte Carlo simulations. The discount rate was further increased by applying the small firm premium to the WACC. In addition, DOE assumed that the subgroups do not have access to national purchasing accounts and, consequently, face a higher distribution channel markup. Apart from these changes, all other inputs for the subgroup analysis are the same as those in the LCC analysis. Details of the data used for the subgroup analysis and results are presented in chapter 11 of the final rule TSD.

The Society of American Florists stated that the percent of refrigerated product sold at retail by florists is higher than in other retail industries and that they would be particularly sensitive to an increase in equipment price. (SAF, No. 74 at p. 3) SAF suggested that DOE should conduct analyses for floriculture growers, wholesalers, and retail florists to determine the impact of amended standards on these end-users. (SAF, No. 74 at p. 7)

While the subgroups considered by DOE do not exactly correspond to florist-related businesses, DOE believes that the impacts experienced by the selected subgroups are indicative of the impacts that would be experienced by florist-related businesses. Thus, the analyses suggested by SAF are not warranted.

The National Restaurant Association suggested that DOE re-analyze the small business subgroups based on more accurate costs and equipment lifetime assumptions. (NRA, No. 90 at p. 2) DOE has used the best available data to estimate equipment costs and lifetime for the considered subgroups, so there would be no basis for re-analysis.

Mercatus stated that 26 percent of restaurants fail in their first year and by year three the rate of failure is just over 60 percent; therefore, it is not rational for these types of customers to purchase more efficient equipment before realizing a net benefit. (Mercatus, No. 72 at p. 3) DOE acknowledges that some CRE units may outlive the particular business that purchased them new, but the customer that purchases the used equipment would see the energy cost benefits of higher-efficiency equipment.

Several parties stated that higher equipment costs will induce small businesses to purchase used or refurbished equipment. The National Restaurant Association commented that an equipment cost increase of 15 to 20 percent will force small restaurants to purchase used or refurbished equipment. (NRA, No. 90 at p. 3) The Air Conditioning Contractors of America (ACCA) commented that small consumers would elect to extend the life of existing equipment rather than purchase new more expensive equipment. (ACCA, Public Meeting Transcript, No. 62 at pp. 343 - 44) True commented that individually owned restaurants would elect to purchase used equipment due to lower first cost instead of purchasing new, more efficient equipment. (True, Public Meeting Transcript, No. 62 at p. 208) Traulsen opined that smaller entities are more likely to keep existing equipment longer, and will be negatively affected by the proposed standard. (Traulsen, No. 65 at p. 19) Hoshizaki commented that the proposed standards will increase costs and deter small business owners from buying new equipment. (Hoshizaki, No. 84 at p. 1)

DOE acknowledges that some small businesses may respond to amended CRE standards by purchasing used or refurbished equipment. However, as discussed in section V.B.1.b, DOE did not have sufficient information to evaluate the likely extent of this response. The consumer subgroup results (shown in section V.B.1.b of this document) indicate that in nearly all cases the considered small business subgroups see higher average LCC savings and lower median payback periods when compared to all CRE customers. These results suggest that most small businesses would find it beneficial to purchase new commercial refrigeration equipment that meets today's standards.

J. Manufacturer Impact Analysis

1. Overview

DOE performed a MIA to estimate the financial impact of amended energy conservation standards on manufacturers of commercial refrigeration equipment and to understand the impact of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model with inputs specific to this rulemaking. The key GRIM inputs are data on the industry cost structure, product costs, shipments, and assumptions about markups and conversion expenditures. The key output is the INPV. Different sets of markup scenarios will produce different results. The qualitative part of the MIA addresses factors such as equipment characteristics, impacts on particular subgroups of manufacturers, and important market and product trends. 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 commercial refrigeration equipment industry that includes a top-down cost analysis of manufacturers used to derive preliminary financial inputs for the GRIM (e.g., sales general and administration (SG&A) expenses; research and development (R&D) expenses; and tax rates). DOE used public sources of information, including company SEC 10-K filings, corporate annual reports, the U.S. Census Bureau's Economic Census, and Hoover's reports.

In Phase 2 of the MIA, DOE prepared an industry cash-flow analysis to quantify the impacts of an amended energy conservation standard. In general, more-stringent energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) by creating a need for increased investment; (2) by raising production costs per unit; and (3) by altering revenue due to higher per-unit prices and possible changes in sales volumes.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with a representative cross-section of 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.

Additionally, in Phase 3, DOE 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. For example, small manufacturers, niche players, or manufacturers exhibiting a cost structure that largely differs from the industry average could be more negatively affected.

DOE identified one subgroup, small manufacturers, for separate impact analyses. DOE applied the small business size standards published by the SBA to determine whether a company is considered a small business. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (September 5, 2000) and codified at 13 CFR part 121. To be categorized as a small business under North American Industry Classification System (NAICS) 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing," a commercial refrigeration manufacturer and its affiliates may employ a maximum of 750 employees. The 750-employee threshold includes all employees in a business's parent company and any other subsidiaries. Based on this classification, DOE identified at least 32 commercial refrigeration equipment manufacturers that qualify as small businesses. The commercial refrigeration equipment small manufacturer subgroup is discussed in chapter 12 of the final rule TSD and in section I.A.1 of this document.

2. Government Regulatory Impact Model

DOE uses the GRIM to quantify the changes in the commercial refrigeration equipment industry cash flow due to amended standards that result in a higher or lower industry value. The GRIM analysis uses a standard, annual cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs, and models changes in costs, investments, and manufacturer margins that would result from new and amended energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning with the base year of the analysis, 2013 in this case, and continuing to 2046. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For commercial refrigeration equipment manufacturers, DOE used a real discount rate of 10 percent. DOE's discount rate estimate was derived from industry financials and then modified according to feedback during manufacturer interviews.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between a base case and various TSLs (the standards cases). The difference in INPV between the base case and a standards case represents the financial impact of the amended standard on manufacturers. As discussed previously, DOE collected the information on the critical GRIM inputs from a number of sources, including publicly available data and interviews with a number of manufacturers (described in the next section). The GRIM results are shown in section V.B.2.a. Additional details about the GRIM can be found in chapter 12 of the final rule TSD.

a. Government Regulatory Impact Model Key Inputs

Manufacturer Production Costs

Manufacturing a higher efficiency product is typically more expensive than manufacturing a baseline product due to the use of more complex components, which are more costly than baseline components. The changes in the MPCs of the analyzed products can affect the revenues, gross margins, and cash flow of the industry, making these product cost data key GRIM inputs for DOE's analysis.

In the MIA, DOE used the MPCs for each considered efficiency level calculated in the engineering analysis, as described in section IV.B and further detailed in chapter 5 of the NOPR TSD. In addition, DOE used information from its teardown analysis, described in section IV.D.4.a, to disaggregate the MPCs into material, labor, and overhead costs. To calculate the MPCs for equipment above the baseline, DOE added incremental material, labor, overhead costs from the engineering cost-efficiency curves to the baseline MPCs. These cost breakdowns and equipment markups were validated with manufacturers during manufacturer interviews.

Base-Case Shipments Forecast

The GRIM estimates manufacturer revenues based on total unit shipment forecasts and the distribution of these values 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 forecasts derived from the shipments analysis from 2013, the base year, to 2046, the end of the analysis period. See chapter 9 of the final rule TSD for additional details.

Product and Capital Conversion Costs

Amended energy conservation standards will cause manufacturers to incur conversion costs to bring their production facilities and product designs into compliance. For the MIA, DOE classified these conversion costs into two major groups: (1) product conversion costs and (2) capital conversion costs. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with a new or amended energy conservation standard. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new product designs can be fabricated and assembled.

To evaluate the level of capital conversion expenditures manufacturers would likely incur to comply with amended energy conservation standards, DOE used manufacturer interviews to gather data on the level of capital investment required at each efficiency level. DOE validated manufacturer comments through estimates of capital expenditure requirements derived from the product teardown analysis and engineering model described in section IV.D.4. Further adjustments were made to capital conversion costs based on feedback in the NOPR written comments. The key driver of capital conversion costs was new production equipment associated with improving cabinet insulation.

DOE assessed the product conversion costs at each level by integrating data from quantitative and qualitative sources. DOE considered feedback regarding the potential costs of each efficiency level from multiple manufacturers to determine conversion costs such as R&D expenditures and certification costs. Manufacturer data were aggregated to better reflect the industry as a whole and to protect confidential information. For the final rule, adjustments were made to product conversion costs based on feedback in the NOPR written comments submitted following the NOPR. Key drivers of product conversion costs included the re-design effort associated with modifying cabinets to incorporate improved cabinet insulation, along with the product and food safety certification costs associated with redesigning key equipment components.

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

b. Government Regulatory Impact Model Scenarios

Markup Scenarios

As discussed above, MSPs include direct manufacturing production costs (i.e., labor, material, 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 markups to the MPCs estimated in the engineering analysis and then added in the cost of shipping. Modifying these markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case markup scenarios to represent the 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 markup scenario; and (2) a preservation of operating profit markup scenario. These scenarios lead to different markups values that, when applied to the inputted MPCs, result in varying revenue and cash flow impacts.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform "gross margin percentage" markup across all efficiency levels. As production costs increase with efficiency, this scenario implies that the absolute dollar markup will increase as well. Based on publicly available financial information for manufacturers of commercial refrigeration equipment and comments from manufacturer interviews, DOE assumed the non-production cost markup—which includes SG&A expenses, R&D expenses, interest, and profit—to be 1.42. Because this markup scenario assumes that manufacturers would be able to maintain their gross margin percentage markups as production costs increase in response to an amended energy conservation standard, the scenario represents a high bound to industry profitability under an amended energy conservation standard.

In the preservation of operating profit scenario, manufacturer markups are set so that operating profit 1 year after the compliance date of the amended energy conservation standard is the same as in the base case. Under this scenario, as the cost of production and the cost of sales go up, manufacturers are generally required to reduce their markups to a level that maintains base-case operating profit. The implicit assumption behind this markup scenario is that the industry can only maintain its operating profit in absolute dollars after compliance with the amended standard is required. Therefore, operating margin in percentage terms is squeezed (reduced) between the base case and standards case. DOE adjusted the manufacturer markups in the GRIM at each TSL to yield approximately the same earnings before interest and taxes in the standards case in the year after the compliance date of the amended standards as in the base case. This markup scenario represents a low bound to industry profitability under an amended energy conservation standard.

3. Discussion of Comments

During the NOPR public meeting, interested parties commented on the assumptions and results of the analyses as described in the TSD. Oral and written comments addressed several topics, including volume purchasing of components, refrigerants, redesign issues, LED material costs, the GRIM, foaming fixtures, cumulative regulatory burden, certification costs, and issues specific to small manufacturers.

a. Volume Purchasing of Components

Traulsen commented that the prices of high-efficiency condenser fan motors were higher than DOE stated, and that this would place a cost burden on small manufacturers who could not receive a purchase volume discount. (Traulsen, No. 65 at p. 4) DOE recognizes that small manufacturers face pricing disadvantages for key components in both the base case and the standards case. This issue is incorporated into the discussion of Regulatory Flexibility in section VI.B.2 of this final rule.

b. Refrigerants

True commented that there was the potential for a substantial cost increase to manufacturers in the very near future due to the phasing out of HFCs. True further commented that new refrigerants may have an incremental cost of 5-10 times over what is currently being paid for refrigerants. (True, Public Meeting Transcript, No. 62 at p. 279) The use of alternative refrigerants by manufacturers of commercial refrigeration equipment would not arise as a direct result of this rule, and thus was not considered in this analysis. Furthermore, there is no requirement mandating the use of alternative refrigerants at this time. DOE does not include the impacts of pending legislation or unfinalized regulations in its analyses, as any impact would be speculative.

c. Redesign Issues

Several manufacturers pointed out that high capital costs were required by the proposed standards. Traulsen asserted that up to 95% of all equipment would need to be redesigned as a result of the proposed standard. (Traulsen, No. 62 at p. 315) True added that the cost of redesigning and retooling entire product lines, and including the costs of new refrigerants, would be cost prohibitive. (True, No. 62 at p. 341) With regard to the specific cost of replacing foaming fixtures, True commented that new fixtures could cost several hundred thousand dollars, and modifying fixtures in order to manufacture thicker foam panels could cost $40,000-$50,000 per fixture, while Southern Store Fixtures noted that it would have to change over 3,000 molds and 1,000 foaming fixtures for its entire product line, and that it would cost much more than the assumed $2,500,000. (True, No. 62 at p. 340)(SSF, No. 67 at p. 3)

With regard to capital costs, True commented that switching from double-pane to triple pane glass would require new tooling and molds for manufacturing, costing up to $300,000 per door model produced, and that if the interior volume of a unit were to change due to thicker foam, all shelving systems and weld fixtures would need to be redesigned. (True, No. 76 at p. 3) Furthermore, Traulsen commented that changing fixture depth would cause a change in production time per unit, and that this cost had not been reflected in the DOE analysis. (Traulsen, No. 65 at p. 9) Similarly, Hussmann commented that there was a substantial engineering cost associated with re-engineering case components in order to incorporate increased foam thickness. Specifically, Hussmann noted that in order to maintain outside dimensions of a case and increase insulation thickness, manufacturers would be required to redesign and retool every component based on the case's internal dimensions. (Hussmann, No. 77 at p. 2) Hoshizaki, also expressed the same concern, adding that that DOE underestimated the cost associated with increasing foam thickness by 1/2", since this increase would require engineering, testing, tooling, production line changeover, down-time, packaging changes, and certification. (Hoshizaki, No. 84 at p. 2)

DOE estimated the conversion costs associated with increases in foam thickness based on direct input from the industry in interviews, as well as through analysis of production equipment that is part of the engineering cost model. DOE's analysis included capital conversion costs, including as tooling costs and production line upgrades, and product conversion costs, including redesign efforts, testing costs, industry certifications, and marketing changes. Differences in packing and shipping costs were also accounted for in the shipping cost component of the engineering analysis.

In its NOPR analysis, DOE recognized the need for new foaming fixtures to accommodate thicker panels. However, for the final rule analysis, DOE revised its estimate of fixture investment for the entire CRE industry upward to $210 million.

At the NOPR stage, the MIA analysis did not associate a conversion cost with changes in display door designs based on DOE's understanding that the vast majority of CRE manufacturers consider display doors to be purchased parts. Furthermore, in the final rule engineering analysis, DOE does not consider triple-pane display doors as a design option in its analysis. However, for the final rule, DOE updated its manufacturer impact analysis to account for the conversion costs associated with changes in door design and specification, such as moving from single-pane to double-pane for horizontal cases with transparent doors.

d. LED Material Costs

Structural Concepts commented that the implementation of LEDs would cost over $500,000 annually in material costs alone. (Structural Concepts, No. 85 at p. 3) DOE agrees with Structural Concepts that some design options, such as LED lighting, require larger upfront investments in component inventory by manufacturers. DOE accounts for investment in more expensive components and greater amounts of raw materials as increases in working capital. Increases in working capital decrease free cash flow and are reflected in industry net present value (INPV), which DOE considers as a key input when selecting a standard level.

e. GRIM

AHRI asserted that the GRIM model should account for periodic revisions to energy standards and potential changes in refrigerant policy when estimating the INPV. (AHRI, No. 75 at p. 11) Additionally, AHRI commented that, since the GRIM predicts INPV across an extended period, the model should have accounted for impacts on manufacturers due to periodic revisions of energy conservation standards and potential changes to refrigerant policy, and that the INPV range at TSL4 was grossly underestimated since there will likely be up to five revisions to CRE standards by 2046. (AHRI, No. 75 at p. 13) However, DOE does not take unfinalized regulation into account in its analysis. Any forecast of amendments to the standard level in the future and the potential costs of those changes would be purely speculative and, therefore, outside the scope of analysis.

f. Cumulative Regulatory Burden

Traulsen commented that the cost burden to manufacturers of complying with both the 2009 and 2017 rules, which overlap, is unmanageable. (Traulsen, No. 65 at p. 22) Lennox also stated that the proposed standards would place significant cumulative regulatory burden on manufacturers. (Traulsen, No. 65 at p. 9)

DOE defines cumulative regulatory burden (CRB) as regulations that go into effect within 3 years of the effective date of the standard under consideration. As a result, the 2009 amended standard is not one of the regulations listed in the CRB analysis in section V.B.2.e of this document. However, the market changes and equipment price impacts that resulted from the 2009 standard are incorporated into DOE's analyses.

g. Certification Costs

AHRI commented that the implementation of higher efficiency compressors should include costs associated with safety certification (UL, etc.), compliance with NSF Standards, and recertification due to the induced change in the equipment performance. (AHRI, No. 75 at p. 13) In its NOPR and final rule analyses, DOE accounted for the UL and NSF certification costs associated with compressor changes. While UL and NSF certification costs can vary by manufacturers, DOE used an industry average combined cost of $8,000 per model for those certifications in its final rule analysis.

h. Small Manufacturers

In its written comment, Traulsen expressed the opinion that the proposed rule would have a significant economic impact on a substantial number of small businesses and was therefore in violation of the Regulatory Flexibility Act. In particular, Traulsen drew attention to page 55983, column 2 of the Federal Register NOPR document, which stated that DOE could not certify that the proposed standards would not have a significant impact on a significant number of small businesses. (Traulsen, No. 65 at p.16) The George Washington University (GWU) also asserted in its comment that the proposed rule affected small businesses – both manufacturers and consumers – since it did not maintain flexibility and freedom of choice. (GWU, No. 66 at p. 11) To better understand the potential impact of the final rule on small businesses, DOE provides an assessment of the impacts on small manufacturers in section VI.B.

K. Emissions Analysis

In the emissions analysis, DOE estimated the reduction in power sector emissions of CO_2, NO_x, sulfur dioxide (SO_2) and Hg from amended energy conservation standards for commercial refrigeration equipment. In addition, DOE estimates emissions impacts in production activities (extracting, processing, and transporting fuels) that provide the energy inputs to power plants. These are referred to as "upstream" emissions. Together, these emissions account for the full-fuel-cycle (FFC). In accordance with DOE's FFC Statement of Policy (76 FR 51282 (August 18, 2011)) 77 FR 49701 (August 17, 2012), the FFC analysis includes impacts on emissions of methane (CH_4) and nitrous oxide (N_2O), both of which are recognized as greenhouse gases.

DOE primarily conducted the emissions analysis using emissions factors for CO_2 and most of the other gases derived from data in AEO 2013, supplemented by data from other sources. DOE developed separate emissions factors for power sector emissions and upstream emissions. The method that DOE used to derive emissions factors is described in chapter 13 of the final rule TSD.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of carbon dioxide equivalent (CO_2eq). Gases are converted to CO_2eq by multiplying the physical units by the gas' global warming potential (GWP) over a 100 year time horizon. Based on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,[62] DOE used GWP values of 25 for CH_4 and 298 for N_2O.

EIA prepares the Annual Energy Outlook using the National Energy Modeling System (NEMS). Each annual version of NEMS incorporates the projected impacts of existing air quality regulations on emissions. AEO 2013 generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2012.

[62] Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn,G. Raga, M. Schulz and R. Van Dorland. 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller, Editors. 2007. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p. 212.

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 (42 U.S.C. 7651 et seq.) and the District of Columbia (D.C.). SO_2 emissions from 28 eastern States and D.C. were also limited under the Clean Air Interstate Rule (CAIR; 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program. CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia but it remained in effect.[63] See North Carolina v. EPA, 550 F.3d 1176 (D.C. Cir. 2008); North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008). In 2011, EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). On August 21, 2012, the D.C. Circuit issued a decision to vacate CSAPR.[64] The court ordered EPA to continue administering CAIR. The AEO 2013 emissions factors used for today's final rule assume that CAIR remains a binding regulation through 2040.

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of a new or amended efficiency standard could be used to allow offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing

[63] See North Carolina v. EPA, 550 F.3d 1176 (D.C. Cir. 2008); North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008).
[64] See EME Homer City Generation, LP v. EPA, 696 F.3d 7, 38 (D.C. Cir. 2012), cert. granted, 81 U.S.L.W. 3567, 81 U.S.L.W. 3696, 81 U.S.L.W. 3702 (U.S. June 24, 2013) (No. 12-1182).

cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning around 2015, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (February 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. AEO2013 assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2015. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, NEMS shows a reduction in SO_2 emissions when electricity demand decreases (e.g., as a result of energy efficiency standards). Emissions will be far below the cap that would be established by CAIR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to allow offsetting increases in SO_2 emissions by any regulated EGU. Therefore, DOE believes that energy efficiency standards will reduce SO_2 emissions in 2015 and beyond.

CAIR established a cap on NO_x emissions in 28 eastern States and the District of Columbia. Energy conservation standards are expected to have little effect on NO_x emissions in those States covered by CAIR because excess NO_x emissions allowances resulting from the lower electricity demand could be used to allow offsetting increases in NO_x emissions. However, standards would be expected to reduce NO_x emissions in the States not affected by the caps, so DOE estimated NO_x emissions reductions from the standards considered in today's final rule for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would likely reduce Hg emissions. DOE estimated mercury emissions factors based on AEO2013, which incorporates the MATS.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of the standards in this final rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_x 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 customer benefit, DOE considered the reduced emissions expected to result over the lifetime of equipment shipped in the forecast period for each TSL. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this final rule.

For today's final rule, DOE is relying on a set of values for the SCC that was developed by a Federal interagency process. The basis for these values is summarized below, and a more detailed description of the methodologies used is provided as an appendix to chapter 14 of the final rule TSD.

1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of carbon dioxide. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b) of Executive Order 12866, agencies must, to the extent permitted by law, "assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

As part of the interagency process that developed these SCC estimates, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of challenges. A report from the National Research Council[65] points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) future emissions of GHGs, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise questions of science, economics, and ethics and should be viewed as provisional.

