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DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket Number EERE-2015-BT-STD-0008

RIN 1904-AD52

Energy Conservation Program: Energy Conservation Standards for Dedicated-Purpose Pool Pumps

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

ACTION: Direct final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, sets forth a variety of provisions designed to improve energy efficiency. Part C of Title III establishes the "Energy Conservation Program for Certain Industrial Equipment." The covered equipment includes pumps. In this direct final rule, DOE is adopting new energy conservation standards for dedicated-purpose pool pumps. It has determined that the 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 120 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]** unless adverse comment is received by **[INSERT DATE 110 DAYS AFTER OF PUBLICATION IN THE**

FEDERAL REGISTER]. If adverse comments are received that DOE determines may provide a reasonable basis for withdrawal of the direct final rule, a timely withdrawal of this rule will be published in the Federal Register. If no such adverse comments are received, compliance with the standards established for dedicated-purpose pool pumps in this direct final rule is required on and after **[INSERT DATE 54 MONTHS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].**

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

A link to the docket web page can be found at https://www.regulations.gov/docket?D=EERE-2015-BT-STD-0008. The docket web page contains simple instructions on how to access all documents, including public comments, in the docket.

FOR FURTHER INFORMATION CONTACT:

Mr. John Cymbalsky, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW, Washington, DC, 20585-0121. Telephone: (202) 586-9507. Email: ApplianceStandardsQuestions@ee.doe.gov.

Ms. Johanna Jochum, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-6307. Email: Johanna.Jochum@hq.doe.gov.

SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Direct Final Rule

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C.6291, et seq; EPCA), sets forth a variety of provisions designed to improve energy efficiency of appliances and commercial equipment. Part C of Title III, which for editorial reasons was redesignated as Part A-1 upon incorporation into the U.S. Code (42 U.S.C. 6311–6317), establishes the "Energy Conservation Program for Certain Industrial Equipment." Covered industrial equipment includes pumps. (42 U.S.C. 6311(1)(H))[1] Pumps include dedicated-purpose pool pumps, the subject of this document.

The energy conservation standards for dedicated-purpose pool pumps (also referred to as "pool pumps") established in this document reflect the consensus of a negotiation among interested parties with a broad cross-section of interests, including the manufacturers who produce the subject equipment, environmental and energy-efficiency advocacy organizations, and electric utility companies. A working group representing these parties was established under the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC)[2] to discuss and, if possible, reach consensus on proposed standards for pool pump energy efficiency. On June 23, 2016, the dedicated-purpose pool pumps (DPPP) Working Group successfully reached consensus on recommended energy

[1] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Public Law 114-11 (Apr. 30, 2015).
[2] In accordance with the Federal Advisory Committee Act and the Negotiated Rulemaking Act (5 U.S.C. App.; 5 U.S.C. 561-570)

conservation standards for pool pumps. See section III.A for further discussion of the Working Group and its recommendations.

After carefully considering the recommendations submitted by the DPPP Working Group and adopted by ASRAC related to energy conservation standards for pool pumps, DOE has determined that these recommendations comprise a statement submitted by interested persons who represent relevant points of view on this matter, and which, if compliant with certain statutory requirements, could result in issuance of a direct final rule.

Pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 6316(a)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B) and 6316(a))

In accordance with these and other statutory provisions discussed in this document, DOE is adopting new energy conservation standards for certain dedicated-purpose pool pumps. The adopted standards are shown in Table I-1 and Table I-2. Standards for the equipment classes in Table I-1 are performance based, expressed in terms of weighted energy factor (WEF); standards in Table I-2 are prescriptive. These standards apply to all equipment listed in Table I-1 and Table I-2 and manufactured in or imported into the United States starting on [**INSERT DATE 54 MONTHS AFTER**

DATE OF PUBLICATION IN THE FEDERAL REGISTER]. DOE is not adopting standby or off-mode standards for this equipment.

Table I-1 Performance-Based Energy Conservation Standards for Dedicated-Purpose Pool Pumps

Equipment Class			Minimum Allowable WEF** Score
Dedicated-Purpose Pool Pump Variety	**Hydraulic Horsepower Applicability***	**Motor Phase**	
Standard-Size Self-Priming Pool Filter Pumps	<2.5 hhp and >=0.711 hhp	Single	WEF = - 2.30 * ln (hhp) + 6.59
Small-Size Self-Priming Pool Filter Pumps	hhp < 0.711 hp	Single	WEF = 5.55 for hhp ≤ 0.13 hp, -1.30 * ln (hhp) + 2.90 for hhp > 0.13 hp
Non-Self-Priming Pool Filter Pumps	hhp < 2.5 hp	Any	WEF = 4.60 for hhp ≤ 0.13 hp, -0.85 * ln (hhp) + 2.87 for hhp > 0.13 hp
Pressure Cleaner Booster Pumps	Any	Any	WEF = 0.42

*All instances of hhp refer to rated hydraulic horsepower determined in accordance with the DOE test procedure at 10 CFR 431.464 and applicable sampling plans.
** WEF is measured by kgal/kWh.