Despite the limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing CO_2 emissions. The agency can estimate the benefits

[65] National Research Council. Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use. 2009. National Academies Press: Washington, DC.

from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SCC values appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Development of Social Cost of Carbon Values

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across Federal agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006$) of $55, $33, $19, $10, and $5 per metric ton of CO_2. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules.

c. Current Approach and Key Assumptions

After the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. Specially, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: the FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change (IPCC). Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models, while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three IAMs, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, was included to represent higher than expected impacts from temperature change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects,[66] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV.4 presents the values in the 2010 interagency group report,[67] which is reproduced in appendix 14A of the DOE final rule TSD.

Table IV.4 Annual SCC Values from 2010 Interagency Report, 2010–2050 (2007 dollars per metric ton)

Year	Discount Rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

[66] It is recognized that this calculation for domestic values is approximate, provisional, and highly speculative. There is no a priori reason why domestic benefits should be a constant fraction of net global damages over time.
[67] Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government, February 2010. www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

The SCC values used for today's document were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.[68] Table IV.5 shows the updated sets of SCC estimates in 5-year increments from 2010 to 2050. The full set of annual SCC estimates between 2010 and 2050 is reported in appendix 14B of the DOE final rule TSD. The central value that emerges is the average SCC across models at the 3 percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

Table IV.5 Annual SCC Values from 2013 Interagency Report, 2010–2050 (2007 dollars per metric ton)

Year	Discount Rate			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
2010	11	32	51	89
2015	11	37	57	109
2020	12	43	64	128
2025	14	47	69	143
2030	16	52	75	159
2035	19	56	80	175
2040	21	61	86	191
2045	24	66	92	206
2050	26	71	97	220

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the

[68] Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government. May 2013; revised November 2013.
http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf

existing models are imperfect and incomplete. The 2009 National Research Council report mentioned above points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of analytic challenges that are being addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

In summary, in considering the potential global benefits resulting from reduced CO_2 emissions, DOE used the values from the 2013 interagency report adjusted to 2012$ using the GDP price deflator. For each of the four sets of SCC values, the values for emissions in 2015 were $11.8, $39.7, $61.2, and $117 per metric ton avoided (values expressed in 2012$). DOE derived values after 2050 using the relevant growth rates for the 2040-2050 period in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

In responding to the NOPR, many commenters questioned the scientific and economic basis of the SCC values. These commenters made extensive comments about: the alleged lack of economic theory underlying the models; the sufficiency of the models for policy-making; potential flaws in the models' inputs and assumptions (including the discount rates and climate sensitivity chosen); whether there had been adequate peer review of the three models; whether there had been adequate peer review of the interagency TSD supporting the 2013 SCC values;[69] whether the SCC estimates comply with OMB's "Final Information Quality Bulletin for Peer Review"[70] and DOE's own guidelines for ensuring and maximizing the quality, objectivity, utility and integrity of information disseminated by DOE; and why DOE is considering global benefits of carbon dioxide emission reductions rather than solely domestic benefits. (See AHRI, No. 75; Joint Comment from America's Natural Gas Alliance, the American Chemistry Council, the American Petroleum Institute, the National Association of Home Builders, the National Association of Manufacturers, the Portland Cement Association, and the U.S. Chamber of Commerce (ANGA et al/Chamber of Commerce), No. 79; Cato Institute (Cato), No. 69; EEI, No. 89; GWU, No. 66; Mercatus, No. 72; NRECA, No. 88; Traulsen, No. 65. Several other parties expressed support for the derivation and application of the SCC values. (Joint Comment from the Environmental Defense Fund, Institute for Policy Integrity, Natural Resources Defense Council, and the Union of Concerned Scientists, No. 83; ASAP, No. 91; Kopp, No. 60)

[69] Available at: http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf

[70] Available at: http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf

In response to the comments on the SCC values, DOE acknowledges the limitations in the SCC estimates, which are discussed in detail in the 2010 interagency group report. Specifically, uncertainties in the assumptions regarding climate sensitivity, as well as other model inputs such as economic growth and emissions trajectories, are discussed and the reasons for the specific input assumptions chosen are explained. Regarding discount rates, there is not consensus in the scientific or economics literature regarding the appropriate discount rate to use for intergenerational time horizons. The SCC estimates thus use a reasonable range of discount rates, from 2.5% to 5%, in order to show the effects that different discount rate assumptions have on the estimated values. More information about the choice of discount rates can be found in the 2010 interagency group report starting on page 17.

Regarding peer review of the models, the three integrated assessment models used to estimate the SCC are frequently cited in the peer-reviewed literature and were used in the last assessment of the IPCC. In addition, new versions of the models that were used in 2013 to estimate revised SCC values were published in the peer-reviewed literature (see appendix 14B of the DOE final rule TSD for discussion).

DOE believes that the SCC estimates comply with OMB's Final Information Quality Bulletin for Peer Review and DOE's own guidelines for ensuring and maximizing the quality, objectivity, utility and integrity of information disseminated by DOE.[71]

[71] https://www.directives.doe.gov/references/secretarial_policy_statement_on_scientific_integrity/view

As to why DOE is considering global benefits of carbon dioxide emission reductions rather than solely domestic benefits, a global measure of SCC because of the distinctive nature of the climate change problem, which is highly unusual in at least two respects. First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Second, climate change presents a problem that the United States alone cannot solve. The issue of global versus domestic measures of the SCC is further discussed in appendix 14A of the DOE final rule TSD.

AHRI stated that DOE calculates the present value of the costs of standards to consumers and manufacturers over a 30-year period, but the SCC values reflect the present value of future climate related impacts well beyond 2100. AHRI stated that DOE's comparison of 30 years of cost to hundreds of years of presumed future benefits is inconsistent and improper. (AHRI, No. 84 at p. 12)

For the analysis of national impacts of the proposed standards, DOE considered the lifetime impacts of equipment shipped in a 30-year period. With respect to energy and energy cost savings, impacts continue past 30 years until all of the equipment shipped in the 30-year period is retired. With respect to the valuation of CO_2 emissions reductions, the SCC estimates developed by the interagency working group are meant to represent the full discounted value (using an appropriate range of discount rates) of emissions reductions occurring in a given year. DOE is thus comparing the costs of achieving the emissions reductions in each year of the analysis, with the carbon reduction value of the emissions reductions in those same years.

Neither the costs nor the benefits of emissions reductions outside the analytic time frame are included in the analysis.

In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. See 78 FR 70586. The comment period for the OMB announcement closed on February 26, 2014. OMB is currently reviewing comments and considering whether further revisions to the 2013 SCC estimates are warranted. DOE stands ready to work with OMB and the other members of the interagency working group on further review and revision of the SCC estimates as appropriate.

2. Valuation of Other Emissions Reductions

DOE investigated the potential monetary benefit of reduced NO_x emissions from the potential standards it considered. As noted above, DOE has taken into account how new or amended energy conservation standards would reduce NO_x emissions in those 22 States not affected by emissions caps. DOE estimated the monetized value of NO_x emissions reductions resulting from each of the TSLs considered for today's final rule based on estimates found in the relevant scientific literature. Estimates of monetary value for reducing NO_x from stationary sources range from $468 to $4,809 per ton (2012$).[72] DOE calculated monetary benefits using a

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

medium value for NO_X emissions of $2,639 per short ton (in 2012$), and real discount rates of 3 percent and 7 percent.

DOE is evaluating appropriate monetization of avoided SO_2 and Hg emissions in energy conservation standards rulemakings. It has not included monetization in the current analysis.

M. Utility Impact Analysis

The utility impact analysis estimates several important effects on the utility industry of the adoption of new or amended standards. For this analysis, DOE used the National Energy Modeling System - Building Technologies (NEMS-BT)[73] model to generate forecasts of electricity consumption, electricity generation by plant type, and electric generating capacity by plant type, that would result from each considered TSL. DOE obtained the energy savings inputs associated with efficiency improvements to considered products from the NIA. DOE conducts the utility impact analysis as a scenario that departs from the latest AEO Reference Case. In the analysis for today's rule, the estimated impacts of standards are the differences between values forecasted by NEMS-BT and the values in the AEO2013 Reference Case. For more details on the utility impact analysis, see chapter 15 of the final rule TSD.

[73] The EIA allows the use of the name "NEMS" to describe only an AEO version of the model without any modification to code or data. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from AEO assumptions, the name "NEMS-BT" refers to the model as used here. For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (98) (Feb.1998), available at: http://tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf.

N. Employment Impact Analysis

Employment impacts are one of the factors that DOE considers in selecting an efficiency standard. Employment impacts include direct and indirect impacts. Direct employment impacts are any changes that affect employment of commercial refrigeration equipment manufacturers, their suppliers, and related service firms. Indirect impacts are those changes in employment in the larger economy which occur because of the shift in expenditures and capital investment caused by the purchase and operation of more-efficient commercial refrigeration equipment. Direct employment impacts are analyzed as part of the MIA. Indirect impacts are assessed as part of the employment impact analysis.

Indirect employment impacts from amended commercial refrigeration equipment standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, as a consequence of (1) reduced spending by end users on electricity; (2) reduced spending on new energy supply by the utility industry; (3) increased spending on the purchase price of new commercial refrigeration equipment; and (4) the effects of those three factors throughout the Nation's economy. DOE expects the net monetary savings from amended standards to stimulate other forms of economic activity. DOE also expects these shifts in spending and economic activity to affect the demand for labor.

In developing this analysis for today's standard, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy, called ImSET (Impact of Sector Energy Technologies), developed by DOE's Building Technologies Program. ImSET is an economic analysis model that characterizes the interconnections among 188 sectors of the economy as national input/output structural matrices, using data from the U.S. Department of Commerce's 1997 Benchmark U.S. input/output table.[74] The ImSET model estimates changes in employment, industry output, and wage income in the overall U.S. economy resulting from changes in expenditures in various sectors of the economy. DOE estimated changes in expenditures using the NIA model. ImSET then estimated the net national indirect employment impacts that amended commercial refrigeration equipment efficiency standards could have on employment by sector.

For more details on the employment impact analysis and its results, see chapter 16 of the TSD.

V. Analytical Results

A. Trial Standard Levels

1. Trial Standard Level Formulation Process and Criteria

Based on the results of the LCC analysis and NIA, DOE selected five TSLs above the baseline level for each equipment class for the final rule. TSL 5 was selected at the max-tech level for all equipment classes. TSL 4 was chosen so as to group the efficiency levels with the highest energy savings combined with a positive customer NPV at a 7-percent discount rate. TSL 3 was chosen to represent the group of efficiency levels with the highest customer NPV at a 7-

[74] U.S. Department of Commerce, Bureau of Economic Analysis. Benchmark Input-Output Accounts. 1997. U.S. Government Printing Office: Washington, DC.

percent discount rate. . TSL 2 and TSL 1 were chosen to provide intermediate efficiency levels that fill the gap between the baseline efficiency levels and TSL 3.

For the HCT.SC.I, HZO.RC.M, and HZO.RC.L equipment classes, there is only one efficiency level above baseline. For the HZO.SC.L equipment class, there are no efficiency levels above baseline, because there was only one analytical design analyzed engineering analysis compliant with the 2009 final rule. While TSL 5 was associated with the max-tech level for HCT.SC.I, HZO.RC.M, and HZO.RC.L equipment classes, TSLs 1 through 4 did not have corresponding efficiency levels that satisfied the TSL formulation criteria. Therefore, the baseline efficiency level was assigned to TSL 1 through TSL 4 for each of these equipment classes. Table V.1 shows the mapping between TSLs and efficiency levels.

Table V.1 Mapping Between TSLs and Efficiency Levels

Equipment Class	**Intermediate Level**	**Intermediate Level**	**Max NPV***	**Max NES NPV* > 0-†**	**Max-tech**
	TSL 1	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
VOP.RC.M	Baseline	Baseline	EL 1	EL 3	EL 4
VOP.RC.L	Baseline	Baseline	EL 1	EL 2	EL 3
VOP.SC.M	Baseline	Baseline	Baseline	EL 1	EL 2
VCT.RC.M	Baseline	Baseline	EL 1	EL 3	EL 4
VCT.RC.L	EL 1	EL 1	EL 2	EL 3	EL 4
VCT.SC.M	EL 1	EL 2	EL 3	EL 5	EL 7
VCT.SC.L	EL 1	EL 3	EL 5	EL 7	EL 7
VCT.SC.I	EL 1	EL 1	EL 1	EL 3	EL 4
VCS.SC.M	EL 1	EL 2	EL 4	EL 6	EL 7
VCS.SC.L	EL 1	EL 3	EL 5	EL 6	EL 7
VCS.SC.I	EL 1	EL 2	EL 4	EL 4	EL 5
SVO.RC.M	EL 1	EL 1	EL 1	EL 3	EL 4
SVO.SC.M	Baseline	Baseline	Baseline	EL 1	EL 3
SOC.RC.M	Baseline	Baseline	Baseline	EL 1	EL 4
SOC.SC.M	Baseline	Baseline	Baseline	EL 2	EL 4
HZO.RC.M	Baseline	Baseline	Baseline	Baseline	EL 1

HZO.RC.L	Baseline	Baseline	Baseline	Baseline	EL 1
HZO.SC.M	Baseline	EL 1	EL 1	EL 2	EL 3
HZO.SC.L	Baseline	Baseline	Baseline	Baseline	Baseline
HCT.SC.M	EL 2	EL 3	EL 4	EL 6	EL 7
HCT.SC.L	EL 2	EL 3	EL 4	EL 6	EL 7
HCT.SC.I	Baseline	Baseline	Baseline	Baseline	EL 1
HCS.SC.M	EL 1	EL 2	EL 3	EL 4	EL 6
HCS.SC.L	EL 1	EL 2	EL 3	EL 5	EL 6
PD.SC.M	EL 1	EL 2	EL 3	EL 4	EL 7

*NPV is estimated at a 7 percent discount rate

2. Trial Standard Level Equations

Because of the equipment size variation within each equipment class and the use of daily energy consumption as the efficiency metric, DOE developed a methodology to express efficiency standards in terms of a normalizing metric. DOE used two normalizing metrics that were each used for certain equipment classes: (1) volume (V), and (2) total display area (TDA). The use of these two normalization metrics allows for the development of a standard in the form of a linear equation that can be used to represent the entire range of equipment sizes within a given equipment class.

DOE retained the respective normalization metric (TDA or volume) previously used in the EPACT 2005, AEMTCA, or January 2009 final rule standard for each covered equipment class. (42 U.S.C. 6313(c)(2)–(3)); 74 FR at 1093 (January 9, 2009). Additionally, for its January 2009 final rule, DOE developed offset factors as a method to adjust the energy efficiency requirements for smaller equipment in each equipment class analyzed. These offset factors, which form the y-intercept on a plot of each standard level equation (representing a limit case of zero volume or zero TDA), accounted for certain components of the refrigeration load (such as conduction end effects) that remain constant even when equipment sizes vary. These constant loads affect smaller cases disproportionately. The offset factors were intended to approximate these constant loads and provide a fixed end point in an equation that describes the relationship between energy consumption and the corresponding normalization metric. 74 FR at 1118–19 (January 9, 2009). The standard level equations prescribed by EPACT 2005 also contained similar fixed parts not multiplied by the volume metric and which correspond to these offset factors. (42 U.S.C. 6313(c)(2)) In this final rule, DOE retained the January 2009 final rule offset factors at all TSLs, and updated those included in the EPACT 2005 standards to reflect size-based trends in energy consumption for each equipment class. See chapter 5 of the TSD for further details and discussion of offset factors.

For the equipment classes covered under this rulemaking, the standards equation at each TSL is presented in the form of MDEC (in kilowatt-hours per day), normalized by a volume (V) or TDA metric, with an offset factor added to that value. These equations take the form:

MDEC = A x TDA + B (for equipment using TDA as a normalizing metric)

or

MDEC = A x V + B (for equipment using volume as a normalizing metric)

The standards equations may be used to prescribe the MDEC for equipment of different sizes within the same equipment class. Chapter 9 of the final rule TSD explains the methodology used for selecting TSLs and developing the coefficients shown in Table V.3.

Table V.2 CDEC Values by TSL for Representative Units Analyzed in the Engineering Analysis for Each Primary Equipment Class

Equipment Class	CDEC Values by TSL kWh/day				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	46.84	46.84	38.02	36.1	35.65
VOP.RC.L	105.6	105.6	104.94	101.70	100.01
VOP.SC.M	30.01	30.01	30.01	29.91	29.71
VCT.RC.M	13.65	13.65	11.8	11.49	10.99
VCT.RC.L	35.34	35.34	34.78	34.50	33.04
VCT.SC.M	6.83	5.99	5.64	5.45	5.15
VCT.SC.L	27.46	18.23	17.16	16.05	16.05
VCT.SC.I	19.52	19.52	19.52	18.95	18.11
VCS.SC.M	5.29	4.03	3.69	3.45	3.03
VCS.SC.L	13.94	12.94	12.19	12.08	11.13
VCS.SC.I	18.70	18.01	17.43	17.43	16.04
SVO.RC.M	29.45	29.45	29.45	28.01	27.70
SVO.SC.M	26.32	26.32	26.32	25.65	25.4
SOC.RC.M	22.74	22.74	22.74	22.31	21.56
SOC.SC.M	27.72	27.72	27.72	26.61	26.12
HZO.RC.M	14.47	14.47	14.47	14.47	14.15
HZO.RC.L	32.36	32.36	32.36	32.36	31.08
HZO.SC.M	14.66	14.16	14.16	14.02	13.75
HZO.SC.L	29.92	29.92	29.92	29.92	29.92
HCT.SC.M	1.62	0.99	0.90	0.79	0.61
HCT.SC.L	2.15	2.03	1.92	1.73	1.32
HCT.SC.I	3.13	3.13	3.13	3.13	2.33
HCS.SC.M	1.42	1.36	1.28	1.26	0.98
HCS.SC.L	1.78	1.67	1.53	1.29	0.71
PD.SC.M	4.73	3.90	3.78	3.75	3.41

Table V.3 Equations Representing the Standards at Each TSL for All Primary Equipment Classes

Equipment Class	Trial Standard Levels for Primary Equipment Classes Analyzed					
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.82 x TDA + 4.07	0.8 x TDA + 4.07	0.8 x TDA + 4.07	0.64 x TDA + 4.07	0.6 x TDA + 4.07	0.59 x TDA + 4.07
VOP.RC.L	2.27 x TDA + 6.85	2.21 x TDA + 6.85	2.21 x TDA + 6.85	2.2 x TDA + 6.85	2.12 x TDA + 6.85	2.09 x TDA + 6.85
VOP.SC.M	1.74 x TDA + 4.71	1.69 x TDA + 4.71	1.69 x TDA + 4.71	1.69 x TDA + 4.71	1.69 x TDA + 4.71	1.67 x TDA + 4.71
VCT.RC.M	0.22 x TDA + 1.95	0.18 x TDA + 1.95	0.18 x TDA + 1.95	0.15 x TDA + 1.95	0.15 x TDA + 1.95	0.14 x TDA + 1.95

VCT.RC.L	0.56 x TDA + 2.61	0.5 x TDA + 2.61	0.5 x TDA + 2.61	0.49 x TDA + 2.61	0.49 x TDA + 2.61	0.47 x TDA + 2.61
VCT.SC.M	0.12 x V + 3.34	0.1 x V + 2.05	0.1 x V + 1.21	0.1 x V + 0.86	0.1 x V + 0.68	0.1 x V + 0.38
VCT.SC.L	0.75 x V + 4.1	0.48 x V + 4.1	0.29 x V + 4.1	0.29 x V + 2.95	0.29 x V + 1.84	0.29 x V + 1.84
VCT.SC.I	0.67 x TDA + 3.29	0.62 x TDA + 3.29	0.62 x TDA + 3.29	0.62 x TDA + 3.29	0.6 x TDA + 3.29	0.57 x TDA + 3.29
VCS.SC.M	0.1 x V + 2.04	0.07 x V + 2.04	0.05 x V + 1.69	0.05 x V + 1.36	0.05 x V + 1.11	0.05 x V + 0.7
VCS.SC.L	0.4 x V + 1.38	0.26 x V + 1.38	0.24 x V + 1.38	0.22 x V + 1.38	0.22 x V + 1.38	0.2 x V + 1.38
VCS.SC.I	0.38 x V + 0.88	0.37 x V + 0.88	0.36 x V + 0.88	0.34 x V + 0.88	0.34 x V + 0.88	0.32 x V + 0.88
SVO.RC.M	0.83 x TDA + 3.18	0.66 x TDA + 3.18	0.66 x TDA + 3.18	0.66 x TDA + 3.18	0.62 x TDA + 3.18	0.61 x TDA + 3.18
SVO.SC.M	1.73 x TDA + 4.59	1.7 x TDA + 4.59	1.7 x TDA + 4.59	1.7 x TDA + 4.59	1.65 x TDA + 4.59	1.63 x TDA + 4.59
SOC.RC.M	0.51 x TDA + 0.11	0.44 x TDA + 0.11	0.44 x TDA + 0.11	0.44 x TDA + 0.11	0.44 x TDA + 0.11	0.42 x TDA + 0.11
SOC.SC.M	0.6 x TDA + 1	0.52 x TDA + 1	0.52 x TDA + 1	0.52 x TDA + 1	0.5 x TDA + 1	0.49 x TDA + 1
HZO.RC.M	0.35 x TDA + 2.88	0.35 x TDA + 2.88	0.35 x TDA + 2.88	0.35 x TDA + 2.88	0.35 x TDA + 2.88	0.34 x TDA + 2.88
HZO.RC.L	0.57 x TDA + 6.88	0.55 x TDA + 6.88	0.55 x TDA + 6.88	0.55 x TDA + 6.88	0.55 x TDA + 6.88	0.53 x TDA + 6.88
HZO.SC.M	0.77 x TDA + 5.55	0.76 x TDA + 5.55	0.72 x TDA + 5.55	0.72 x TDA + 5.55	0.71 x TDA + 5.55	0.68 x TDA + 5.55
HZO.SC.L	1.92 x TDA + 7.08	1.9 x TDA + 7.08	1.9 x TDA + 7.08	1.9 x TDA + 7.08	1.9 x TDA + 7.08	1.9 x TDA + 7.08
HCT.SC.M	0.12 x V + 3.34	0.06 x V + 1.09	0.06 x V + 0.46	0.06 x V + 0.37	0.06 x V + 0.27	0.06 x V + 0.09
HCT.SC.L	0.75 x V + 4.1	0.08 x V + 1.47	0.08 x V + 1.35	0.08 x V + 1.23	0.08 x V + 1.05	0.08 x V + 0.63
HCT.SC.I	0.56 x TDA + 0.43	0.56 x TDA + 0.43	0.56 x TDA + 0.43	0.56 x TDA + 0.43	0.56 x TDA + 0.43	0.4 x TDA + 0.43
HCS.SC.M	0.1 x V + 2.04	0.05 x V + 1.05	0.05 x V + 0.98	0.05 x V + 0.91	0.05 x V + 0.89	0.02 x V + 0.81
HCS.SC.L	0.4 x V + 1.38	0.06 x V + 1.38	0.06 x V + 1.26	0.06 x V + 1.12	0.06 x V + 0.89	0.06 x V + 0.31
PD.SC.M	0.126 x V + 3.51	0.11 x V + 1.76	0.11 x V + 0.93	0.11 x V + 0.81	0.11 x V + 0.78	0.11 x V + 0.44

In addition to the 25 primary equipment classes analyzed, DOE evaluated existing and potential amended standards for 24 secondary equipment classes of commercial refrigeration equipment covered in this rulemaking that were not directly analyzed in the engineering analysis.

DOE's approach to evaluating standards for these secondary equipment classes involves extension multipliers developed using the engineering results for the primary equipment classes analyzed and a set of matched-pair analyses performed during the January 2009 final rule analysis.[75] In addition, DOE believes that standards for certain primary equipment classes can be directly applied to similar secondary equipment classes. Chapter 5 of the final rule TSD discusses the development of the extension multipliers.

Using the extension multiplier approach, DOE developed an additional set of TSLs and associated equations for the secondary equipment classes, as shown in Table V.4. The TSLs shown in Table V.4 do not necessarily satisfy the criteria spelled out in section V.A. DOE is presenting the standards equations developed for each TSL for all 47 equipment classes to allow interested parties to better observe the ramifications of each TSL across the range of equipment sizes on the market.

Table V.4 Equations Representing the Standards at Each TSL for All Secondary Equipment Classes

Equipment Class	Trial Standard Levels for Secondary Equipment Classes Analyzed					
	Baseline	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.I	2.89 x TDA + 8.7	2.81 x TDA + 8.7	2.81 x TDA + 8.7	2.79 x TDA + 8.7	2.7 x TDA + 8.7	2.65 x TDA + 8.7
SVO.RC.L	2.27 x TDA + 6.85	2.21 x TDA + 6.85	2.21 x TDA + 6.85	2.2 x TDA + 6.85	2.12 x TDA + 6.85	2.09 x TDA + 6.85
SVO.RC.I	2.89 x TDA + 8.7	2.81 x TDA + 8.7	2.81 x TDA + 8.7	2.79 x TDA + 8.7	2.7 x TDA + 8.7	2.65 x TDA + 8.7
HZO.RC.I	0.72 x TDA +	0.7 x TDA +	0.7 x TDA +	0.7 x TDA +	0.7 x TDA +	0.67 x TDA +

[75] The matched-pair analyses compared calculated energy consumption levels for pieces of equipment with similar designs but one major construction or operational difference; for example, vertical open remote condensing cases operating at medium and low temperatures. The relationships between these sets of units were used to determine the effect of the design or operational difference on applicable equipment. For more information, please see chapter 5 of the 2009 final rule TSD, which can be found at http://www.regulations.gov/#!documentDetail;D=EERE-2006-STD-0126-0058.

	8.74	8.74	8.74	8.74	8.74	8.74
VOP.SC.L	4.37 x TDA + 11.82	4.25 x TDA + 11.82	4.25 x TDA + 11.82	4.25 x TDA + 11.82	4.24 x TDA + 11.82	4.2 x TDA + 11.82
VOP.SC.I	5.55 x TDA + 15.02	5.4 x TDA + 15.02	5.4 x TDA + 15.02	5.4 x TDA + 15.02	5.38 x TDA + 15.02	5.34 x TDA + 15.02
SVO.SC.L	4.34 x TDA + 11.51	4.26 x TDA + 11.51	4.26 x TDA + 11.51	4.26 x TDA + 11.51	4.13 x TDA + 11.51	4.08 x TDA + 11.51
SVO.SC.I	5.52 x TDA + 14.63	5.41 x TDA + 14.63	5.41 x TDA + 14.63	5.41 x TDA + 14.63	5.24 x TDA + 14.63	5.18 x TDA + 14.63
HZO.SC.I	2.44 x TDA + 9	2.42 x TDA + 9	2.42 x TDA + 9	2.42 x TDA + 9	2.42 x TDA + 9	2.42 x TDA + 9
SOC.RC.L	1.08 x TDA + 0.22	0.93 x TDA + 0.22	0.93 x TDA + 0.22	0.93 x TDA + 0.22	0.91 x TDA + 0.22	0.88 x TDA + 0.22
SOC.RC.I	1.26 x TDA + 0.26	1.09 x TDA + 0.26	1.09 x TDA + 0.26	1.09 x TDA + 0.26	1.07 x TDA + 0.26	1.03 x TDA + 0.26
SOC.SC.I	1.76 x TDA + 0.36	1.53 x TDA + 0.36	1.53 x TDA + 0.36	1.53 x TDA + 0.36	1.5 x TDA + 0.36	1.45 x TDA + 0.36
VCT.RC.I	0.66 x TDA + 3.05	0.59 x TDA + 3.05	0.59 x TDA + 3.05	0.58 x TDA + 3.05	0.57 x TDA + 3.05	0.55 x TDA + 3.05
HCT.RC.M	0.16 x TDA + 0.13	0.16 x TDA + 0.13	0.16 x TDA + 0.13	0.16 x TDA + 0.13	0.16 x TDA + 0.13	0.12 x TDA + 0.13
HCT.RC.L	0.34 x TDA + 0.26	0.34 x TDA + 0.26	0.34 x TDA + 0.26	0.34 x TDA + 0.26	0.34 x TDA + 0.26	0.24 x TDA + 0.26
HCT.RC.I	0.4 x TDA + 0.31	0.4 x TDA + 0.31	0.4 x TDA + 0.31	0.4 x TDA + 0.31	0.4 x TDA + 0.31	0.28 x TDA + 0.31
VCS.RC.M	0.11 x V + 0.26	0.11 x V + 0.26	0.1 x V + 0.26	0.1 x V + 0.26	0.1 x V + 0.26	0.09 x V + 0.26
VCS.RC.L	0.23 x V + 0.54	0.23 x V + 0.54	0.22 x V + 0.54	0.21 x V + 0.54	0.21 x V + 0.54	0.19 x V + 0.54
VCS.RC.I	0.27 x V + 0.63	0.27 x V + 0.63	0.25 x V + 0.63	0.25 x V + 0.63	0.25 x V + 0.63	0.23 x V + 0.63
HCS.SC.I	0.38 x V + 0.88	0.37 x V + 0.88	0.36 x V + 0.88	0.34 x V + 0.88	0.34 x V + 0.88	0.32 x V + 0.88
HCS.RC.M	0.11 x V + 0.26	0.11 x V + 0.26	0.1 x V + 0.26	0.1 x V + 0.26	0.1 x V + 0.26	0.09 x V + 0.26
HCS.RC.L	0.23 x V + 0.54	0.23 x V + 0.54	0.22 x V + 0.54	0.21 x V + 0.54	0.21 x V + 0.54	0.19 x V + 0.54
HCS.RC.I	0.27 x V + 0.63	0.27 x V + 0.63	0.25 x V + 0.63	0.25 x V + 0.63	0.25 x V + 0.63	0.23 x V + 0.63
SOC.SC.L*	0.75 x V + 4.10	1.1 x TDA + 2.1	1.1 x TDA + 2.1	1.1 x TDA + 2.1	1.05 x TDA + 2.1	1.03 x TDA + 2.1

* Equipment class SOC.SC.L was inadvertently grouped under the category self-contained commercial freezers with transparent doors in the standards prescribed by EPCA, as amended by EPACT 2005. (42 U.S.C. 6313(c)(2)) The baseline expression is thus given by the expression 0.75 × V + 4.10, which is the current standard for SOC.SC.L equipment. A similar anomaly (of inadvertent classification under a different equipment category) for SOC.SC.M equipment was corrected by the standard established by AEMTCA. (42 U.S.C. 6313(c)(4)) However, no such corrective action has been prescribed for standards for SOC.SC.L equipment. In establishing a new standard for SOC.SC.M equipment, AEMTCA also changed the normalization metric from volume (V) to total display area (TDA). Accordingly, DOE is promulgating amended standards for SOC.SC.M equipment with TDA as the normalization metric (see

Table V.3), DOE derives the standard for secondary equipment classes based on the standard of a primary equipment that has similar characteristics as the secondary equipment class under consideration (see chapter 5 of the final rule TSD for details). For the equipment class SOC.SC.L, the standard was derived from the standard level selected for equipment class SOC.SC.M. Since the standard for SOC.SC.M is in terms of TDA, the standard for SOC.SC.L equipment has also been specified in terms of TDA. Therefore, while the baseline expression has been shown with V as the normalization metric, the expressions for TSLs 1 through 5 have been shown in terms of TDA. This change of normalization metric for equipment class SOC.SC.L is consistent with the legislative intent, evident in AEMTCA, for equipment class SOC.SC.M.

B. Economic Justification and Energy Savings

1. Economic Impacts on Commercial Customers

a. Life-Cycle Cost and Payback Period

Customers affected by new or amended standards usually incur higher purchase prices and lower operating costs. DOE evaluates these impacts on individual customers by calculating the LCC and the PBP associated with the TSLs. The results of the LCC analysis for each TSL were obtained by comparing the installed and operating costs of the equipment in the base-case scenario (scenario with no amended energy conservation standards) against the standards-case scenarios at each TSL. The energy consumption values for both the base-case and standards-case scenarios were calculated based on the DOE test procedure conditions specified in the 2012 test procedure final rule. 77 FR 10292, 10318-21 (February 21, 2012) The DOE test procedure adopted an industry-accepted test method and has been widely accepted as a reasonably accurate representation of the conditions to which a vast majority of the equipment covered in this rulemaking is subjected during actual use. As described in section IV.F, the LCC analysis was carried out in the form of Monte Carlo simulations. Consequently, the results are distributed over a range of values, as opposed to a single deterministic value. DOE presents the mean or median values, as appropriate, calculated from the distributions of results.

Table V.5 through Table V.29 show key results of the LCC and PBP analysis for each equipment class. Each table presents the mean LCC, mean LCC savings, median

PBP, and distribution of customer impacts in the form of percentages of customers who experience net cost, no impact, or net benefit.

All of the equipment classes, except for VCT.SC.L, have negative LCC savings values at TSL 5. Negative average LCC savings imply that, on average, customers experience an increase in LCC as a consequence of buying equipment associated with that particular TSL.

The mean LCC savings associated with TSL 4 vary by equipment class, and are negative for some equipment classes with significant market shares. The mean LCC savings at today's standard, TSL 3, are all positive. (LCC savings are equal in cases in which both TSLs are associated with the same efficiency level.)

Generally, customers who currently buy equipment in the base case scenario at or above the level of performance specified by the TSL under consideration would be unaffected if the amended standard were to be set at that TSL. Customers who buy equipment below the level of the TSL under consideration would be affected if the amended standard were to be set at that TSL. Among these affected customers, some may benefit (lower LCC) and some may incur net cost (higher LCC). DOE's results indicate that only a small percentage of customers may benefit from an amended standard that is set at TSL 5. At TSL 4, the percentage of customers who experience net benefits or no impacts ranges from 0 to 92 percent. At TSL 3, a larger percentage of customers experience net benefits or no impacts as compared to TSL 4. At TSLs 1 and 2, almost all customers experience either net benefits or no impacts.

For all of the equipment classes, except VCT.SC.L, the median PBPs for TSL 5 are greater than the average lifetime of the equipment, indicating that a majority of customers may not be able to recover the higher equipment installed costs through savings in operating costs during the life of the equipment. The median PBP values for TSL 4 range from 1.4 years to 63.1 years. The median PBP values at TSL 3 are all below the average lifetime of a majority of the commercial refrigeration equipment under consideration is 10 to 15 years. Therefore, PBP results for TSL 3 indicate that, in general, the majority of customers will be able to recover the increased purchase costs associated with equipment that is compliant with TSL 3 through operating cost savings within the lifetime of the equipment.

Table V.5 Summary LCC and PBP Results for VOP.RC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	17,095	10,527	2,376	30,748	---	0%	100%	0%	---
2	17,095	10,527	2,376	30,748	---	0%	100%	0%	---
3	13,877	11,988	2,099	29,826	922	4%	41%	55%	5.7
4	13,177	12,786	2,071	30,374	-5	64%	0%	36%	9.9
5	13,013	15,901	2,202	34,572	-4,203	100%	0%	0%	34.1

*Percentages may not add up to 100 percent due to rounding.

Table V.6 Summary LCC and PBP Results for VOP.RC.L Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average	% of Customers that Experience**			
						Net	No	Net	

					Savings 2012$	Cost	Impact	Benefit	
1	38,544	11,699	4,445	49,574	---	0%	100%	0%	---
2	38,544	11,699	4,445	49,574	---	0%	100%	0%	---
3	38,301	11,799	4,427	49,521	53	7%	40%	53%	5.7
4	37,117	12,631	4,353	49,707	-148	59%	20%	21%	7.2
5	36,502	17,725	4,534	56,289	-6,701	100%	0%	0%	9.9

*Percentages may not add up to 100 percent due to rounding.

Table V.7 Summary LCC and PBP Results for VOP.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	10,953	6,365	1,340	20,337	---	0%	100%	0%	---
2	10,953	6,365	1,340	20,337	---	0%	100%	0%	---
3	10,953	6,365	1,340	20,337	---	0%	100%	0%	---
4	10,917	6,432	1,339	20,391	-54	60%	40%	0%	5.7
5	10,846	7,483	1,368	21,742	-1,384	100%	0%	0%	7.2

*Percentages may not add up to 100 percent due to rounding.

Table V.8 Summary LCC and PBP Results for VCT.RC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	4,981	12,951	1,263	23,996	---	0%	100%	0%	---
2	4,981	12,951	1,263	23,996	---	0%	100%	0%	---
3	4,307	13,102	1,185	23,454	542	0%	40%	60%	2.1
4	4,192	13,384	1,193	23,803	41	36%	13%	51%	6.6
5	4,011	17,093	1,341	28,775	-4,937	100%	0%	0%	364.7

*Percentages may not add up to 100 percent due to rounding.

Table V.9 Summary LCC and PBP Results for VCT.RC.L Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	12,898	14,411	2,081	32,705	647	0%	40%	60%	1.8
2	12,898	14,411	2,081	32,705	647	0%	40%	60%	1.8
3	12,694	14,508	2,066	32,665	526	4%	20%	76%	2.7
4	12,593	14,809	2,070	32,996	93	43%	0%	57%	6.3
5	12,061	19,567	2,232	39,125	-6,036	100%	0%	0%	194.7

*Percentages may not add up to 100 percent due to rounding.

Table V.10 Summary LCC and PBP Results for VCT.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience** Net Cost	No Impact	Net Benefit	
1	2,491	5,184	490	10,025	-10	71%	10%	18%	23.4
2	2,184	5,336	452	9,800	214	1%	10%	89%	4.8
3	2,057	5,401	442	9,767	226	3%	0%	97%	5.3
4	1,991	5,487	440	9,830	163	17%	0%	83%	7.0
5	1,879	6,831	478	11,534	-1,541	100%	0%	0%	96.2

*Percentages may not add up to 100 percent due to rounding.

Table V.11 Summary LCC and PBP Results for VCT.SC.L Equipment Class

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience** Net Cost	No Impact	Net Benefit	
1	10,022	6,498	1,270	19,135	2,503	0%	10%	90%	0.5
2	6,654	6,822	964	16,397	4,709	0%	0%	100%	0.8
3	6,262	7,003	917	16,105	5,001	0%	0%	100%	1.1
4	5,857	8,909	948	18,294	2,812	11%	0%	89%	4.7
5	5,857	8,909	948	18,294	2,812	11%	0%	89%	4.7

*Percentages may not add up to 100 percent due to rounding.

Table V.12 Summary LCC and PBP Results for VCT.SC.I Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience** Net Cost	No Impact	Net Benefit	
1	7,124	7,305	1,015	17,384	18	10%	40%	50%	7.2
2	7,124	7,305	1,015	17,384	18	10%	40%	50%	7.2
3	7,124	7,305	1,015	17,384	18	10%	40%	50%	7.2
4	6,916	7,509	1,003	17,468	-68	65%	24%	11%	16.2
5	6,609	9,780	1,057	20,242	-2,834	84%	16%	0%	663.6

*Percentages may not add up to 100 percent due to rounding.

Table V.13 Summary LCC and PBP Results for VCS.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience** Net Cost	No Impact	Net Benefit	
1	1,929	3,572	368	6,378	223	0%	40%	60%	0.5
2	1,469	3,601	326	6,083	518	0%	40%	60%	0.6

3	1,346	3,651	318	6,067	363	7%	10%	83%	1.4
4	1,258	3,734	314	6,125	305	25%	10%	65%	2.6
5	1,105	5,062	365	7,828	-1,428	100%	0%	0%	48.0

*Percentages may not add up to 100 percent due to rounding.

Table V.14 Summary LCC and PBP Results for VCS.SC.L Equipment Class*

TSL	Annual Energy Consumption <u>kWh/yr</u>	Life-Cycle Cost, All Customers <u>2012$</u>			Life-Cycle Cost Savings				Median Payback Period <u>years</u>
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings <u>2012$</u>	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	5,088	4,007	702	9,374	588	0%	40%	60%	0.6
2	4,722	4,083	672	9,215	550	0%	10%	90%	1.3
3	4,448	4,216	653	9,201	507	7%	0%	93%	2.5
4	4,410	4,238	651	9,213	495	9%	0%	91%	2.7
5	4,062	5,988	703	11,349	-1,640	100%	0%	0%	31.8

*Percentages may not add up to 100 percent due to rounding.

Table V.15 Summary LCC and PBP Results for VCS.SC.I Equipment Class*

TSL	Annual Energy Consumption <u>kWh/yr</u>	Life-Cycle Cost, All Customers <u>2012$</u>			Life-Cycle Cost Savings				Median Payback Period <u>years</u>
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings <u>2012$</u>	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	6,824	4,349	895	11,195	41	0%	40%	60%	2.6
2	6,574	4,420	876	11,117	114	0%	32%	68%	3.6
3	6,361	4,515	861	11,096	113	9%	17%	75%	5.0
4	6,361	4,515	861	11,096	113	9%	17%	75%	5.0
5	5,855	6,839	927	13,909	-2,710	92%	8%	0%	183.7

*Percentages may not add up to 100 percent due to rounding.

Table V.16 Summary LCC and PBP Results for SVO.RC.M Equipment Class*

TSL	Annual Energy Consumption <u>kWh/yr</u>	Life-Cycle Cost, All Customers <u>2012$</u>			Life-Cycle Cost Savings				Median Payback Period <u>years</u>
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings <u>2012$</u>	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	10,748	10,304	1,694	24,841	564	7%	40%	54%	6.2
2	10,748	10,304	1,694	24,841	564	7%	40%	54%	6.2
3	10,748	10,304	1,694	24,841	564	7%	40%	54%	6.2
4	10,226	10,875	1,670	25,201	-19	67%	0%	33%	10.4
5	10,111	12,867	1,752	27,873	-2,691	100%	0%	0%	29.9

*Percentages may not add up to 100 percent due to rounding.

Table V.17 Summary LCC and PBP Results for SVO.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	9,608	4,980	1,150	16,733	---	0%	100%	0%	---
2	9,608	4,980	1,150	16,733	---	0%	100%	0%	---
3	9,608	4,980	1,150	16,733	---	0%	100%	0%	---
4	9,361	5,157	1,132	16,728	6	32%	40%	27%	10.9
5	9,271	5,897	1,151	17,648	-917	100%	0%	0%	151.6

*Percentages may not add up to 100 percent due to rounding.

Table V.18 Summary LCC and PBP Results for SOC.RC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	8,300	13,971	1,679	28,172	---	0%	100%	0%	---
2	8,300	13,971	1,679	28,172	---	0%	100%	0%	---
3	8,300	13,971	1,679	28,172	---	0%	100%	0%	---
4	8,144	14,144	1,674	28,301	-128	60%	40%	0%	38.0
5	7,869	15,879	1,729	30,492	-2,268	100%	0%	0%	114.1

*Percentages may not add up to 100 percent due to rounding.

Table V.19 Summary LCC and PBP Results for SOC.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	10,119	13,965	1,821	27,861	---	0%	100%	0%	---
2	10,119	13,965	1,821	27,861	---	0%	100%	0%	---
3	10,119	13,965	1,821	27,861	---	0%	100%	0%	---
4	9,711	14,332	1,808	28,128	-209	100%	0%	1%	28.7
5	9,533	15,880	1,868	30,123	-2,204	100%	0%	0%	25.3

*Percentages may not add up to 100 percent due to rounding.