Table I-2 Prescriptive Energy Conservation Standards for Dedicated-Purpose Pool Pumps

Equipment Class			Prescriptive Standard
Dedicated-Purpose Pool Pump Variety	**Hydraulic Horsepower Applicability**	**Motor Phase**	
Integral Sand Filter Pool Pump	Any	Any	Must be distributed in commerce with a pool pump timer that is either integral to the pump or a separate component that is shipped with the pump.*
Integral Cartridge Filter Pool Pump	Any	Any	Must be distributed in commerce with a pool pump timer that is either integral to the pump or a separate component that is shipped with the pump.*
All Dedicated-Purpose Pool Pumps Distributed in Commerce with Freeze Protection Controls	Any	Any	The pump must be shipped with freeze protection disabled or with the following default, user-adjustable settings: • The default dry-bulb air temperature setting is no greater than 40 °F;

			• The default run time setting shall be no greater than 1 hour (before the temperature is rechecked); and • The default motor speed shall not be more than ½ of the maximum available speed.

* Pool pump timer means a pool pump control that automatically turns off a dedicated-purpose pool pump after a run-time of no longer than 10 hours.

A. Benefits and Costs to Consumers[3]

Table I-3 presents DOE's evaluation of the economic impacts of the adopted standards on consumers of pool pumps, as measured by the average life-cycle cost (LCC) savings and the simple payback period (PBP).[4] The average LCC savings are positive for all equipment classes, and the PBP is much less than the average lifetime of dedicated-purpose pool pumps, which is estimated to range from 4 to 7 years, depending on equipment class (see section IV.F.6).

Table I-3 Impacts of Adopted Energy Conservation Standards on End Users of Dedicated-Purpose Pool Pumps

Equipment Class	Average LCC Savings 2015$	Simple Payback Period years
Standard-Size Self-Priming Pool Filter Pump	2,140	0.7
Small-Size Self-Priming Pool Filter Pump	295	0.8
Standard-Size Non-Self-Priming Pool Filter Pump	191	0.2
Extra-Small Non-Self-Priming Pool Filter Pump	36	0.9
Pressure Cleaner Booster Pump	111	0.6
Integral Cartridge Filter Pool Pump	128	0.4
Integral Sand Filter Pool Pump	73	0.5

[3] All monetary values in this document are expressed in 2015 dollars and, where appropriate, are discounted to 2016 unless explicitly stated otherwise.
[4] The average LCC savings refer to consumers that are affected by a standard are measured relative to the efficiency distribution in the no-standards case, which depicts the market in the compliance year in the absence of new or amended standards (see section IV.H.2). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline model (see section IV.C.3).

DOE's analysis of the impacts of the adopted standards on consumers is described in section V.B.1 of this document.

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the reference year through the end of the analysis period 2016–2050. Using a real discount rate of 11.8 percent, DOE estimates that the INPV for manufacturers of dedicated-purpose pool pumps in the case without standards is $212.8 million in 2015$. Under the new standards, DOE expects the change in INPV to range from -21.8 percent to 3.3 percent, which is approximately -$46.3 million to $7.0 million. In order to bring equipment into compliance with the new standards, DOE expects the industry to incur total conversion costs of $35.6 million.

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

C. National Benefits and Costs

DOE's analyses indicate that the adopted energy conservation standards for dedicated-purpose pool pumps would save a significant amount of energy. Relative to the case without new standards, the lifetime energy savings for dedicated-purpose pool pumps purchased in the 30-year period that begins in the anticipated year of compliance with the standards (2021–2050), amount to 3.8 quadrillion British thermal units (Btu), or quads.[5] This represents an estimated savings of 61 percent relative to the energy use of this equipment in the case without standards (referred to as the "no-standards case").

The cumulative net present value (NPV) of total consumer benefits of the standards for dedicated-purpose pool pumps ranges from $11 billion (at a 7-percent discount rate) to $24 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment costs for dedicated-purpose pool pumps purchased in 2021–2050.