Table V.20 Summary LCC and PBP Results for HZO.RC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	5,282	8,290	1,036	16,958	---	0%	100%	0%	---
2	5,282	8,290	1,036	16,958	---	0%	100%	0%	---

3	5,282	8,290	1,036	16,958	---	0%	100%	0%	---
4	5,282	8,290	1,036	16,958	---	0%	100%	0%	---
5	5,165	9,921	1,103	19,137	-2,180	60%	40%	0%	---

*Percentages may not add up to 100 percent due to rounding.

Table V.21 Summary LCC and PBP Results for HZO.RC.L Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	11,812	8,504	1,673	22,548	---	0%	100%	0%	---
2	11,812	8,504	1,673	22,548	---	0%	100%	0%	---
3	11,812	8,504	1,673	22,548	---	0%	100%	0%	---
4	11,812	8,504	1,673	22,548	---	0%	100%	0%	---
5	11,344	11,822	1,787	26,795	-4,249	60%	40%	0%	288.9

*Percentages may not add up to 100 percent due to rounding.

Table V.22 Summary LCC and PBP Results for HZO.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	5,351	2,605	629	9,022	---	0%	100%	0%	---
2	5,168	2,698	615	8,967	55	5%	40%	54%	6.9
3	5,168	2,698	615	8,967	55	5%	40%	54%	6.9
4	5,118	2,763	613	9,013	-4	50%	21%	29%	11.8
5	5,018	3,689	636	10,163	-1,154	100%	0%	0%	194.7

*Percentages may not add up to 100 percent due to rounding.

Table V.23 Summary LCC and PBP Results for HZO.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	10,922	5,008	1,265	17,894	---	0%	100%	0%	---
2	10,922	5,008	1,265	17,894	---	0%	100%	0%	---
3	10,922	5,008	1,265	17,894	---	0%	100%	0%	---
4	10,922	5,008	1,265	17,894	---	0%	100%	0%	---
5	10,922	5,008	1,265	17,894	---	0%	100%	0%	---

*Percentages may not add up to 100 percent due to rounding.

Table V.24 Summary LCC and PBP Results for HCT.SC.M Equipment Class

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	590	2,101	140	3,577	66	0%	40%	60%	2.5
2	360	2,198	122	3,478	165	0%	40%	60%	4.7
3	327	2,213	120	3,476	101	20%	0%	80%	5.8
4	289	2,279	120	3,534	43	45%	0%	55%	9.2
5	224	2,807	131	4,175	-599	100%	0%	0%	46.6

*Percentages may not add up to 100 percent due to rounding.

Table V.25 Summary LCC and PBP Results for HCT.SC.L Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	785	2,297	190	3,882	428	0%	41%	59%	1.8
2	742	2,312	187	3,876	435	0%	41%	59%	2.0
3	701	2,330	185	3,870	293	10%	10%	80%	2.5
4	632	2,399	182	3,915	248	29%	10%	61%	3.6
5	480	3,120	200	4,775	-613	87%	10%	3%	19.5

**Percentages may not add up to 100 percent due to rounding.

Table V.26 Summary LCC and PBP Results for HCT.SC.I Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	1,141	2,490	240	4,348	---	0%	100%	0%	---
2	1,141	2,490	240	4,348	---	0%	100%	0%	---
3	1,141	2,490	240	4,348	---	0%	100%	0%	---
4	1,141	2,490	240	4,348	---	0%	100%	0%	---
5	849	3,553	264	5,587	-1,240	61%	39%	0%	23.8

* Percentages may not add up to 100 percent due to rounding.

Table V.27 Summary LCC and PBP Results for HCS.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	518	1,986	146	3,100	12	0%	9%	91%	2.9
2	495	1,993	145	3,095	17	1%	9%	90%	3.7

3	466	2,008	143	3,097	15	10%	9%	80%	5.5
4	461	2,014	144	3,107	5	42%	9%	48%	7.5
5	358	2,488	157	3,679	-568	91%	9%	0%	680.6

* Percentages may not add up to 100 percent due to rounding.

Table V.28 Summary LCC and PBP Results for HCS.SC.L Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience**			
						Net Cost	No Impact	Net Benefit	
1	650	2,006	160	3,224	31	0%	10%	90%	1.4
2	609	2,013	156	3,205	50	0%	10%	90%	1.7
3	558	2,028	153	3,191	64	0%	10%	90%	2.5
4	472	2,093	148	3,222	33	20%	10%	70%	6.2
5	260	2,663	156	3,845	-590	90%	10%	0%	68.9

* Percentages may not add up to 100 percent due to rounding.

Table V.29 Summary LCC and PBP Results for PD.SC.M Equipment Class*

TSL	Annual Energy Consumption kWh/yr	Life-Cycle Cost, All Customers 2012$			Life-Cycle Cost Savings				Median Payback Period years
		Installed Cost	Discounted Operating Cost	LCC	Affected Customers' Average Savings 2012$	% of Customers that Experience*			
						Net Cost	No Impact	Net Benefit	
1	1,726	3,502	342	6,732	8	28%	39%	33%	9.3
2	1,422	3,654	310	6,574	163	3%	0%	97%	5.3
3	1,381	3,677	308	6,572	165	5%	0%	95%	5.6
4	1,369	3,691	308	6,587	150	8%	0%	92%	6.0
5	1,243	4,808	340	7,989	-1,252	100%	0%	0%	102.2

*Percentages may not add up to 100 percent due to rounding.

b. Customer Subgroup Analysis

As described in section IV.I, DOE estimated the impact of potential amended efficiency standards for commercial refrigeration equipment on two representative customer subgroups: full-service restaurants and convenience stores with gas stations.

The results for full-service restaurants are presented only for the self-contained equipment classes because full-service restaurants that are small businesses generally do not use remote condensing equipment. Table V.30 presents the comparison of mean LCC savings for the subgroup with the values for all CRE customers. For all TSLs in all equipment classes save one, the LCC savings for this subgroup are higher (or less negative) than the national average values. This can be attributed to the longer average lifetimes of CRE used by small business customers, and higher electricity prices in the case of full service restaurants.

Table V.31 compares median PBPs for full-service restaurants with the values for all CRE customers. The PBP values are lower for the small business subgroup in all cases save one, which is consistent with the decrease in LCC savings.

Table V.30 Comparison of Mean LCC Savings for the Full-service Restaurants Subgroup with the Savings for All CRE Customers

Equipment Class	Category	Mean LCC Savings 2012$*				
		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.SC.M	Small Business	---	---	---	$(57)	$(1,508)
	All Business Types	---	---	---	$(54)	$(1,384)
VCT.SC.M	Small Business	$0	$299	$330	$280	$(1,391)
	All Business Types	$(10)	$214	$226	$163	$(1,541)
VCT.SC.L	Small Business	$3,073	$5,868	$6,254	$4,163	$4,163
	All Business Types	$2,503	$4,709	$5,001	$2,812	$2,812
VCT.SC.I	Small Business	$34	$34	$34	$(12)	$(2,706)
	All Business Types	$18	$18	$18	$(68)	$(2,834)
VCS.SC.M	Small Business	$375	$870	$652	$632	$(1,031)
	All Business Types	$223	$518	$363	$305	$(1,428)
VCS.SC.L	Small Business	$979	$971	$999	$1,000	$(936)
	All Business Types	$588	$550	$507	$495	$(1,640)
VCS.SC.I	Small Business	$81	$257	$321	$321	$(2,241)
	All Business Types	$41	$114	$113	$113	$(2,710)
SOC.SC.M	Small Business	---	---	---	$(74)	$(1,952)
	All Business Types	---	---	---	$(209)	$(2,204)
SVO.SC.M	Small Business	---	---	---	$53	$(871)
	All Business Types	---	---	---	$6	$(917)
HZO.SC.M	Small Business	---	$92	$92	$33	$(1,097)
	All Business Types	---	$55	$55	$(4)	$(1,154)
HZO.SC.L	Small Business	---	---	---	---	---
	All Business Types	---	---	---	---	---
HCT.SC.M	Small Business	$81	$216	$137	$85	$(546)
	All Business Types	$66	$165	$101	$43	$(599)

HCT.SC.L	Small Business	$687	$707	$487	$468	$(319)
	All Business Types	$428	$435	$293	$248	$(613)
HCT.SC.I	Small Business	---	---	---	---	$(1,081)
	All Business Types	---	---	---	---	$(1,240)
HCS.SC.M	Small Business	$23	$38	$48	$38	$(477)
	All Business Types	$12	$17	$15	$5	$(568)
HCS.SC.L	Small Business	$55	$91	$127	$133	$(381)
	All Business Types	$31	$50	$64	$33	$(590)

Table V.31 Comparison of Median Payback Periods for the Full-service Restaurants Subgroup with the Values for All CRE Customers

Equipment Class	Category	Mean LCC Savings 2012$*				
		TSL1	TSL2	TSL3	TSL4	TSL5
VOP.SC.M	Small Business	---	---	---	54.1	541.3
	All Business Types	---	---	---	63.1	593.2
VCT.SC.M	Small Business	12.9	4.1	4.5	5.9	64.8
	All Business Types	23.4	4.8	5.3	7.0	96.2
VCT.SC.L	Small Business	0.4	0.7	0.9	4.0	4.0
	All Business Types	0.5	0.8	1.1	4.7	4.7
VCT.SC.I	Small Business	5.8	5.8	5.8	12.4	310.0
	All Business Types	7.2	7.2	7.2	16.2	663.6
VCS.SC.M	Small Business	0.4	0.5	1.2	2.1	22.4
	All Business Types	0.5	0.6	1.4	2.6	48.0
VCS.SC.L	Small Business	0.5	1.1	2.0	2.2	19.2
	All Business Types	0.6	1.3	2.5	2.7	31.8
VCS.SC.I	Small Business	2.1	2.9	3.9	3.9	91.7
	All Business Types	2.6	3.6	5.0	5.0	183.7
SOC.SC.M	Small Business	---	---	---	15.5	221.7
	All Business Types	---	---	---	28.7	25.3
SVO.SC.M	Small Business	---	---	---	8.9	124.3
	All Business Types	---	---	---	10.9	151.6
HZO.SC.M	Small Business	---	5.7	5.7	9.5	166.7
	All Business Types	---	6.9	6.9	11.8	194.7
HZO.SC.L	Small Business	---	---	---	---	---
	All Business Types	---	---	---	---	---
HCT.SC.M	Small Business	2.1	4.0	4.7	7.5	33.9
	All Business Types	2.5	4.7	5.8	9.2	46.6
HCT.SC.L	Small Business	1.5	1.6	2.0	2.9	14.0
	All Business Types	1.8	2.0	2.5	3.6	19.5
HCT.SC.I	Small Business	---	---	---	---	176.3
	All Business Types	---	---	---	---	23.8
HCS.SC.M	Small Business	2.3	2.9	4.2	5.4	136.0
	All Business Types	2.9	3.7	5.5	7.5	680.6
HCS.SC.L	Small Business	1.1	1.4	2.1	4.7	27.9
	All Business Types	1.4	1.7	2.5	6.2	68.9
PD.SC.M	Small Business	6.9	4.5	4.7	5.0	63.3
	All Business Types	9.3	5.3	5.6	6.0	102.2

Table V.32 presents the comparison of mean LCC savings for convenience stores with gasoline stations with the national average values at each TSL. This comparison shows higher (or less negative) LCC savings for the subgroups in nearly all instances.

Table V.33 presents the comparison of median PBPs for convenience stores with gasoline stations with national median values at each TSL. This comparison shows lower PBP for the subgroup in nearly all cases.

Table V.32 Comparison of Mean LCC Savings for Convenience Stores with Gasoline Stations with Savings for All CRE Customers

Equipment Class	Category	Mean LCC Savings* 2012$				
		TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	Small Business	---	---	$1,334	$299	$(4,003)
	All Business Types	---	---	$922	$(5)	$(4,203)
VOP.RC.L	Small Business	---	---	$82	$2	$(6,703)
	All Business Types	---	---	$53	$(148)	$(6,701)
VOP.SC.M	Small Business	---	---	---	$(62)	$(1,485)
	All Business Types	---	---	---	$(54)	$(1,384)
VCT.RC.M	Small Business	---	---	$636	$135	$(4,544)
	All Business Types	---	---	$542	$41	$(4,937)
VCT.RC.L	Small Business	$751	$751	$634	$213	$(5,486)
	All Business Types	$647	$647	$526	$93	$(6,036)
VCT.SC.M	Small Business	$(8)	$214	$229	$169	$(1,479)
	All Business Types	$(10)	$214	$226	$163	$(1,541)
VCT.SC.L	Small Business	$2,489	$4,699	$4,988	$2,878	$2,878
	All Business Types	$2,503	$4,709	$5,001	$2,812	$2,812
VCT.SC.I	Small Business	$19	$19	$19	$(59)	$(2,732)
	All Business Types	$18	$18	$18	$(68)	$(2,834)
VCS.SC.M	Small Business	$299	$696	$511	$476	$(1,157)
	All Business Types	$223	$518	$363	$305	$(1,428)
VCS.SC.L	Small Business	$785	$765	$763	$758	$(1,190)
	All Business Types	$588	$550	$507	$495	$(1,640)

VCS.SC.I	Small Business	$62	$189	$224	$224	$(2,354)
	All Business Types	$41	$114	$113	$113	$(2,710)
SVO.RC.M	Small Business	$966	$966	$966	$340	$(2,148)
	All Business Types	$564	$564	$564	$(19)	$(2,691)
SVO.SC.M	Small Business	---	---	---	$5	$(891)
	All Business Types	---	---	---	$6	$(917)
SOC.RC.M	Small Business	---	---	---	$(93)	$(2,058)
	All Business Types	---	---	---	$(128)	$(2,268)
HZO.RC.M**	Small Business	---	---	---	---	$(2,015)
	All Business Types	---	---	---	---	$(2,180)
HZO.RC.L**	Small Business	---	---	---	---	$(3,880)
	All Business Types	---	---	---	---	$(4,249)
HZO.SC.M	Small Business	---	$55	$55	$(3)	$(1,114)
	All Business Types	---	$55	$55	$(4)	$(1,154)
HZO.SC.L**	Small Business	---	---	---	---	---
	All Business Types	---	---	---	---	---
HCT.SC.M	Small Business	$62	$151	$92	$35	$(591)
	All Business Types	$66	$165	$101	$43	$(599)
HCT.SC.L	Small Business	$535	$548	$374	$343	$(451)
	All Business Types	$428	$435	$293	$248	$(613)
HCT.SC.I	Small Business	---	---	---	---	$(1,106)
	All Business Types	---	---	---	---	$(1,240)
HCS.SC.M	Small Business	$18	$28	$32	$23	$(498)
	All Business Types	$12	$17	$15	$5	$(568)
HCS.SC.L	Small Business	$44	$71	$97	$87	$(453)
	All Business Types	$31	$50	$64	$33	$(590)
PD.SC.M	Small Business	$14	$186	$190	$177	$(1,159)
	All Business Types	$8	$163	$165	$150	$(1,252)

Table V.33 Comparison of Median Payback Periods for Convenience Stores with Gasoline Stations with Values for All CRE Customers

Equipment Class	Category	Median Payback Period years				
		TSL1	TSL2	TSL3	TSL4	TSL5
VOP.RC.M	Small Business	---	---	5.5	9.0	25.1
	All Business Types	---	---	5.7	9.9	34.1
VOP.RC.L	Small Business	---	---	5.8	10.2	195.3
	All Business Types	---	---	6.1	11.3	310.0

VOP.SC.M	Small Business	---	---	---	69.5	513.9
	All Business Types	---	---	---	63.1	593.2
VCT.RC.M	Small Business	---	---	1.9	5.8	308.8
	All Business Types	---	---	2.1	6.6	364.7
VCT.RC.L	Small Business	1.7	1.7	2.5	5.7	171.0
	All Business Types	1.8	1.8	2.7	6.3	194.7
VCT.SC.M	Small Business	18.2	4.5	5.0	6.5	82.7
	All Business Types	23.4	4.8	5.3	7.0	96.2
VCT.SC.L	Small Business	0.4	0.8	1.0	4.4	4.4
	All Business Types	0.5	0.8	1.1	4.7	4.7
VCT.SC.I	Small Business	6.6	6.6	6.6	14.3	531.1
	All Business Types	7.2	7.2	7.2	16.2	663.6
VCS.SC.M	Small Business	0.5	0.6	1.3	2.3	26.4
	All Business Types	0.5	0.6	1.4	2.6	48.0
VCS.SC.L	Small Business	0.5	1.2	2.2	2.4	22.2
	All Business Types	0.6	1.3	2.5	2.7	31.8
VCS.SC.I	Small Business	2.3	3.2	4.3	4.3	118.4
	All Business Types	2.6	3.6	5.0	5.0	183.7
SVO.RC.M	Small Business	5.4	5.4	5.4	8.4	20.7
	All Business Types	6.2	6.2	6.2	10.4	29.9
SVO.SC.M	Small Business	---	---	---	10.0	150.5
	All Business Types	---	---	---	10.9	151.6
SOC.RC.M	Small Business	---	---	---	23.2	656.6
	All Business Types	---	---	---	38.0	114.1
SOC.SC.M	Small Business	---	---	---	18.2	265.4
	All Business Types	---	---	---	28.7	25.3
HZO.RC.M	Small Business	---	---	---	---	---
	All Business Types	---	---	---	---	---
HZO.RC.L	Small Business	---	---	---	---	59.8
	All Business Types	---	---	---	---	288.9
HZO.SC.M	Small Business	---	6.4	6.4	10.8	174.0
	All Business Types	---	6.9	6.9	11.8	194.7
HZO.SC.L	Small Business	---	---	---	---	---
	All Business Types	---	---	---	---	---
HCT.SC.M	Small Business	2.3	4.4	5.4	8.5	40.5
	All Business Types	2.5	4.7	5.8	9.2	46.6
HCT.SC.L	Small Business	1.7	1.8	2.3	3.3	15.6
	All Business Types	1.8	2.0	2.5	3.6	19.5
HCT.SC.I	Small Business	---	---	---	---	208.9

	All Business Types	---	---	---	---	23.8
HCS.SC.M	Small Business	2.6	3.3	4.7	6.2	151.6
	All Business Types	2.9	3.7	5.5	7.5	680.6
HCS.SC.L	Small Business	1.3	1.6	2.3	5.3	33.7
	All Business Types	1.4	1.7	2.5	6.2	68.9
PD.SC.M	Small Business	8.0	4.9	5.2	5.6	78.9
	All Business Types	9.3	5.3	5.6	6.0	102.2

c. Rebuttable Presumption Payback

As discussed in section IV.F.12, EPCA provides a rebuttable presumption that a given 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. However, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the customer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i) and 42 U.S.C. 6316(e)(1). The results of this analysis serve as the basis for DOE to evaluate definitively the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). Therefore, if the rebuttable presumption is not met, DOE may justify its standard on another basis.

Table V.34 shows the rebuttable payback periods analysis for each equipment class.

Table V.34 Summary of Results for Commercial Refrigeration Equipment TSLs: Rebuttable Median Payback Period

Median Payback Period
years

Equipment Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	---	---	5.1	7.6	17.3
VOP.RC.L	---	---	4.6	7.3	36.2
VOP.SC.M	---	---	---	21.2	127.9
VCT.RC.M	---	---	2.5	6.8	56.3
VCT.RC.L	2.2	2.2	3.0	6.6	43.0
VCT.SC.M	4.4	5.4	5.5	6.5	28.1
VCT.SC.L	0.5	0.8	1.1	4.2	4.2
VCT.SC.I	5.0	5.0	5.0	9.5	48.7
VCS.SC.M	0.4	0.6	1.2	2.1	16.5
VCS.SC.L	0.5	1.2	2.1	2.3	13.6
VCS.SC.I	2.3	3.0	3.8	3.8	28.7
SVO.RC.M	5.4	5.4	5.4	7.8	16.5
SVO.SC.M	---	---	---	8.1	35.9
SOC.RC.M	---	---	---	12.4	54.3
SOC.SC.M	---	---	---	10.2	39.8
HZO.RC.M	---	---	---	---	156.3
HZO.RC.L	---	---	---	---	79.5
HZO.SC.M	---	5.6	5.6	8.1	42.9
HZO.SC.L	---	---	---	---	---
HCT.SC.M	2.2	4.0	4.4	6.6	20.9
HCT.SC.L	1.7	1.8	2.2	3.0	11.4
HCT.SC.I	---	---	---	---	40.8
HCS.SC.M	2.5	2.9	4.0	4.5	30.5
HCS.SC.L	1.3	1.6	2.2	4.5	16.7
PD.SC.M	4.9	5.4	5.5	5.7	26.7

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of commercial refrigeration equipment. The following section describes the expected impacts on manufacturers at each TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash-Flow Analysis Results

The following tables depict the financial impacts (represented by changes in INPV) of amended energy standards on manufacturers as well as the conversion costs that DOE estimates manufacturers would incur for all equipment classes at each TSL. To evaluate the range of cash flow impacts on the commercial refrigeration industry, DOE modeled two different scenarios using different assumptions for markups that correspond to the range of anticipated market responses to amended standards.

To assess the lower (less severe) end of the range of potential impacts, DOE modeled a preservation of gross margin percentage markup scenario, in which a uniform "gross margin percentage" markup was applied across all potential efficiency levels. In this scenario, DOE assumed that a manufacturer's absolute dollar markup would increase as production costs increase in the amended standards case. Manufacturers have indicated that it is optimistic to assume that they would be able to maintain the same gross margin percentage markup as their production costs increase in response to an amended efficiency standard, particularly at higher TSLs. To assess the higher (more severe) end of the range of potential impacts, DOE modeled the preservation of operating profit markup scenario, which assumes that manufacturers would be able to earn the same operating margin in absolute dollars in the amended standards case as in the base case. Table V.35 and Table V.36 show the potential INPV impacts for commercial refrigeration equipment manufacturers at each TSL: Table V.35 reflects the lower bound of impacts and Table V.36 represents the upper bound.

Each of the modeled scenarios results in a unique set of cash flows and corresponding industry values at each TSL. In the following discussion, the INPV results refer to the difference in industry value between the base case and each potential amended standards case that results from the sum of discounted cash flows from the base year 2013 through 2046, the end of the analysis period. To provide perspective on the short-run cash flow impact, DOE includes in the discussion of the results below a comparison of free cash flow between the base case and the standards case at each TSL in the year before amended standards take effect.

Table V.35 Manufacturer Impact Analysis for Commercial Refrigeration Equipment – Preservation of Gross Margin Percentage Markup Scenario*

	Units	Base Case	Trial Standard Level				
			1	2	3	4	5
INPV	2012$ Millions	2,660.0	2,650.1	2,651.3	2,566.1	2,470.6	2,475.6
Change in INPV	2012$ Millions	-	(9.9)	(8.7)	(93.9)	(189.4)	(184.4)
	(%)	-	(0.37)	(0.33)	(3.53)	(7.12)	(6.93)
Product Conversion Costs	2012$ Millions	-	20.6	32.1	125.9	194.2	282.1
Capital Conversion Costs	2012$ Millions	-	3.5	3.6	58.1	160.7	499.7
Total Conversion Costs	2012$ Millions	-	24.1	35.6	184.0	354.9	781.8

* Values in parentheses are negative values.

Table V.36 Manufacturer Impact Analysis for Commercial Refrigeration Equipment – Preservation of Operating Profit Markup Scenario*

	Units	Base Case	Trial Standard Level				
			1	2	3	4	5
INPV	2012$ Millions	2,660.0	2,636.1	2,617.1	2,495.0	2,339.1	1,515.2
Change in INPV	2012$ Millions	-	(23.9)	(42.9)	(165.0)	(320.9)	(1,144.8)
	(%)	-	(0.90)	(1.61)	(6.20)	(12.07)	(43.04)
Product Conversion Costs	2012$ Millions	-	20.6	32.1	125.9	194.2	282.1
Capital Conversion Costs	2012$ Millions	-	3.5	3.6	58.1	160.7	499.7
Total Conversion Costs	2012$ Millions	-	24.1	35.6	184.0	354.9	781.8

* Values in parentheses are negative values.

At TSL 1, DOE estimates impacts on INPV for commercial refrigeration equipment manufacturers to range from -$23.9 million to -$9.9 million, or a change in INPV of -0 percent to -0.37 percent. At this potential standard level, industry free cash flow is estimated to decrease by approximately 4.16 percent to $192.1 million, compared to the base-case value of $200.4 million in the year before the compliance date (2016).

The INPV impacts at TSL 1 are relatively minor because DOE manufacturer production costs do not increase significant. The average unit price for the industry (calculated by dividing industry revenue by industry unit shipments) increases 0.8% from $2,892.72 to $2,916.55 in the standards year. Few capital conversion costs are expected because DOE anticipates that manufacturers would be able to make simple component swaps to meet the efficiency levels for each equipment class at this TSL. However, product conversion costs are required for industry certifications to incorporate the new components into existing designs. Industry conversion costs total $24.1 million.

Under the preservation of gross margin percentage markup scenario, impacts on manufacturers are marginally negative because while manufacturers can maintain their gross margin percentages, they also incur conversion costs that offset the higher profits that they gain from increasing their selling prices to accommodate higher production costs. However, the effects of these conversion costs are more apparent in the preservation of operating profit markup scenario because manufacturers earn the same operating profit at TSL 1 as they do in the base case. In general, manufacturers stated that the preservation of operating profit scenario is a more likely representation of the industry than the preservation of operating profit scenario, especially as MPCs increase.

At TSL 2, DOE estimates impacts on INPV for commercial refrigeration equipment manufacturers to range from -$42.9 million to -$8.7 million, or a change in INPV of -1.61 percent to -0.33 percent. At this potential standard level, industry free cash flow is estimated to decrease by approximately 6.04 percent to $188.3 million, compared to the base-case value of $200.4 million in the year before the compliance date (2016).

Although DOE continues to expect mild INPV impacts on the industry at TSL 2, product conversion costs do increase. Nearly 20% of product in the industry would require some level of component redesign, such as changes in evaporator coil, condenser coil, or compressor selection, that would necessitate UL or NSF certification changes. These industry certification investments push total industry conversion costs to $35.4 million.

At TSL 3, DOE estimates impacts on INPV for commercial refrigeration equipment manufacturers to range from -$165.0 million to -$93.9 million, or a change in INPV of -6.20 percent to -3.53 percent. At this potential standard level, industry free cash flow is estimated to decrease by approximately 33.64 percent to $133.0 million, compared to the base-case value of $200.4 million in the year before the compliance date (2016).

At TSL 3, the expected design options do not dramatically alter manufacturer per unit production costs. Average unit costs increase by 4.1% to $3,011.93 while industry shipments remain steady. However, DOE expects higher conversion costs at TSL 3 due to the possible need for improved insulation for high-volume products, such as VCS.SC.L, which accounts for approximately 18.3 percent of total shipments, and VCT.RC.L, which accounts for approximately 4.1 percent. In total, DOE expects 5 of the 24 equipment classes to require improved insulation due to higher standards. The need for improved insulation necessitates redesign efforts for the cabinet as well as interior components. Furthermore, thicker insulation requires investment in new production tooling. Total industry conversion costs reach $184.0 million.

At TSL 4, DOE estimates impacts on INPV for commercial refrigeration equipment manufacturers range from -$320.9 million to -$189.4 million, or a change in INPV of -12.7 percent to -7.12 percent. At this potential standard level, industry free cash flow is estimated to decrease by approximately 67.84 percent to $64.4 million, compared to the base-case value of $200.4 million in the year before the compliance date (2016).

The drop in INPV at TSL 4 is driven by conversion costs. Industry average unit price increases 7.6% and industry shipments are modeled to remain steady. However, the need for new tooling to accommodate additional foam insulation in 16 of the 25 analyzed equipment classes pushes up industry conversion costs. The redesign effort, coupled with industry certification costs, push product conversion costs up to $194.2 million. Total industry conversion costs are expected to reach $354.9 million.

At TSL 5, DOE estimates impacts on INPV for commercial refrigeration equipment manufacturers to range from -$1,144.85 million to -$184.4 million, or a change in INPV of -43.04 percent to -6.93 percent. At this potential standard level, industry free cash flow is estimated to decrease by approximately 158.32 percent to -$116.9 million, compared to the base-case value of $200.4 million in the year before the compliance date (2016).

A substantial increase in conversion costs are expected at TSL 5 due to the possible need for VIP technology. VIPs are not currently used by any commercial refrigeration equipment manufacturers and the production of VIPs would require processes different from those used to produce standard foam panels. High R&D investments would be necessary to integrate the technology into CRE cases. Based on industry feedback, DOE estimated the R&D investment to be 1-2 times the industry's typical annual R&D expenditure and the capital conversion cost to be more than double the cost of all current fixtures in use. Total industry conversion costs total $781.8 million.

b. Impacts on Direct Employment

To quantitatively assess the impacts of amended energy conservation standards on employment, DOE used the GRIM to estimate the domestic labor expenditures and number of employees in the base case and at each TSL from 2013 through 2046. DOE used statistical data from the U.S. Census Bureau's 2011 Annual Survey of Manufacturers (ASM), the results of the engineering analysis, the commercial refrigeration equipment shipments forecast, and interviews with manufacturers to determine the inputs necessary to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures related to manufacturing of the product are a function of 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 MPCs by the labor percentage of MPCs.

The total labor expenditures in the GRIM were then converted to domestic production employment levels by dividing production labor expenditures by the annual payment per production worker (production worker hours times the labor rate found in the U.S. Census Bureau's 2011 ASM). The estimates of production workers in this section cover workers, including line supervisors who are directly involved in fabricating and assembling a product 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 products covered by this rulemaking.

Table V.37 Potential Changes in the Number of Commercial Refrigeration Equipment Production Workers in 2017

Trial Standard Level*						
	Base Case	1	2	3	4	5
Total Number of Domestic Production Workers in 2017 (assuming no changes in production locations)	7,779	7,779	7,779	7,779	7,780	8,220
Range of Potential Changes in Domestic Production Workers in 2017**	-	(7,7790) to 0	(7,740) to 0	(7,779) to 0	(7,779) to 1	(7,779) to 441

*Numbers in parentheses are negative numbers.
**DOE presents a range of potential employment impacts, where the lower range represents the scenario in which all domestic manufacturers move production to other countries.

The employment impacts shown in Table V.37 represent the potential production employment changes that could result following the compliance date of an amended energy conservation standard. The upper end of the results in the table estimates the maximum increase in the number of production workers after the implementation of new energy conservation standards and it assumes that manufacturers would continue to produce the same scope of covered products within the United States. The lower end of the range indicates the total number of U.S. production workers in the industry who could lose their jobs if all existing production were moved outside of the United States. Though manufacturers stated in interviews that shifts in production to foreign countries are unlikely, the industry did not provide enough information for DOE fully quantify what percentage of the industry would move production at each evaluated standard level.

The majority of design options analyzed in the engineering analysis require manufacturers to purchase more-efficient components from suppliers. These components do not require significant additional labor to assemble. A key component of a commercial refrigeration equipment unit that requires fabrication labor by the commercial refrigeration equipment manufacturer is the shell of the unit, which needs to be formed and foamed in. Although this activity may require new production equipment if thicker insulation is needed to meet higher efficiency levels, the process of building the foamed-in-place cases would essentially remain the same, and therefore require no additional labor costs. As a result, labor needs are not expected to increase as the amended energy conservation standard increases from baseline to TSL 4.

At TSL 5, the introduction of vacuum insulation panels may lead to greater labor requirements. In general, the production and handling of VIPs will require more labor than the production of standard refrigerated cases. This is due to the delicate nature of VIPs and the additional labor necessary to embed them into a display case. The additional labor and handling associated with these panels account for the increase in labor at the max-tech trial standard level.

DOE notes that the employment impacts discussed here are independent of the employment impacts to the broader U.S. economy, which are documented in the Employment Impact Analysis, chapter 16 of the TSD.

c. Impacts on Manufacturing Capacity

According to the majority of commercial refrigeration equipment manufacturers interviewed, amended energy conservation standards will not significantly affect manufacturers' production capacities. An amended energy conservation standard for commercial refrigeration equipment would not change the fundamental assembly of the equipment, but manufacturers do anticipate potential for changes to tooling and fixtures. The most significant of these would come as a result of any redesigns performed to accommodate additional foam insulation thickness. However, most of the design options being evaluated are already available on the market as product options. Thus, DOE believes manufacturers would be able to maintain manufacturing capacity levels and continue to meet market demand under amended energy conservation standards.

d. Impacts on Subgroups of Manufacturers

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

For commercial refrigeration equipment, DOE identified and evaluated the impact of amended energy conservation standards on one subgroup: small manufacturers. The SBA defines a "small business" as having 750 employees or less for NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." Based on this definition, DOE identified 32 manufacturers in the commercial refrigeration equipment industry that are small businesses.

For a discussion of the impacts on the small 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

While any one regulation may not impose a significant burden on manufacturers, the combined effects of recent or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers' financial operations. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

For the cumulative regulatory burden analysis, DOE looks at other regulations that could affect CRE manufacturers that will take effect approximately three years before or after the 2017 compliance date of amended energy conservation standards for these products. In interviews, manufacturers cited Federal regulations on certification, on walk-in cooler and freezer equipment, and from ENERGY STAR as contributing to their cumulative regulatory burden. The compliance years and expected industry conversion costs are listed below:

Walk-in Cooler and Freezer Energy Conservation Standard Rulemaking

Nine commercial refrigeration equipment manufacturers also produce walk-ins, and therefore they must comply with two rulemakings that follow similar timelines. These manufacturers will incur conversion costs for both types of products at around the same time, which could be a significant strain on resources. In the 2013 NOPR for walk-ins, the proposed standard was estimated to require conversion costs of $71 million (in 2012$) to be incurred by the industry ahead of the 2017 compliance date. 78 FR 55781.

However, the analysis is not final and these figures are subject to change in the forthcoming final rule for walk-in coolers and freezers. DOE discusses these and other requirements, and includes the full details of the cumulative regulatory burden, in chapter 12 of the final rule TSD.

Certification, Compliance, and Enforcement Rule

Many manufacturers have expressed concerns about the Certification, Compliance, and Enforcement (CC&E) March 2011 final rule, which allows DOE to enforce the energy and water conservation standards for covered products and equipment, and provides for more accurate, comprehensive information about the energy and water use characteristics of products sold in the United States. The rule revises former certification regulations so that the Department has the information it needs to ensure that regulated products sold in the United States comply with the law. According to the rule, manufacturers of covered consumer products and commercial and industrial equipment must certify on an annual basis, by means of a compliance statement and a certification report, that each of their basic models meets its applicable energy conservation, water conservation, and/or design standard before it is distributed within the United States. For purposes of certification testing, the determination that a basic model complies with the applicable conservation standard must be based on sampling procedures, which currently require that a minimum of two units of a basic model must be tested in order to certify that the model is compliant (unless the product-specific regulations specify otherwise). 76 FR 12422 (March 7, 2011).

However, DOE recognizes that sampling requirements can create burden for certain commercial refrigeration equipment manufacturers who build one-of-a kind customized units and have a large number of basic models. Therefore, DOE conducted a rulemaking to expand AEDM coverage and issued a final rule on December 31, 2013. (78 FR 79579) An AEDM is a computer modeling or mathematical tool that predicts the performance of non-tested basic models. In the final rule, DOE is allowing CRE manufacturers to rate their basic models using AEDMs, reducing the need for sample units and reducing burden on manufacturers. More information can be found at http://www1.eere.energy.gov/buildings/appliance_standards/implement_cert_and_enforce.html. DOE discusses these and other requirements, and includes the full details of the cumulative regulatory burden, in chapter 12 of the final rule TSD.

EPA's ENERGY STAR

Some stakeholders have also expressed concern regarding potential conflicts with other certification programs, in particular EPA's ENERGY STAR requirements. However, DOE notes that certain standards, such as ENERGY STAR, are voluntary for manufacturers. As such, they are not part of DOE's consideration of cumulative regulatory burden.

DOE discusses these and other non-Federal regulations in chapter 12 of the NOPR TSD.

3. National Impact Analysis

a. Energy Savings

DOE estimated the NES by calculating the difference in annual energy consumption for the base-case scenario and standards-case scenario at each TSL for each equipment class and summing up the annual energy savings over the lifetime of all equipment purchased in 2017-2046.

Table V.38 presents the primary NES (taking into account losses in the generation and transmission of electricity) for all equipment classes and the sum total of NES for each TSL, and

Table V.39 presents estimated FFC energy savings for each considered TSL. The total FFC NES progressively increases from 1.195 quads at TSL 1 to 4.207 quads at TSL 5.

Table V.38 Cumulative National Primary Energy Savings for Equipment Purchased in 2017–2046

Equipment Class	quads				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.000	0.000	0.403	0.550	0.584
VOP.RC.L	0.000	0.000	0.001	0.011	0.017
VOP.SC.M	0.000	0.000	0.000	0.002	0.007
VCT.RC.M	0.000	0.000	0.006	0.008	0.010
VCT.RC.L	0.096	0.096	0.130	0.150	0.259
VCT.SC.M	0.010	0.060	0.093	0.110	0.139
VCT.SC.L	0.018	0.041	0.045	0.050	0.050
VCT.SC.I	0.001	0.001	0.001	0.003	0.008
VCS.SC.M	0.309	0.687	0.794	0.870	1.080
VCS.SC.L	0.450	0.631	0.808	0.839	1.121
VCS.SC.I	0.000	0.001	0.002	0.002	0.005
SVO.RC.M	0.229	0.229	0.229	0.316	0.335
SVO.SC.M	0.000	0.000	0.000	0.010	0.016
SOC.RC.M	0.000	0.000	0.000	0.004	0.016
SOC.SC.M	0.000	0.000	0.000	0.001	0.002

HZO.RC.M	0.000	0.000	0.000	0.000	0.002
HZO.RC.L	0.000	0.000	0.000	0.000	0.023
HZO.SC.M	0.000	0.001	0.001	0.001	0.002
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.000	0.001	0.001	0.002	0.002
HCT.SC.L	0.011	0.012	0.012	0.013	0.016
HCT.SC.I	0.000	0.000	0.000	0.000	0.005
HCS.SC.M	0.004	0.008	0.013	0.013	0.030
HCS.SC.L	0.001	0.002	0.003	0.005	0.010
PD.SC.M	0.046	0.271	0.301	0.310	0.403
Total	1.176	2.041	2.844	3.270	4.140

Table V.39 Cumulative National Full-Fuel-Cycle Energy Savings for Equipment Purchased in 2017–2046

Equipment Class	quads				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.000	0.000	0.410	0.559	0.593
VOP.RC.L	0.000	0.000	0.001	0.011	0.018
VOP.SC.M	0.000	0.000	0.000	0.002	0.007
VCT.RC.M	0.000	0.000	0.006	0.008	0.010
VCT.RC.L	0.098	0.098	0.132	0.153	0.263
VCT.SC.M	0.010	0.061	0.094	0.112	0.141
VCT.SC.L	0.018	0.042	0.046	0.050	0.050
VCT.SC.I	0.001	0.001	0.001	0.003	0.008
VCS.SC.M	0.314	0.699	0.807	0.884	1.097
VCS.SC.L	0.458	0.641	0.821	0.852	1.139
VCS.SC.I	0.000	0.001	0.002	0.002	0.005
SVO.RC.M	0.233	0.233	0.233	0.321	0.340
SVO.SC.M	0.000	0.000	0.000	0.010	0.016
SOC.RC.M	0.000	0.000	0.000	0.004	0.016
SOC.SC.M	0.000	0.000	0.000	0.001	0.002
HZO.RC.M	0.000	0.000	0.000	0.000	0.002
HZO.RC.L	0.000	0.000	0.000	0.000	0.023
HZO.SC.M	0.000	0.001	0.001	0.001	0.002
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.000	0.001	0.001	0.002	0.002
HCT.SC.L	0.011	0.012	0.012	0.013	0.016
HCT.SC.I	0.000	0.000	0.000	0.000	0.005
HCS.SC.M	0.004	0.008	0.013	0.014	0.030
HCS.SC.L	0.001	0.002	0.003	0.005	0.010
PD.SC.M	0.047	0.275	0.306	0.315	0.410
Total	1.195	2.074	2.889	3.323	4.207

Circular A-4 requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using nine 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.[76] The review timeframe established in EPCA generally does not overlap with the product lifetime, product manufacturing cycles or other factors specific to commercial refrigeration equipment. Thus, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology. The primary and full-fuel cycle NES results based on a 9-year analysis period are presented in Table V.40 and Table V.41, respectively. The impacts are counted over the lifetime of products purchased in 2017–2025.

[76] EPCA requires DOE to review its standards at least once every 6 years (42 U.S.C. 6295(m)(1), 6316(e)), 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. 6295(m)(4), 6316(e)).While adding a 6-year review to the 3-year compliance period sums 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 be extended to 5 years. 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 consumer products, the period following establishment of a new or amended standard before which compliance is required is 5 years rather than 3 years.

Table V.40 Cumulative National Primary Energy Savings for 9-year Analysis Period (Equipment Purchased in 2017–2025)

Equipment Class	quads				
	TSL 1	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
VOP.RC.M	0.000	0.000	0.099	0.134	0.143
VOP.RC.L	0.000	0.000	0.000	0.003	0.004
VOP.SC.M	0.000	0.000	0.000	0.000	0.002
VCT.RC.M	0.000	0.000	0.002	0.002	0.003
VCT.RC.L	0.024	0.024	0.032	0.037	0.063
VCT.SC.M	0.003	0.017	0.025	0.029	0.036
VCT.SC.L	0.005	0.011	0.012	0.013	0.013
VCT.SC.I	0.000	0.000	0.000	0.001	0.002
VCS.SC.M	0.075	0.168	0.198	0.219	0.270
VCS.SC.L	0.110	0.156	0.202	0.209	0.278
VCS.SC.I	0.000	0.000	0.001	0.001	0.001
SVO.RC.M	0.056	0.056	0.056	0.077	0.082
SVO.SC.M	0.000	0.000	0.000	0.002	0.004
SOC.RC.M	0.000	0.000	0.000	0.001	0.004
SOC.SC.M	0.000	0.000	0.000	0.000	0.001
HZO.RC.M	0.000	0.000	0.000	0.000	0.000
HZO.RC.L	0.000	0.000	0.000	0.000	0.006
HZO.SC.M	0.000	0.000	0.000	0.000	0.000
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.000	0.000	0.000	0.000	0.001
HCT.SC.L	0.003	0.003	0.003	0.003	0.004
HCT.SC.I	0.000	0.000	0.000	0.000	0.001
HCS.SC.M	0.001	0.002	0.003	0.004	0.008
HCS.SC.L	0.000	0.001	0.001	0.001	0.003
PD.SC.M	0.011	0.066	0.074	0.076	0.099
Total	0.289	0.504	0.707	0.814	1.027

Table V.41 Cumulative Full Fuel Cycle National Energy Savings for 9-year Analysis Period (Equipment Purchased in 2017–2025)

Equipment Class	quads				
	TSL 1	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
VOP.RC.M	0.000	0.000	0.100	0.137	0.145
VOP.RC.L	0.000	0.000	0.000	0.003	0.004
VOP.SC.M	0.000	0.000	0.000	0.000	0.002
VCT.RC.M	0.000	0.000	0.002	0.002	0.003
VCT.RC.L	0.024	0.024	0.032	0.037	0.064
VCT.SC.M	0.003	0.017	0.025	0.029	0.037
VCT.SC.L	0.005	0.012	0.013	0.014	0.014
VCT.SC.I	0.000	0.000	0.000	0.001	0.002
VCS.SC.M	0.077	0.171	0.201	0.222	0.275
VCS.SC.L	0.112	0.158	0.205	0.213	0.283
VCS.SC.I	0.000	0.000	0.001	0.001	0.001
SVO.RC.M	0.057	0.057	0.057	0.079	0.083
SVO.SC.M	0.000	0.000	0.000	0.002	0.004
SOC.RC.M	0.000	0.000	0.000	0.001	0.004
SOC.SC.M	0.000	0.000	0.000	0.000	0.001
HZO.RC.M	0.000	0.000	0.000	0.000	0.000
HZO.RC.L	0.000	0.000	0.000	0.000	0.006
HZO.SC.M	0.000	0.000	0.000	0.000	0.000
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.000	0.000	0.000	0.000	0.001
HCT.SC.L	0.003	0.003	0.003	0.003	0.004
HCT.SC.I	0.000	0.000	0.000	0.000	0.001
HCS.SC.M	0.001	0.002	0.004	0.004	0.008
HCS.SC.L	0.000	0.001	0.001	0.001	0.003
PD.SC.M	0.011	0.067	0.075	0.077	0.100
Total	0.294	0.513	0.719	0.828	1.045

b. Net Present Value of Customer Costs and Benefits

DOE estimated the cumulative NPV to the Nation of the net savings for CRE customers that would result from potential standards at each TSL. In accordance with OMB guidelines on regulatory analysis (OMB Circular A-4, section E, September 17, 2003), DOE calculated NPV using both a 7-percent and a 3-percent real discount rate.