In addition, the standards for dedicated-purpose pool pumps are projected to yield significant environmental benefits. DOE estimates that the standards would result in cumulative greenhouse gas emission reductions (over the same period as for energy savings) of 202 million metric tons (Mt)[6] of carbon dioxide (CO_2), 147 thousand tons of sulfur dioxide (SO_2), 257 thousand tons of nitrogen oxides (NO_X), 968 thousand tons of methane (CH_4), 3.0 thousand tons of nitrous oxide (N_2O), and 0.50 tons of mercury (Hg).[7] The cumulative reduction in CO_2 emissions through 2030 amounts to 48 Mt,

[5] The quantity refers to full-fuel-cycle (FFC) energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (i.e., coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.2.
[6] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.
[7] DOE calculated emissions reductions relative to the no-standards-case, which reflects key assumptions in the Annual Energy Outlook 2016 (AEO2016). AEO2016 generally represents current legislation and environmental regulations for which implementing regulations were available as of the end of February 2016.

which is equivalent to the emissions resulting from the annual electricity use of 7.1 million homes.

The value of the CO_2 reduction is calculated using a range of values per metric ton (t) of CO_2 (otherwise known as the "Social Cost of Carbon Dioxide," or SC-CO_2) developed by a Federal interagency working group.[8] The derivation of the SC-CO_2 values is discussed in section IV.L. Using discount rates appropriate for each set of SC-CO_2 values, DOE estimates that the present value of the CO_2 emissions reduction is between $1.5 billion and $21 billion. Using the central SCC case represented by $40.6/metric ton (t) in 2015 and a discount rate of 3-percent produces a value of $6.8billion.

DOE also calculated the value of the reduction in emissions of the non-CO_2 greenhouse gases, methane and nitrous oxide, using values for the social cost of methane (SC-CH_4) and the social cost of nitrous oxide (SC-N_2O) recently developed by the interagency working group.[9] See section IV.L.2 for description of the methodology and the values used for DOE's analysis. The estimated present value of the methane emissions reduction is between $0.32 billion and $2.6 billion, with a value of $0.99billion using the central SC-CH_4 case, and the estimated present value of the N_2O emissions

[8] United States Government–Interagency Working Group on Social Cost of Carbon. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. May 2013. Revised July 2015. Available at www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf.

[9] United States Government–Interagency Working Group on Social Cost of Greenhouse Gases. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016. https://www.whitehouse.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf.

reduction is between \$0.008 billion and \$0.09 billion, with a value of \$0.03 billion using the central SC-N_2O case.

DOE also estimates the present value of the NO_X emissions reduction to be \$0.21 billion using a 7-percent discount rate, and \$0.48 billion using a 3-percent discount rate.[10] DOE is still investigating appropriate valuation of the reduction in other emissions, and therefore did not include any such values in the analysis of this direct final rule.

Table I-4 summarizes the economic benefits and costs expected to result from the adopted standards for dedicated-purpose pool pumps.

[10] DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis. See section IV.L for further discussion. The U.S. Supreme Court has stayed the rule implementing the Clean Power Plan until the current litigation against it concludes. Chamber of Commerce, et al. v. EPA, et al., Order in Pending Case, 577 U.S. ___ (2016). However, the benefit-per-ton estimates established in the Regulatory Impact Analysis for the Clean Power Plan are based on scientific studies that remain valid irrespective of the legal status of the Clean Power Plan. DOE is primarily using a national benefit-per-ton estimate for NO_X emitted from the Electricity Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011), the values would be nearly two-and-a-half times larger.

Table I-4 Summary of Economic Benefits and Costs of Adopted Energy Conservation Standards for Dedicated-Purpose Pool Pumps***

Category	Present Value billion 2015$	Discount Rate %
Benefits		
Consumer Operating Cost Savings	13	7
	26	3
GHG Reduction (using avg. social costs at 5% discount rate)*	1.9	5
GHG Reduction (using avg. social costs at 3% discount rate)*	7.8	3
GHG Reduction (using avg. social costs at 2.5% discount rate)*	12	2.5
GHG Reduction (using 95th percentile social costs at 3% discount rate)*	23	3
NO_X Reduction**	0.21	7
	0.48	3
Total Benefits†	21	7
	35	3
Costs		
Consumer Incremental Installed Costs	1.3	7
	2.6	3
Total Net Benefits		
Including GHG and NO_X Reduction Monetized Value	19	7
	32	3