Table V.42 and Table V.43 show the customer NPV results for each of the TSLs DOE considered for commercial refrigeration equipment at 7-percent and 3-percent discount rates, respectively. The impacts cover the expected lifetime of equipment purchased in 2017–2046.

The NPV results at a 7-percent discount rate are negative for all equipment classes at TSL 5 except for the VCT.SC.L equipment class. Efficiency levels for TSL 4 were chosen to correspond to the highest efficiency level with a near positive NPV at a 7-percent discount rate for each equipment class. The criterion for TSL 3 was to select efficiency levels with the highest NPV at a 7-percent discount rate. Consequently, the total NPV is highest for TSL 3. TSL 2 shows the second highest total NPV at a 7-percent discount rate. TSL 1 has a total NPV lower than TSL 2.

Table V.42 Net Present Value of Customer Costs and Benefits at a 7-percent Discount Rate

Equipment Class	billion 2012$ *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.000	0.000	0.570	0.171	-2.941
VOP.RC.L	0.000	0.000	0.001	-0.004	-0.240
VOP.SC.M	0.000	0.000	0.000	-0.009	-0.374
VCT.RC.M	0.000	0.000	0.013	-0.003	-0.271
VCT.RC.L	0.212	0.212	0.234	-0.005	-4.423
VCT.SC.M	-0.006	0.039	0.058	-0.003	-1.531
VCT.SC.L	0.059	0.118	0.123	0.040	0.040
VCT.SC.I	0.000	0.000	0.000	-0.004	-0.141
VCS.SC.M	0.756	1.748	1.829	1.659	-6.820
VCS.SC.L	1.164	1.502	1.579	1.550	-4.692
VCS.SC.I	0.001	0.002	0.003	0.003	-0.050
SVO.RC.M	0.291	0.291	0.291	0.081	-1.493
SVO.SC.M	0.000	0.000	0.000	-0.003	-0.215
SOC.RC.M	0.000	0.000	0.000	-0.011	-0.342
SOC.SC.M	0.000	0.000	0.000	-0.003	-0.032
HZO.RC.M	0.000	0.000	0.000	0.000	-0.123
HZO.RC.L	0.000	0.000	0.000	0.000	-0.734
HZO.SC.M	0.000	0.000	0.000	0.000	-0.025
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.001	0.002	0.002	0.000	-0.014
HCT.SC.L	0.024	0.024	0.025	0.022	-0.030

HCT.SC.I	0.000	0.000	0.000	0.000	-0.076
HCS.SC.M	0.008	0.012	0.012	0.007	-0.342
HCS.SC.L	0.003	0.005	0.006	0.004	-0.047
PD.SC.M	0.007	0.183	0.183	0.146	-3.475
Total	2.519	4.139	4.928	3.637	-28.390

* A value of $0.000 means NES values are less than 0.001 billion 2012$.

Table V.43 Net Present Value of Customer Costs and Benefits at a 3-percent Discount Rate

Equipment Class	billion 2012$ *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.000	0.000	1.500	0.882	-4.894
VOP.RC.L	0.000	0.000	0.004	0.003	-0.433
VOP.SC.M	0.000	0.000	0.000	-0.016	-0.683
VCT.RC.M	0.000	0.000	0.029	0.001	-0.496
VCT.RC.L	0.481	0.481	0.551	0.125	-8.007
VCT.SC.M	-0.006	0.119	0.185	0.086	-2.712
VCT.SC.L	0.124	0.252	0.265	0.116	0.116
VCT.SC.I	0.001	0.001	0.001	-0.005	-0.254
VCS.SC.M	1.656	3.838	4.074	3.825	-11.832
VCS.SC.L	2.551	3.333	3.626	3.592	-7.824
VCS.SC.I	0.001	0.005	0.007	0.007	-0.090
SVO.RC.M	0.790	0.790	0.790	0.476	-2.443
SVO.SC.M	0.000	0.000	0.000	0.003	-0.383
SOC.RC.M	0.000	0.000	0.000	-0.018	-0.625
SOC.SC.M	0.000	0.000	0.000	-0.004	-0.058
HZO.RC.M	0.000	0.000	0.000	0.000	-0.227
HZO.RC.L	0.000	0.000	0.000	0.000	-1.350
HZO.SC.M	0.000	0.001	0.001	0.000	-0.044
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.002	0.004	0.004	0.002	-0.024
HCT.SC.L	0.054	0.056	0.057	0.053	-0.039
HCT.SC.I	0.000	0.000	0.000	0.000	-0.137
HCS.SC.M	0.019	0.029	0.033	0.022	-0.594
HCS.SC.L	0.006	0.010	0.014	0.012	-0.076
PD.SC.M	0.046	0.577	0.602	0.537	-6.090
Total	5.727	9.497	11.742	9.698	-49.199

* A value of $0.000 means NES values are less than 0.001 billion 2012$. Values in parentheses are negative values.

The NPV results based on the aforementioned 9-year analysis period are presented in Table V.44 and Table V.45. The impacts are counted over the lifetime of equipment purchased in 2017–2025. As mentioned previously, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

Table V.44 Net Present Value of Customer Costs and Benefits at a 7-percent Discount Rate for 9-year Analysis Period (Equipment Purchased in 2017–2025)

Equipment Class	billion 2012$ *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.000	0.000	0.237	0.036	-1.454
VOP.RC.L	0.000	0.000	0.000	-0.002	-0.116
VOP.SC.M	0.000	0.000	0.000	-0.005	-0.179
VCT.RC.M	0.000	0.000	0.006	-0.002	-0.130
VCT.RC.L	0.099	0.099	0.107	-0.009	-2.130
VCT.SC.M	-0.004	0.020	0.027	-0.003	-0.736
VCT.SC.L	0.029	0.059	0.061	0.021	0.021
VCT.SC.I	0.000	0.000	0.000	-0.002	-0.068
VCS.SC.M	0.342	0.792	0.827	0.732	-3.338
VCS.SC.L	0.528	0.681	0.709	0.693	-2.311
VCS.SC.I	0.000	0.001	0.001	0.001	-0.024
SVO.RC.M	0.118	0.118	0.118	0.012	-0.742
SVO.SC.M	0.000	0.000	0.000	-0.002	-0.104
SOC.RC.M	0.000	0.000	0.000	-0.006	-0.165
SOC.SC.M	0.000	0.000	0.000	-0.001	-0.015
HZO.RC.M	0.000	0.000	0.000	0.000	-0.059
HZO.RC.L	0.000	0.000	0.000	0.000	-0.353
HZO.SC.M	0.000	0.000	0.000	0.000	-0.012
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.000	0.001	0.001	0.000	-0.007
HCT.SC.L	0.011	0.011	0.011	0.010	-0.018
HCT.SC.I	0.000	0.000	0.000	0.000	-0.037
HCS.SC.M	0.004	0.006	0.006	0.003	-0.182
HCS.SC.L	0.001	0.002	0.003	0.002	-0.025
PD.SC.M	0.000	0.079	0.077	0.059	-1.680
Total	1.129	1.869	2.191	1.536	-13.863

*A value of $0.000 means NES values are less than 0.001 billion 2012$. Values in parentheses are negative values.

Table V.45 Net Present Value of Customer Costs and Benefits at a 3-percent Discount Rate for 9-year Analysis period (Equipment Purchased in 2017–2025)

Equipment Class	billion 2012$ *				
	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	0.000	0.000	0.446	0.208	-1.814
VOP.RC.L	0.000	0.000	0.001	-0.001	-0.154
VOP.SC.M	0.000	0.000	0.000	-0.006	-0.240

VCT.RC.M	0.000	0.000	0.010	0.000	-0.174
VCT.RC.L	0.160	0.160	0.179	0.027	-2.829
VCT.SC.M	-0.004	0.044	0.062	0.025	-0.957
VCT.SC.L	0.045	0.092	0.096	0.043	0.043
VCT.SC.I	0.000	0.000	0.000	-0.002	-0.090
VCS.SC.M	0.533	1.239	1.314	1.204	-4.295
VCS.SC.L	0.824	1.078	1.160	1.143	-2.885
VCS.SC.I	0.000	0.001	0.002	0.002	-0.032
SVO.RC.M	0.231	0.231	0.231	0.108	-0.914
SVO.SC.M	0.000	0.000	0.000	0.000	-0.136
SOC.RC.M	0.000	0.000	0.000	-0.007	-0.221
SOC.SC.M	0.000	0.000	0.000	-0.002	-0.021
HZO.RC.M	0.000	0.000	0.000	0.000	-0.080
HZO.RC.L	0.000	0.000	0.000	0.000	-0.475
HZO.SC.M	0.000	0.000	0.000	0.000	-0.016
HZO.SC.L	0.000	0.000	0.000	0.000	0.000
HCT.SC.M	0.001	0.001	0.001	0.000	-0.009
HCT.SC.L	0.017	0.018	0.018	0.016	-0.020
HCT.SC.I	0.000	0.000	0.000	0.000	-0.049
HCS.SC.M	0.007	0.010	0.011	0.007	-0.237
HCS.SC.L	0.002	0.004	0.005	0.004	-0.031
PD.SC.M	0.009	0.178	0.182	0.158	-2.171
Total	1.826	3.056	3.719	2.929	-17.805

* A value of $0.000 means NES values are less than 0.001 billion 2012$. Values in parentheses are negative values.

c. Employment Impacts

In addition to the direct impacts on manufacturing employment discussed in section V.B.2, DOE develops general estimates of the indirect employment impacts of amended standards on the economy. As discussed above, DOE expects energy amended conservation standards for commercial refrigeration equipment to reduce energy bills for commercial customers, and the resulting net savings to be redirected to other forms of economic activity. DOE also realizes that these shifts in spending and economic activity by commercial refrigeration equipment owners could affect the demand for labor. Thus, indirect employment impacts may result from expenditures shifting between goods (the substitution effect) and changes in income and overall expenditure levels (the income effect) that occur due to the imposition of amended standards. These impacts may affect a variety of businesses not directly involved in the decision to make, operate, or pay the utility bills for commercial refrigeration equipment. To estimate these indirect economic effects, DOE used an input/output model of the U.S. economy using U.S. Department of Commerce, Bureau of Economic Analysis (BEA) and BLS data (as described in section IV.J of this document; see chapter 16 of the final rule TSD for more details).

Customers who purchase more-efficient equipment pay lower amounts towards utility bills, which results in job losses in the electric utilities sector. However, in the input/output model, the dollars saved on utility bills are re-invested in economic sectors that create more jobs than are lost in the electric utilities sector. Thus, the amended energy conservation standards for commercial refrigeration equipment are likely to slightly increase the net demand for labor in the economy. As shown in chapter 16 of the final rule TSD, DOE estimates that net indirect employment impacts from commercial refrigeration equipment amended standards are very small relative to the national economy. However, the net increase in jobs might be offset by other, unanticipated effects on employment. Neither the BLS data nor the input/output model used by DOE includes the quality of jobs.

4. Impact on Utility or Performance of Equipment

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 6316(e)(1)) 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. For today's final rule, DOE concluded that none of the efficiency levels considered for commercial refrigeration equipment reduce the utility or performance of the equipment.

5. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition that is likely to result from standards. It also 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 to the Secretary within 60 days of the publication of a proposed rule and simultaneously published proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) To assist the Attorney General in making a determination for CRE standards, DOE provided the Department of Justice (DOJ) with copies of the NOPR and the TSD for review. DOE received no adverse comments from DOJ regarding the proposal.

6. Need of the Nation to Conserve Energy

An improvement in the energy efficiency of the equipment subject to today's final rule is likely to improve the security of the Nation's energy system by reducing overall demand for energy. Reduced electricity demand may also improve the reliability of the electricity system. Reductions in national electric generating capacity estimated for each considered TSL are reported in chapter 14 of the final rule TSD.

Energy savings from amended standards for commercial refrigeration equipment could also produce environmental benefits in the form of reduced emissions of air pollutants and GHGs associated with electricity production. Table V.46 provides DOE's estimate of cumulative emissions reductions projected to result from the TSLs considered in this rule. The table includes both power sector emissions and upstream emissions. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

Table V.46 Cumulative Emissions Reduction Estimated for Commercial Refrigeration Equipment TSLs for Equipment Purchased in 2017–2046

	TSL				
	1	**2**	**3**	**4**	**5**
Power Sector Emissions					
CO_2 (million metric tons)	54.9	95.4	133.0	152.9	193.6
SO_2 (thousand tons)	84.9	147.4	205.5	236.3	299.1
NO_X (thousand tons)	-11.4	-19.9	-28.1	-32.3	-40.7
Hg (tons)	0.10	0.17	0.24	0.28	0.35
N_2O (thousand tons)	1.3	2.3	3.2	3.7	4.7
CH_4 (thousand tons)	7.7	13.3	18.6	21.4	27.1
Upstream Emissions					
CO_2 (million metric tons)	3.7	6.4	8.9	10.2	13.0
SO_2 (thousand tons)	0.8	1.4	1.9	2.2	2.8
NO_X (thousand tons)	50.6	87.8	122.4	140.7	178.2
Hg (tons)	0.00	0.00	0.00	0.01	0.01
N_2O (thousand tons)	0.0	0.1	0.1	0.1	0.1
CH_4 (thousand tons)	307.2	533.3	743.1	854.6	1081.9
Total Emissions					
CO_2 (million metric tons)	58.6	101.7	141.9	163.2	206.5
SO_2 (thousand tons)	85.7	148.8	207.4	238.5	301.9
NO_X (thousand tons)	39.2	67.9	94.3	108.4	137.4
Hg (tons)	0.10	0.18	0.25	0.28	0.36
N_2O (thousand tons)	1.4	2.4	3.3	3.8	4.8
CH_4 (thousand tons)	314.9	546.6	761.7	875.9	1109.0

As part of the analysis for this final rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_x that were estimated for each of the

TSLs considered. As discussed in section IV.L, for CO_2, DOE used values for the SCC developed by an interagency process. The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth set, which represents the 95^{th}-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The four SCC values for CO_2 emissions reductions in 2015, expressed in 2012$, are $11.8/ton, $39.7/ton, $61.2/ton, and $117/ton. The values for later years are higher due to increasing emissions-related costs as the magnitude of projected climate change increases.

Table V.47 presents the global value of CO_2 emissions reductions at each TSL. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in chapter 14 of the final rule TSD.

Table V.47 Global Present Value of CO_2 Emissions Reduction for Potential Standards for Commercial Refrigeration Equipment

TSL	SCC Scenario			
	5% discount rate, average	3% discount rate, average	2.5% discount rate, average	3% discount rate, 95^{th} percentile
	million 2012$			
Power Sector Emissions				
1	392	1762	2787	5438
2	682	3063	4844	9452
3	952	4274	6758	13187
4	1095	4916	7773	15167
5	1385	6220	9836	19192
Upstream Emissions				
1	25	115	183	356
2	43	200	317	617
3	61	278	442	861

4	70	320	508	990
5	88	405	643	1253
Total Emissions				
1	417	1877	2970	5794
2	725	3263	5161	10070
3	1012	4552	7200	14047
4	1164	5236	8281	16157
5	1473	6625	10479	20444

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 world economy continues to evolve rapidly. Thus, any value placed in this final rule on reducing CO_2 emissions is subject to change. DOE, together with other Federal agencies, will continue to review various 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 final rule and other rulemakings, as well as other methodological assumptions and issues. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this final rule the most recent values and analyses resulting from the ongoing interagency review process.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_x emission reductions anticipated to result from amended commercial refrigeration equipment standards. Table V.48 presents the present value of cumulative NO_x emissions reductions for each TSL calculated using the average dollar-per-ton values and 7-percent and 3-percent discount rates.

Table V.48 Present Value of NO_x Emissions Reduction for Potential Standards for Commercial Refrigeration Equipment

TSL	3% Discount Rate	7% Discount Rate
	million 2012$	
Power Sector Emissions		
1	-25.3	-18.9
2	-44.4	-33.2
3	-62.4	-46.6
4	-71.9	-53.7
5	-90.6	-67.7
Upstream Emissions		
1	68.7	32.6
2	119.4	56.7
3	166.5	79.3
4	191.5	91.2
5	242.4	115.3
Total Emissions		
1	43.4	13.7
2	75.0	23.6
3	104.1	32.6
4	119.6	37.4
5	151.8	47.6

7. Summary of National Economic Impact

The NPV of the monetized benefits associated with emission reductions can be viewed as a complement to the NPV of the customer savings calculated for each TSL considered in this final rule. Table V.49 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of customer savings calculated for each TSL, at both a 7-percent and a 3-percent discount rate. The CO_2 values used in the table correspond to the four scenarios for the valuation of CO_2 emission reductions discussed above.

Table V.49 Commercial Refrigeration Equipment TSLs: Net Present Value of Consumer Savings Combined with Net Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions

TSL	Consumer NPV at 3% Discount Rate added with Value of Emissions Based on:			
	SCC Value of $11.8/metric ton CO_2*and Medium Value for NOx	SCC Value of $39.7/metric ton CO_2* and Medium Value for NOx	SCC Value of $61.2/metric ton CO_2* and Medium Value for NOx	SCC Value of $117/metric ton CO_2* and Medium Value for NOx
	billion 2012$			
1	6.2	7.6	8.7	11.6
2	10.3	12.8	14.7	19.6
3	12.9	16.4	19.0	25.9
4	11.0	15.1	18.1	26.0
5	-47.6	-42.4	-38.6	-28.6
TSL	Consumer NPV at 7% Discount Rate added with Value of Emissions Based on:			
	SCC Value of $11.8/metric ton CO_2* and Medium Value for NOx	SCC Value of $39.7/metric ton CO_2* and Medium Value for NOx	SCC Value of $61.2/metric ton CO_2* and Medium Value for NOx	SCC Value of $117/metric ton CO_2* and Medium Value for NOx
	billion 2012$			
1	3.0	4.4	5.5	8.3
2	4.9	7.4	9.3	14.2
3	6.0	9.5	12.2	19.0
4	4.8	8.9	12.0	19.8
5	-26.9	-21.7	-17.9	-7.9

* These label values represent the global SCC in 2015, in 2012$. The present values have been calculated with scenario-consistent discount rates.

Although adding the value of customer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. customer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and the SCC are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2017–2046. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one metric ton of CO_2 in each year. These impacts continue well beyond 2100.

8. Other Factors

EPCA allows the Secretary, in determining whether a standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII) and 6316(e)(1)) DOE has not considered other factors in development of the standards in this final rule.

C. Conclusions

Any new or amended energy conservation standard for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 6316(e)(1)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i) and 6316(e)(1)) The new or amended standard must also result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B) and 6316(e)(1))

For today's rulemaking, DOE considered the impacts of potential standards at each TSL, beginning with the maximum technologically feasible level, to determine whether that level met the evaluation criteria. If 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 in understanding the benefits and/or burdens of each TSL, tables in this section summarize the quantitative analytical results for each TSL, based on the assumptions and methodology discussed herein. The efficiency levels contained in each TSL are described in section IV.A.1. In addition to the quantitative results presented in the tables below, 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. Section IV.I presents the estimated impacts of each TSL for the considered subgroups. DOE discusses the impacts on employment in CRE manufacturing in section IV.J and discusses the indirect employment impacts in section IV.N.

1. Benefits and Burdens of Trial Standard Levels Considered for Commercial Refrigeration Equipment

Table V.50 through Table V.53 summarizes the quantitative impacts estimated for each TSL for CRE.

Table V.50 Summary of Results for Commercial Refrigeration Equipment TSLs: National Impacts*

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL5
Cumulative National Energy Savings 2017 through 2060 quads					
	1.176	2.041	2.844	3.270	4.140
With full-fuel cycle	1.195	2.074	2.889	3.323	4.207
Cumulative NPV of Customer Benefits 2012$ billion					
3% discount rate	5.73	9.50	11.74	9.70	(49.20)
7% discount rate	2.52	4.14	4.93	3.64	(28.39)
Industry Impacts					
Change in Industry NPV (2012$ million)	(23.9) to (9.9)	(42.9) to (8.7)	(165.0) to (93.9)	(320.9) to (189.4)	(1,144.8) to (184.4)
Change in Industry NPV (%)	(0.90) to (0.37)	(1.61) to (0.33)	(6.20) to (3.53)	(12.07) to (7.12)	(43.04) to (6.93)
Cumulative Emissions Reductions**					
CO_2 (Mt)	58.6	101.7	141.9	163.2	206.5
SO_2 (kt)	85.7	148.8	207.4	238.5	301.9
NO_x (kt)	39.2	67.9	94.3	108.4	137.4
Hg (t)	0.10	0.18	0.25	0.28	0.36
N_2O (kt)	1.4	2.4	3.3	3.8	4.8
N_2O (kt CO_2eq)	408.8	709.4	988.1	1136.2	1438.8
CH_4 (kt)	314.9	546.6	761.7	875.9	1109.0
CH_4 (kt CO_2eq)	7872.6	13665.9	19043.5	21898.5	27724.7
Monetary Value of Cumulative Emissions Reductions 2012$ million†					
CO_2	417 to 5794	725 to 10070	1012 to 14047	1164 to 16157	1473 to 20444
NO_X – 3% discount rate	43.4	75.0	104.1	119.6	151.8
NO_x – 7% discount rate	13.7	23.6	32.6	37.4	47.6

** "Mt" stands for million metric tons; "kt" stands for kilotons; "t" stands for tons. CO_2eq is the quantity of CO_2 that would have the same global warming potential (GWP).

† Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

Table V.51 Summary of Results for Commercial Refrigeration Equipment TSLs: Mean LCC Savings

Mean LCC Savings* 2012$					
Equipment Class	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL 5**
VOP.RC.M	---	---	922	-5	-4,203
VOP.RC.L	---	---	53	-148	-6,701
VOP.SC.M	---	---	---	-54	-1,384
VCT.RC.M	---	---	542	41	-4,937
VCT.RC.L	647	647	526	93	-6,036
VCT.SC.M	-10	214	226	163	-1,541
VCT.SC.L	2,503	4,709	5,001	2,812	2,812
VCT.SC.I	18	18	18	-68	-2,834
VCS.SC.M	223	518	363	305	-1,428
VCS.SC.L	588	550	507	495	-1,640
VCS.SC.I	41	114	113	113	-2,710
SVO.RC.M	564	564	564	-19	-2,691
SVO.SC.M	---	---	---	6	-917
SOC.RC.M	---	---	---	-128	-2,268
SOC.SC.M	---	---	---	-209	-2,204
HZO.RC.M	---	---	---	---	-2,180
HZO.RC.L	---	---	---	---	-4,249
HZO.SC.M	---	55	55	-4	-1,154
HZO.SC.L	---	---	---	---	-
HCT.SC.M	66	165	101	43	-599
HCT.SC.L	428	435	293	248	-613
HCT.SC.I	---	---	---	---	-1,240
HCS.SC.M	12	17	15	5	-568
HCS.SC.L	31	50	64	33	-590
PD.SC.M	8	163	165	150	-1,252

* "NA" means "not applicable," because for equipment classes HZO.RC.M, HZO.RC.L, and HZO.SC.L, TSLs 1 through 4 are associated with the baseline efficiency level.

Table V.52 Summary of Results for Commercial Refrigeration Equipment TSLs: Median Payback Period

Median Payback Period years					
Equipment Class	**TSL 1**	**TSL 2**	**TSL 3**	**TSL 4**	**TSL5**
VOP.RC.M	---	---	5.7	9.9	34.1
VOP.RC.L	---	---	6.1	11.3	310.0
VOP.SC.M	---	---	---	63.1	593.2
VCT.RC.M	---	---	2.1	6.6	364.7
VCT.RC.L	1.8	1.8	2.7	6.3	194.7
VCT.SC.M	23.4	4.8	5.3	7.0	96.2
VCT.SC.L	0.5	0.8	1.1	4.7	4.7
VCT.SC.I	7.2	7.2	7.2	16.2	663.6
VCS.SC.M	0.5	0.6	1.4	2.6	48.0
VCS.SC.L	0.6	1.3	2.5	2.7	31.8
VCS.SC.I	2.6	3.6	5.0	5.0	183.7
SVO.RC.M	6.2	6.2	6.2	10.4	29.9
SVO.SC.M	---	---	---	10.9	151.6
SOC.RC.M	---	---	---	38.0	114.1
SOC.SC.M	---	---	---	28.7	25.3
HZO.RC.M	---	---	---	---	---
HZO.RC.L	---	---	---	---	288.9
HZO.SC.M	---	6.9	6.9	11.8	194.7
HZO.SC.L	---	---	---	---	---
HCT.SC.M	2.5	4.7	5.8	9.2	46.6
HCT.SC.L	1.8	2.0	2.5	3.6	19.5
HCT.SC.I	---	---	---	---	23.8
HCS.SC.M	2.9	3.7	5.5	7.5	680.6
HCS.SC.L	1.4	1.7	2.5	6.2	68.9
PD.SC.M	9.3	5.3	5.6	6.0	102.2

* “NA” means “not applicable,” because for equipment classes HZO.RC.M, HZO.RC.L, and HZO.SC.L, TSLs 1 through 4 are associated with the baseline efficiency level.

Table V.53 Summary of Results for Commercial Refrigeration Equipment TSLs: Distribution of Customer LCC Impacts

Category	TSL 1*	TSL 2*	TSL 3*	TSL 4*	TSL 5*
VOP.RC.M					
Net Cost (%)	0	0	4	64	100
No Impact (%)	100	100	41	0	0
Net Benefit (%)	0	0	55	36	0
VOP.RC.L					
Net Cost (%)	0	0	7	59	100
No Impact (%)	100	100	40	20	0
Net Benefit (%)	0	0	53	21	0
VOP.SC.M					
Net Cost (%)	0	0	0	60	100
No Impact (%)	100	100	100	40	0
Net Benefit (%)	0	0	0	0	0
VCT.RC.M					
Net Cost (%)	0	0	0	36	100
No Impact (%)	100	100	40	13	0
Net Benefit (%)	0	0	60	51	0
VCT.RC.L					
Net Cost (%)	0	0	4	43	100
No Impact (%)	40	40	20	0	0
Net Benefit (%)	60	60	76	57	0
VCT.SC.M					
Net Cost (%)	71	1	3	17	100
No Impact (%)	10	10	0	0	0
Net Benefit (%)	18	89	97	83	0
VCT.SC.L					
Net Cost (%)	0	0	0	11	11
No Impact (%)	10	0	0	0	0
Net Benefit (%)	90	100	100	89	89
VCT.SC.I					
Net Cost (%)	10	10	10	65	84
No Impact (%)	40	40	40	24	16
Net Benefit (%)	50	50	50	11	0
VCS.SC.M					
Net Cost (%)	0	0	7	25	100
No Impact (%)	40	40	10	10	0
Net Benefit (%)	60	60	83	65	0
VCS.SC.L					
Net Cost (%)	0	0	7	9	100
No Impact (%)	40	10	0	0	0
Net Benefit (%)	60	90	93	91	0
VCS.SC.I					
Net Cost (%)	0	0	9	9	92
No Impact (%)	40	32	17	17	8
Net Benefit (%)	60	68	75	75	0
SVO.RC.M					
Net Cost (%)	7	7	7	67	100
No Impact (%)	40	40	40	0	0
Net Benefit (%)	54	54	54	33	0
SVO.SC.M					
Net Cost (%)	0	0	0	32	100

No Impact (%)	100	100	100	40	0
Net Benefit (%)	0	0	0	27	0
SOC.RC.M					
Net Cost (%)	0	0	0	60	100
No Impact (%)	100	100	100	40	0
Net Benefit (%)	0	0	0	0	0
SOC.SC.M					
Net Cost (%)	0	0	0	100	100
No Impact (%)	100	100	100	0	0
Net Benefit (%)	0	0	0	1	0
HZO.RC.M**					
Net Cost (%)	0	0	0	0	60
No Impact (%)	100	100	100	100	40
Net Benefit (%)	0	0	0	0	0
HZO.RC.L**					
Net Cost (%)	0	0	0	0	60
No Impact (%)	100	100	100	100	40
Net Benefit (%)	0	0	0	0	0
HZO.SC.M					
Net Cost (%)	0	5	5	50	100
No Impact (%)	100	40	40	21	0
Net Benefit (%)	0	54	54	29	0
HZO.SC.L					
Net Cost (%)	0	0	0	0	0
No Impact (%)	100	100	100	100	100
Net Benefit (%)	0	0	0	0	0
HCT.SC.M					
Net Cost (%)	0	0	20	45	100
No Impact (%)	40	40	0	0	0
Net Benefit (%)	60	60	80	55	0
HCT.SC.L					
Net Cost (%)	0	0	10	29	87
No Impact (%)	41	41	10	10	10
Net Benefit (%)	59	59	80	61	3
HCT.SC.I					
Net Cost (%)	0	0	0	0	61
No Impact (%)	100	100	100	100	39
Net Benefit (%)	0	0	0	0	0
HCS.SC.M					
Net Cost (%)	0	1	10	42	91
No Impact (%)	9	9	9	9	9
Net Benefit (%)	91	90	80	48	0
HCS.SC.L					
Net Cost (%)	0	0	0	20	90
No Impact (%)	10	10	10	10	10
Net Benefit (%)	90	90	90	70	0
PD.SC.M					
Net Cost (%)	28	3	5	8	100
No Impact (%)	39	0	0	0	0
Net Benefit (%)	33	97	95	92	0

*Values have been rounded to the nearest integer. Therefore, some of the percentages may not add up to 100..

TSL 5 corresponds to the max-tech level for all the equipment classes and offers the potential for the highest cumulative energy savings. The estimated energy savings from TSL 5 is 4.21 quads, an amount DOE deems significant. TSL 5 shows a net negative NPV for customers with estimated increased costs valued at $28.39 billion at a 7-percent discount rate. Estimated emissions reductions are 206.5 Mt of CO_2, 137.4 kt of NO_x, 301.9 kt of SO_2, and 0.36 tons of Hg. The CO_2 emissions have a value of $1.5 billion to $20.4 billion and the NO_x emissions have a value of $47.6 million at a 7-percent discount rate.

For TSL 5 the mean LCC savings for all equipment classes, except for VCT.SC.L are negative, implying an increase in LCC. The median PBP is longer than the lifetime of the equipment for nearly all/most equipment classes. The share of customers that would experience a net benefit (positive LCC savings) is very low in nearly all equipment classes.

At TSL 5, manufacturers may expect diminished profitability due to large increases in product costs, capital investments in equipment and tooling, and expenditures related to engineering and testing. The projected change in INPV ranges from a decrease of $1,144.8 million to a decrease of $184.4 million based on DOE’s manufacturer markup scenarios. The upper bound of -$184.4 million is considered an optimistic scenario for manufacturers because it assumes manufacturers can fully pass on substantial increases in equipment costs to their customers. DOE recognizes the risk of large negative impacts on industry if manufacturers’ expectations concerning reduced profit margins are realized. TSL 5 could reduce commercial refrigeration equipment INPV by up to 43.04 percent if impacts reach the lower bound of the range.

After carefully considering the analyses results and weighing the benefits and burdens of TSL 5, DOE finds that the benefits to the Nation from TSL 5, in the form of energy savings and emissions reductions, are outweighed by the burdens, in the form of a large decrease in customer NPV, negative LCC savings and very long PBPs for nearly all equipment classes, and a decrease in manufacturer INPV. DOE concludes that the burdens of TSL 5 outweigh the benefits and, therefore, does not find TSL 5 to be economically justifiable.

TSL 4 corresponds to the highest efficiency level, in each equipment class, with a near positive NPV at a 7-percent discount rate. The estimated energy savings from TSL 4 is 3.32 quads, an amount DOE deems significant. TSL 4 shows a net positive NPV for customers with estimated benefit of at $3.64 billion at a 7-percent discount rate. Estimated emissions reductions are 163.2 Mt of CO_2, 108.4 kt of NO_x, 238.5 kt of SO_2, and 0.28 tons of Hg. The CO_2 emissions have a value of $1.2 billion to $16.1 billion and the NO_x emissions have a value of $37.4 million at a 7-percent discount rate.

At TSL 4, the mean LCC savings among equipment classes affected by standards range from −$209 for HCS.SC.M to $2,812 for VOP.RC.M.[77] The median PBP ranges

[77] For equipment classes HZO.RC.M, HZO.RC.L, and HZO.SC.L, and HCT.SC.I TSL 4 is associated with the baseline level because these equipment classes have only one efficiency level above baseline and each

from 2.6 years to 63.1 years. The share of customers that would experience a net benefit (positive LCC savings) ranges from 0 percent to 91 percent.

At TSL 4, the projected change in INPV ranges from a decrease of $320.9 million to a decrease of $189.4 million. At TSL 4, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the lower bound of the range of impacts is reached, as DOE expects, TSL 4 could result in a net loss of 12.07 percent in INPV for commercial refrigeration equipment manufacturers.

After carefully considering the analyses results and weighing the benefits and burdens of TSL 4, DOE finds that the benefits to the Nation from TSL 4, in the form of energy savings and emissions reductions, an increase in customer NPV, and positive mean LCC savings for many equipment classes, are outweighed by the burdens, in the form of negative mean LCC savings for many equipment classes (including several classes with a significant share of total shipments), long PBPs for some equipment classes, the fact that over half of customers would experience a net cost (negative LCC savings) in many equipment classes, and a decrease in manufacturer INPV. DOE concludes that the burdens of TSL 4 outweigh the benefits and, therefore, does not find TSL 4 to be economically justifiable.

Next, DOE considered TSL 3. The estimated energy savings from TSL 3 is 2.89 quads, an amount DOE deems significant. TSL 3 shows a positive NPV for customers

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of those higher efficiency levels yields a negative NPV. Therefore, there are no efficiency levels that satisfy the criteria used for selection of TSLs 1 through 4.

valued at $4.93 billion at a 7-percent discount rate. Estimated emissions reductions are 141.9 Mt of CO_2, 94.3 kt of NO_x, 207.4 kt of SO_2, and 0.25 tons of Hg. The CO_2 emissions have a value of $1.0 billion to $14.0 billion and the NO_x emissions have a value of $32.6 million at a 7-percent discount rate.

At TSL 3, the mean LCC savings for affected equipment classes range from $18 to $5,001.[78] The median PBP ranges from 1.1 years to 7.2 years. The share of customers that would experience a net benefit (positive LCC savings) is over 50 percent for all affected equipment classes.

At TSL 3, the projected change in INPV ranges from a decrease of $165.0 million to a decrease of $93.9 million. At TSL 3, DOE recognizes the risk of negative impacts if manufacturers' expectations concerning reduced profit margins are realized. If the lower bound of the range of impacts is reached, as DOE expects, TSL 3 could result in a net loss of 6.20 percent in INPV for commercial refrigeration equipment manufacturers.

After careful consideration of the analyses results and, weighing the benefits and burdens of TSL 3, DOE finds that the benefits to the Nation from TSL 3, in the form of energy savings and emissions reductions, an increase in customer NPV, positive mean LCC savings for all affected equipment classes, PBPs that are less than seven years for most of the affected equipment classes, and the fact that over half of customers would

[78] Equipment classes VOP.SC.M, SVO.SC.M, SOC.RC.M, SOC.SC.M, HZO.RC.M, HZO.RC.L, HZO.SC.L, and HCT.SC.I at TSL 3 are associated with the baseline level.

experience a net benefit in nearly all affected equipment classes, outweigh the burdens, in the form of a decrease in manufacturer INPV. The Secretary concludes that TSL 3 will offer the maximum improvement in efficiency that is technologically feasible and economically justified and will result in the significant conservation of energy. Therefore, DOE today is adopting standards at TSL 3 for commercial refrigeration equipment. The amended energy conservation standards for commercial refrigeration equipment, which consist of maximum daily energy consumption (MDEC) values as a function of either refrigerated volume or total display area (TDA), are shown in Table V.54.

Table V.54 Energy Conservation Standards for Commercial Refrigeration Equipment (Compliance Required Starting March 27, 2017)

Equipment Class*	Standard Level**, †		Equipment Class*	Standard Level**, †
VCT.RC.L	0.49 x TDA + 2.61		VOP.RC.I	2.79 x TDA + 8.7
VOP.RC.M	0.63 x TDA + 4.07		SVO.RC.L	2.2 x TDA + 6.85
SVO.RC.M	0.66 x TDA + 3.18		SVO.RC.I	2.79 x TDA + 8.7
HZO.RC.L	0.55 x TDA + 6.88		HZO.RC.I	0.7 x TDA + 8.74
HZO.RC.M	0.35 x TDA + 2.88		VOP.SC.L	4.25 x TDA + 11.82
VCT.RC.M	0.15 x TDA + 1.95		VOP.SC.I	5.4 x TDA + 15.02
VOP.RC.L	2.2 x TDA + 6.85		SVO.SC.L	4.26 x TDA + 11.51
SOC.RC.M	0.44 x TDA + 0.11		SVO.SC.I	5.41 x TDA + 14.63
VOP.SC.M	1.69 x TDA + 4.71		HZO.SC.I	2.42 x TDA + 9
SVO.SC.M	1.7 x TDA + 4.59		SOC.RC.L	0.93 x TDA + 0.22
HZO.SC.L	1.9 x TDA + 7.08		SOC.RC.I	1.09 x TDA + 0.26
HZO.SC.M	0.72 x TDA + 5.55		SOC.SC.I	1.53 x TDA + 0.36
HCT.SC.I	0.56 x TDA + 0.43		VCT.RC.I	0.58 x TDA + 3.05
VCT.SC.I	0.62 x TDA + 3.29		HCT.RC.M	0.16 x TDA + 0.13
VCS.SC.I	0.34 x V + 0.88		HCT.RC.L	0.34 x TDA + 0.26
VCT.SC.M	0.1 x V + 0.86		HCT.RC.I	0.4 x TDA + 0.31
VCT.SC.L	0.29 x V + 2.95		VCS.RC.M	0.1 x V + 0.26
VCS.SC.M	0.05 x V + 1.36		VCS.RC.L	0.21 x V + 0.54
VCS.SC.L	0.22 x V + 1.38		VCS.RC.I	0.25 x V + 0.63
HCT.SC.M	0.06 x V + 0.37		HCS.SC.I	0.34 x V + 0.88
HCT.SC.L	0.08 x V + 1.23		HCS.RC.M	0.1 x V + 0.26
HCS.SC.M	0.05 x V + 0.91		HCS.RC.L	0.21 x V + 0.54
HCS.SC.L	0.06 x V + 1.12		HCS.RC.I	0.25 x V + 0.63
PD.SC.M	0.11 x V + 0.81		SOC.SC.L	1.1 x TDA + 2.1
SOC.SC.M	0.52 x TDA + 1			

* Equipment class designations consist of a combination (in sequential order separated by periods) of: (1) an equipment family code (VOP = vertical open, SVO = semivertical open, HZO = horizontal open, VCT = vertical closed with transparent doors, VCS = vertical closed with solid doors, HCT = horizontal closed with transparent doors, HCS = horizontal closed with solid doors, SOC = service over counter, or PD = pull-down); (2) an operating mode code (RC = remote condensing or SC = self-contained); and (3) a rating temperature code (M = medium temperature (38±2 °F), L = low temperature (0±2 °F), or I = ice-cream temperature (-15±2 °F)). For example, “VOP.RC.M” refers to the “vertical open, remote condensing, medium temperature” equipment class. See discussion in chapter 3 of the final rule technical support document (TSD) for a more detailed explanation of the equipment class terminology.
** “TDA” is the total display area of the case, as measured in the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1200-2010, appendix D.
† “V” is the volume of the case, as measured in American National Standards Institute (ANSI) / Association of Home Appliance Manufacturers (AHAM) Standard HRF-1-2004.

2. Summary of Benefits and Costs (Annualized) of the Standards

The benefits and costs of today's standards, for equipment sold in 2017-2046, can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value of the benefits from operating the product (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing consumer NPV), plus (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[79]

Estimates of annualized benefits and costs of today's standards are shown in Table V.55. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the average SCC series that uses a 3-percent discount rate, the cost of the standards in today's rule is $256 million per year in increased equipment costs, while the benefits are $710 million per year in reduced equipment operating costs, $246 million in CO_2 reductions, and $3.01 million in reduced NO_X emissions. In this case, the net benefit amounts to $704 million per year. Using a 3-percent discount rate for all benefits and costs and the average SCC series, the cost of the standards in today's rule is $264 million per year in increased equipment costs, while the

[79] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2013, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of three and seven percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table I.3. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2017 through 2046) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined is a steady stream of payments.

benefits are $900 million per year in reduced operating costs, $246 million in CO_2 reductions, and $5.64 million in reduced NO_X emissions. In this case, the net benefit amounts to $888 million per year.

Table V.55 Annualized Benefits and Costs of New and Amended Standards for Commercial Refrigeration Equipment

	Discount Rate	Primary Estimate*	Low Net Benefits Estimate*	High Net Benefits Estimate*
		million 2012$/year		
Benefits				
Operating Cost Savings	7%	710	688	744
	3%	900	865	947
CO_2 Reduction at ($11.8/t case)**	5%	73	73	73
CO_2 Reduction at ($39.7/t case)**	3%	246	246	246
CO_2 Reduction at ($61.2/t case)**	2.5%	361	361	361
CO_2 Reduction at ($117.0/t case)**	3%	760	760	760
NO_X Reduction at ($2,591/ton)**	7%	3.01	3.01	3.01
	3%	5.64	5.64	5.64
Total Benefits†	7% plus CO_2 range	786 to 1,474	764 to 1,451	820 to 1,508
	7%	960	937	994
	3% plus CO_2 range	978 to 1,666	943 to 1,631	1,026 to 1,713
	3%	1,152	1,117	1,200
Costs				
Incremental Equipment Costs	7%	256	250	261
	3%	264	258	271
Net Benefits				
Total†	7% plus CO_2 range	530 to 1,218	513 to 1,201	559 to 1,246
	7%	704	687	733
	3% plus CO_2 range	714 to 1,402	685 to 1,373	755 to 1,442
	3%	888	859	929

* This table presents the annualized costs and benefits associated with commercial refrigeration equipment shipped in 2017 - 2046. These results include benefits to customers which accrue after 2046 from the products purchased in 2017 - 2046. The results account for the incremental variable and fixed costs incurred by manufacturers due to the amended standard, some of which may be incurred in preparation for the final rule. The primary, low, and high estimates utilize projections of energy prices from the AEO 2013 Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental equipment costs reflect a medium decline rate for projected product price trends in the Primary Estimate, a low decline rate

for projected product price trends in the Low Benefits Estimate, and a high decline rate for projected product price trends in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.H.
** The CO_2 values represent global monetized values of the SCC, in 2012$, in 2015 under several scenarios of the updated SCC values. The first three cases use the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The fourth case represents the 95^{th} percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series used by DOE incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.
† Total Benefits for both the 3-percent and 7-percent cases are derived using the series corresponding to average SCC with 3-percent discount rate. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 range," the operating cost and NO_X benefits are calculated using the labeled discount rate, and those values are added to the full range of CO_2 values.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (October 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that today's standards address are as follows:

(1) For certain segments of the companies that purchase commercial refrigeration equipment, such as small grocers, there may be a lack of consumer information and/or information processing capability about energy efficiency opportunities in the commercial refrigeration equipment market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information).

(3) There are external benefits resulting from improved energy efficiency of commercial refrigeration equipment that are not captured by the users of such equipment. These benefits include externalities related to environmental protection that are not reflected in energy prices, such as reduced emissions of greenhouse gases. DOE attempts to quantify some of the external benefits through use of Social Cost of Carbon values.

In addition, DOE has determined that today's regulatory action is an "economically significant regulatory action" under section 3(f)(1) of Executive Order 12866. Accordingly, section 6(a)(3) of the Executive Order requires that DOE prepare a regulatory impact analysis (RIA) on today's rule and that the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. The assessments prepared pursuant to Executive Order 12866 can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011 (76 FR 3281, January 21, 2011). EO 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 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 Executive Order 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs 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, DOE believes that today’s final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.) requires preparation of an 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 Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (August 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 (http://energy.gov/gc/office-general-counsel).

For manufacturers of commercial refrigeration equipment, the Small Business Administration (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. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (September 5, 2000) and codified at 13 CFR part 121.The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at http://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf. Commercial refrigeration equipment manufacturing 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 750 employees or less for an entity to be considered as a small business for this category. Based on this threshold, DOE present the following FRFA analysis:

1. Description and Estimated Number of Small Entities Regulated

During its market survey, DOE used available public information to identify potential small manufacturers. DOE's research involved industry trade association membership directories (including AHRI), public databases (e.g., AHRI Directory,[80] the SBA Database[81]), individual company websites, and market research tools (e.g., Dunn and Bradstreet reports[82] and Hoovers reports[83]) to create a list of companies that manufacture or sell products covered by this rulemaking. DOE also asked stakeholders and industry representatives if they were aware of any other small manufacturers during manufacturer interviews and at DOE public meetings. DOE reviewed publicly available data and contacted select companies on its list, as necessary, to determine whether they met the SBA's definition of a small business manufacturer of covered commercial refrigeration equipment. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a "small business," or are foreign owned.

DOE identified 54 companies selling commercial refrigeration equipment in the United States. Nine of the companies are foreign-owned firms. Of the remaining 45 companies, about 70 percent (32 companies) are small domestic manufacturers. DOE

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[80] "AHRI Certification Directory." AHRI Certification Directory. AHRI. (Available at: https://www.ahridirectory.org/ahridirectory/pages/home.aspx) (Last accessed October 10, 2011). See www.ahridirectory.org/ahriDirectory/pages/home.aspx.
[81] "Dynamic Small Business Search." SBA. (Available at: See http://dsbs.sba.gov/dsbs/search/dsp_dsbs.cfm) (Last accessed October 12, 2011).
[82] "D&B | Business Information | Get Credit Reports | 888 480-6007.". Dun & Bradstreet (Available at: www.dnb.com) (Last accessed October 10, 2011). See www.dnb.com/.
[83] "Hoovers | Company Information | Industry Information | Lists." D&B (2013) (Available at: See http://www.hoovers.com/) (Last accessed December 12, 2012).

contacted eight domestic commercial refrigeration equipment manufacturers for interviews and all eight companies accepted. Of these eight companies, four were small businesses.

2. Description and Estimate of Compliance Requirements

The 32 identified domestic manufacturers of commercial refrigeration equipment that qualify as small businesses under the SBA size standard account for approximately 26 percent of commercial refrigeration equipment shipments.[84] While some small businesses have significant market share (e.g., Continental has a 4-percent market share for foodservice commercial refrigeration[84]), the majority of small businesses have less than a 1-percent market share. These smaller firms often specialize in designing custom products and servicing niche markets.

At the amended level, the average small manufacturer is expected to face capital conversion costs that are nearly five times typical annual capital expenditures, and product conversion costs that are roughly double the typical annual R&D spending, as shown in Table VI.1. At the amended level, the conversion costs are driven by the incorporation of thicker insulation into case designs. The thicker case designs necessitate the purchase of new jigs for production. Manufacturers estimate of the cost of modifying an existing jig at approximately $50,000. Manufacturer estimates of the cost of a new jig ranged from $100,000 to $300,000, depending on the jig size and design. In addition to the cost of jigs, changes in case thickness may require product redesign due to changes in

[84] 32nd Annual Portrait of the U.S. Appliance Industry. Appliance Magazine. September 2009. 66(7).

the interior volume of the equipment. All shelving and internally fitted components would need to be redesigned to fit the revised cabinet's interior dimensions. Furthermore, changes in insulation and in refrigeration components could necessitate new industry certifications.

The proposed standard could cause small manufacturers to be at a disadvantage relative to large manufacturers. The capital conversion costs represent a smaller percentage of annual capital expenditures for large manufacturers than for small manufacturers. The capital conversion costs are 49 percent of annual capital expenditures for an average large manufacturer, while capital conversion costs are 278 percent of annual capital expenditures for an average small manufacturer. Small manufacturers may have greater difficulty obtaining credit, or may obtain less favorable terms than larger competitors when financing the equipment necessary to meet the amended standard.

Manufacturers indicated that many design options evaluated in the engineering analysis (e.g., higher efficiency lighting, motors, and compressors) would force them to purchase more expensive components. Due to smaller purchasing volumes, small manufacturers typically pay higher prices for components, while their large competitors receive volume discounts. At the amended standard, small businesses will likely have greater increases in component costs than large businesses and will thus be at a pricing disadvantage

To estimate how small manufacturers would be impacted, DOE used the market share of small manufacturers to estimate the annual revenue, earnings before interest and tax (EBIT), R&D expense, and capital expenditures for a typical small manufacturer. DOE then compared these costs to the required capital and product conversion costs at each TSL for both an average small manufacturer (Table VI.1) and an average large manufacturer (Table VI.2). The conversion costs in these tables are presented relative to annual financial metrics for the purposes of comparing impacts of small versus large manufacturers. In practice, these conversion costs will likely be spread out over a period of multiple years. TSL 3 represents the level adopted in today's final rule:

Table VI.1 Comparison of an Average Small Commercial Refrigeration Equipment Manufacturer's Conversion Costs to Annual Expenses, Revenue, and Profit

TSL	Capital Conversion Cost as a Percentage of Annual Capital Expenditures	Product Conversion Cost as a Percentage of Annual R&D Expense	Total Conversion Cost as a Percentage of Annual Revenue	Total Conversion Cost as a Percentage of Annual EBIT
TSL 1	20%	45%	1%	13%
TSL 2	20%	71%	2%	18%
TSL 3	330%	278%	11%	129%
TSL 4	913%	428%	26%	296%
TSL 5	2838%	622%	70%	792%

Table VI.2 Comparison of an Average Large Commercial Refrigeration Equipment Manufacturer's Conversion Costs to Annual Expenses, Revenue, and Profit

TSL	Capital Conversion Cost as a Percentage of Annual Capital Expenditures	Product Conversion Cost as a Percentage of Annual R&D Expense	Total Conversion Cost as a Percentage of Annual Revenue	Total Conversion Cost as a Percentage of Annual EBIT
TSL 1	3%	49%	1%	10%
TSL 2	3%	49%	1%	10%
TSL 3	46%	49%	2%	20%
TSL 4	128%	49%	3%	40%
TSL 5	398%	49%	9%	104%

Small firms would likely be at a disadvantage relative to larger firms in meeting the amended energy conservation standard for commercial refrigeration equipment. The small businesses face disadvantages in terms of access to capital, the cost of re-tooling production lines and investing in redesigns, and pricing for key components. As a result, DOE could not certify that the amended standards would not have a significant impact on a significant number of small businesses.

3. Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being adopted today.

4. Significant Alternatives to the Rule

The discussion above analyzes impacts on small businesses that would result from DOE's amended standards. In addition to the other TSLs being considered, the rulemaking TSD includes a regulatory impact analysis (RIA). For commercial refrigeration equipment, the RIA discusses the following policy alternatives: (1) no change in standard; (2) consumer rebates; (3) consumer tax credits; and (4) manufacturer tax credits; (5) voluntary energy efficiency targets; and (6) bulk government purchases. While these alternatives may mitigate to some varying extent the economic impacts on small entities compared to the standards, DOE determined that the energy savings of these alternatives are significantly smaller than those that would be expected to result from adoption of the amended standard levels. Accordingly, DOE is declining to adopt any of these alternatives and is adopting the standards set forth in this rulemaking. (See chapter 17 of the final rule TSD for further detail on the policy alternatives DOE considered.)

C. Review Under the Paperwork Reduction Act

Manufacturers of commercial refrigeration equipment 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 commercial refrigeration equipment, 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 commercial refrigeration equipment. (76 FR 12422 (March 7, 2011). 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 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that the rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR part 1021, App. B, B5.1(b); §1021.410(b) and Appendix B, B(1)-(5). The rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental Assessment or Environmental Impact Statement for this rule. DOE's CX determination for this rule is available at http://cxnepa.energy.gov/.

E. Review Under Executive Order 13132

Executive Order 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.

EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) 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 Executive Order 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; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 61 FR 4729 (February 7, 1996). Section 3(b) of Executive Order 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 Executive Order 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 Executive Order 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 an amended regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The 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 small governments. 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 http://energy.gov/gc/office-general-counsel.

DOE has concluded that this final rule would likely require expenditures of $100 million or more on the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by commercial refrigeration equipment manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by consumers to purchase higher-efficiency commercial refrigeration equipment, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the final rule. 2 U.S.C. 1532(c). The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of the notice of final rulemaking and the "Regulatory Impact Analysis" section of the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. 2 U.S.C. 1535(a). DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(d), (f), and (o), 6313(e), and 6316(a), today's final rule would establish energy conservation standards for commercial refrigeration equipment that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the "Regulatory Impact Analysis" chapter 17 of the TSD for today's final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights" 53 FR 8859 (March 18, 1988), that this regulation 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 guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (February

22, 2002), and DOE's guidelines were published at 67 FR 62446 (October 7, 2002). DOE has reviewed today's 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

Executive Order 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 (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) 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 today's regulatory action, which sets forth energy conservation standards for commercial refrigeration equipment, is not a significant energy action because the amended 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 the final rule.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (January 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 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. 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. The

"Energy Conservation Standards Rulemaking Peer Review Report" dated February 2007 has been disseminated and is available at the following Web site: www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.

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 report will state that it has been determined that the rule is not a "major rule" as defined by 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's final rule.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Incorporation by reference, Reporting and recordkeeping requirements.

Issued in Washington, DC, on February 28, 2014.

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David T. Danielson,
Assistant Secretary,
Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE amends part 431 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, to read 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.

2. Section 431.62 is amended by adding in alphabetical order a definition for "Service over counter" to read as follows:

§ 431.62 Definitions concerning commercial refrigerators, freezers and refrigerator-freezers.

* * * * *

Service over counter means equipment that has sliding or hinged doors in the back intended for use by sales personnel, with glass or other transparent material in the front for displaying merchandise, and that has a height not greater than 66 inches and is intended to serve as a counter for transactions between sales personnel and customers. "Service over the counter, self-contained, medium temperature commercial refrigerator", also defined in this section, is one specific equipment class within the service over counter equipment family.

* * * * *

3. Section 431.66 is amended by:

a. Revising paragraph (a)(3);

b. Revising paragraph (b)(1) introductory text;

c. Revising paragraph (c);

d. Revising paragraph (d) introductory text; and

c. Adding paragraph (e).

The revisions and addition read as follows:

§ 431.66 Energy conservation standards and their effective dates.

(a) * * *

(3) For the purpose of paragraph (d) of this section, the term "TDA" means the total display area (ft^2) of the case, as defined in ARI Standard 1200-2006, appendix D (incorporated by reference, see §431.63). For the purpose of paragraph (e) of this section, the term "TDA" means the total display area (ft^2) of the case, as defined in AHRI Standard 1200 (I-P)-2010, appendix D (incorporated by reference, see §431.63).

(b)(1) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications manufactured on or after January 1, 2010 and before **March 27, 2017** shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the following:

* * * * *

(c) Each commercial refrigerator with a self-contained condensing unit designed for pull-down temperature applications and transparent doors manufactured on or after

January 1, 2010 and before **March 27, 2017** shall have a daily energy consumption (in kilowatt-hours per day) of not more than 0.126V + 3.51.

(d) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit and without doors; commercial refrigerator, freezer, and refrigerator-freezer with a remote condensing unit; and commercial ice-cream freezer manufactured on or after January 1, 2012 and before **March 27, 2017** shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the levels specified:

*   *   *   *   *

(e) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications and with solid or transparent doors; commercial refrigerator with a self-contained condensing unit designed for pull-down temperature applications and with transparent doors; commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit and without doors; commercial refrigerator, freezer, and refrigerator-freezer with a remote condensing unit; and commercial ice-cream freezer manufactured on or after **March 27, 2017**, shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the levels specified:

(1) For equipment other than hybrid equipment, refrigerator/freezers, or wedge cases:

Equipment Category	**Condensing Unit Configuration**	**Equipment Family**	**Rating Temp. °F**	**Operating Temp. °F**	**Equipment Class Designation***	**Maximum Daily Energy Consumption kWh/day**
Remote Condensing Commercial Refrigerators and	Remote (RC)	Vertical Open (VOP)	38 (M)	≥32	VOP.RC.M	0.64 x TDA + 4.07
			0 (L)	<32	VOP.RC.L	2.2 x TDA + 6.85

Commercial Freezers		Semivertical Open (SVO)	38 (M)	≥32	SVO.RC.M	0.66 x TDA + 3.18
			0 (L)	<32	SVO.RC.L	2.2 x TDA + 6.85
		Horizontal Open (HZO)	38 (M)	≥32	HZO.RC.M	0.35 x TDA + 2.88
			0 (L)	<32	HZO.RC.L	0.55 x TDA + 6.88
		Vertical Closed Transparent (VCT)	38 (M)	≥32	VCT.RC.M	0.15 x TDA + 1.95
			0 (L)	<32	VCT.RC.L	0.49 x TDA + 2.61
		Horizontal Closed Transparent (HCT)	38 (M)	≥32	HCT.RC.M	0.16 x TDA + 0.13
			0 (L)	<32	HCT.RC.L	0.34 x TDA + 0.26
		Vertical Closed Solid (VCS)	38 (M)	≥32	VCS.RC.M	0.1 x V + 0.26
			0 (L)	<32	VCS.RC.L	0.21 x V + 0.54
		Horizontal Closed Solid (HCS)	38 (M)	≥32	HCS.RC.M	0.1 x V + 0.26
			0 (L)	<32	HCS.RC.L	0.21 x V + 0.54
		Service Over Counter (SOC)	38 (M)	≥32	SOC.RC.M	0.44 x TDA + 0.11
			0 (L)	<32	SOC.RC.L	0.93 x TDA + 0.22
Self-Contained Commercial Refrigerators and Commercial Freezers Without Doors	Self-Contained (SC).	Vertical Open (VOP)	38 (M)	≥32	VOP.SC.M	1.69 x TDA + 4.71
			0 (L)	<32	VOP.SC.L	4.25 x TDA + 11.82
		Semivertical Open (SVO)	38 (M)	≥32	SVO.SC.M	1.7 x TDA + 4.59
			0 (L)	<32	SVO.SC.L	4.26 x TDA + 11.51
		Horizontal Open (HZO)	38 (M)	≥32	HZO.SC.M	0.72 x TDA + 5.55
			0 (L)	<32	HZO.SC.L	1.9 x TDA + 7.08
Self-Contained Commercial Refrigerators and Commercial Freezers With Doors	Self-Contained (SC).	Vertical Closed Transparent (VCT)	38 (M)	≥32	VCT.SC.M	0.1 x V + 0.86
			0 (L)	<32	VCT.SC.L	0.29 x V + 2.95

		Vertical Closed Solid (VCS)	38 (M)	≥32	VCS.SC.M	0.05 x V + 1.36
				<32	VCS.SC.L	0.22 x V + 1.38
		Horizontal Closed Transparent (HCT)	38 (M)	≥32	HCT.SC.M	0.06 x V + 0.37
			0 (L)	<32	HCT.SC.L	0.08 x V + 1.23
		Horizontal Closed Solid (HCS)		≥32	HCS.SC.M	0.05 x V + 0.91
			0 (L)	<32	HCS.SC.L	0.06 x V + 1.12
		Service Over Counter (SOC)		≥32	SOC.SC.M	0.52 x TDA + 1
			0 (L)	<32	SOC.SC.L	1.1 x TDA + 2.1
Self-Contained Commercial Refrigerators with Transparent Doors for Pull-Down Temperature Applications	Self-Contained (SC).	Pull-Down (PD)	38 (M)	≥32	PD.SC.M	0.11 x V + 0.81
Commercial Ice-Cream Freezers.	Remote (RC)	Vertical Open (VOP)	-15 (I)	≤-5**	VOP.RC.I	2.79 x TDA + 8.7
		Semivertical Open (SVO)			SVO.RC.I	2.79 x TDA + 8.7
		Horizontal Open (HZO)			HZO.RC.I	0.7 x TDA + 8.74
		Vertical Closed Transparent (VCT)			VCT.RC.I	0.58 x TDA + 3.05
		Horizontal Closed Transparent (HCT)			HCT.RC.I	0.4 x TDA + 0.31
		Vertical Closed Solid (VCS)			VCS.RC.I	0.25 x V + 0.63
		Horizontal Closed Solid (HCS)			HCS.RC.I	0.25 x V + 0.63
		Service Over Counter (SOC)			SOC.RC.I	1.09 x TDA + 0.26
	Self-Contained (SC).	Vertical Open (VOP)			VOP.SC.I	5.4 x TDA + 15.02

		Semivertical Open (SVO).			SVO.SC.I	5.41 x TDA + 14.63
		Horizontal Open (HZO).			HZO.SC.I	2.42 x TDA + 9
		Vertical Closed Transparent (VCT).			VCT.SC.I	0.62 x TDA + 3.29
		Horizontal Closed Transparent (HCT).			HCT.SC.I	0.56 x TDA + 0.43
		Vertical Closed Solid (VCS).			VCS.SC.I	0.34 x V + 0.88
		Horizontal Closed Solid (HCS).			HCS.SC.I	0.34 x V + 0.88
		Service Over Counter (SOC)			SOC.SC.I	1.53 x TDA + 0.36

* The meaning of the letters in this column is indicated in the columns to the left.
** Ice-cream freezer is defined in 10 CFR 431.62 as a commercial freezer that is designed to operate at or below -5 °F *(-21 °C) and that the manufacturer designs, markets, or intends for the storing, displaying, or dispensing of ice cream.

(2) For commercial refrigeration equipment with two or more compartments (i.e., hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers), the maximum daily energy consumption for each model shall be the sum of the MDEC values for all of its compartments. For each compartment, measure the TDA or volume of that compartment, and determine the appropriate equipment class based on that compartment's equipment family, condensing unit configuration, and designed operating temperature. The MDEC limit for each compartment shall be the calculated value obtained by entering that compartment's TDA or volume into the standard equation in paragraph (e)(1) of this section for that compartment's equipment class. Measure the CDEC or TDEC for the entire case as described in §431.66(d)(2)(i)

through (iii), except that where measurements and calculations reference ARI Standard 1200-2006 (incorporated by reference, see §431.63), AHRI Standard 1200 (I-P)-2010 (incorporated by reference, see §431.63) shall be used.

(3) For remote condensing and self-contained wedge cases, measure the CDEC or TDEC according to the AHRI Standard 1200 (I-P)-2010 test procedure (incorporated by reference, see §431.63). For wedge cases in equipment classes for which a volume metric is used, the MDEC shall be the amount derived from the appropriate standards equation in paragraph (e)(1) of this section. For wedge cases of equipment classes for which a TDA metric is used, the MDEC for each model shall be the amount derived by incorporating into the standards equation in paragraph (e)(1) of this section for the equipment class a value for the TDA that is the product of:

(i) The vertical height of the air curtain (or glass in a transparent door) and

(ii) The largest overall width of the case, when viewed from the front.

[FR Doc. 2014-05082 Filed 03/27/2014 at 8:45 am; Publication Date: 03/28/2014]