*** This table presents the costs and benefits associated with pool pumps shipped in 2021−2050. These results include benefits to consumers which accrue after 2050 from the equipment purchased in 2021−2050. The incremental installed costs include incremental equipment cost as well as installation costs. The costs account for the incremental variable and fixed costs incurred by manufacturers due to the proposed standards, some of which may be incurred in preparation for the rule. The CO_2 reduction benefits are global benefits due to actions that occur domestically.
* The interagency group selected four sets of SC-CO_2 SC-CH_4, and SC-N_2O values for use in regulatory analyses. Three sets of values are based on the average social costs from the integrated assessment models, at discount rates of 5 percent, 3 percent, and 2.5 percent. The fourth set, which represents the 95th percentile of the social cost distributions calculated using a 3-percent discount rate, is included to represent higher-than-expected impacts from climate change further out in the tails of the social cost distributions. The social cost values are emission year specific. See section IV.L.1 for more details.
** DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.3 for further discussion. DOE is primarily using a national benefit-per-ton estimate for NO_X emitted from the electricity generating unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011), the values would be nearly two-and-a-half times larger.
† Total Benefits for both the 3-percent and 7-percent cases are presented using only the average social costs with 3-percent discount rate.

The benefits and costs of the adopted standards for dedicated-purpose pool pumps sold between 2021−2050 can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increases in equipment purchase prices and installation costs, plus (3) the value of the benefits of CO_2 and NO_X emission reductions, all annualized.[11]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered equipment and are measured for the lifetime of dedicated-purpose pool pumps shipped in 2021−2050. The benefits associated with reduced CO_2 emissions achieved as a result of the adopted standards are also calculated based on the lifetime of dedicated-purpose pool pumps shipped in 2021-2050. Because CO_2 emissions have a very long residence time in the atmosphere, the SC-CO_2 values for emissions in future years reflect CO_2-emissions impacts that continue through 2300. The CO_2 reduction is a benefit that accrues globally. DOE maintains that consideration of global benefits is appropriate because of the global nature of the climate change problem.

Estimates of annualized benefits and costs of the adopted standards are shown in Table I-5. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than GHG reduction (for which DOE used average social costs with a 3-percent discount rate),[12] the estimated cost of the standards in this rule is $138 million per year in increased equipment costs, while the estimated

[11] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2016, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (e.g., 2020 or 2030), and then discounted the present value from each year to 2016. The calculation uses discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions, for which DOE used case-specific discount rates, as shown in Table . Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, which yields the same present value.

[12] DOE used average social costs with a 3-percent discount rate because these values are considered as the "central" estimates by the interagency group.

annual benefits are $1.3 billion in reduced equipment operating costs, $449 million in GHG reductions, and $22 million in reduced NO_X emissions. In this case, the net benefit amounts to $1.7 billion per year. Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is $149 million per year in increased equipment costs, while the estimated annual benefits are $1.5 billion in reduced operating costs, $449 million in GHG reductions, and $27 million in reduced NO_X emissions. In this case, the net benefit amounts to $1.8 billion per year.

Table I-5 Annualized Benefits and Costs of Adopted Standards for Dedicated-Purpose Pool Pumps*

	Discount Rate %	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
		million 2015$/year		
Benefits				
Consumer Operating Cost Savings	7	1,340	1,221	1,467
	3	1,516	1,367	1,678
GHG Reduction (using avg. social costs at 5% discount rate)**	5	147	129	164
GHG Reduction (using avg. social costs at 3% discount rate)**	3	449	392	504
GHG Reduction (using avg. social costs at 2.5% discount rate)**	2.5	642	560	721
GHG Reduction (using 95th percentile social costs at 3% discount rate)**	3	1,346	1,175	1,510
NO_X Reduction†	7%	22	20	55
	3%	27	24	70
Total Benefits‡	7% plus GHG range	1,509 to 2,708	1,369 to 2,416	1,686 to 3,032
	7%	1,811	1,633	2,026
	3% plus GHG range	1,690 to 2,890	1,520 to 2,566	1,912 to 3,258
	3%	1,993	1,783	2,252
Costs				
Consumer Incremental Product Costs	7%	138	124	151
	3%	149	133	164
Manufacturer Conversion Costs††	7%	3	3	3
	3%	2	2	2
Net Benefits				
Total‡	7% plus GHG range	1,371 to 2,570	1,245 to 2,292	1,535 to 2,881
	7%	1,673	1,509	1,875
	3% plus GHG range	1,542 to 2,741	1,387 to 2,433	1,748 to 3,094
	3%	1,844	1,651	2,088

* This table presents the annualized costs and benefits associated with pool pumps shipped in 2021-2050. These results include benefits to consumers which accrue after 2050 from the pool pumps purchased from 2021-2050. The incremental equipment costs include incremental equipment cost as well as installation costs. The costs account for the incremental variable and fixed costs incurred by manufacturers due to the adopted standards, some of which may be incurred in preparation for the rule. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices and real GDP from the AEO2016 No-CPP case, a Low Economic Growth case, and a High Economic Growth case, respectively. In addition, incremental product costs reflect the default price trend in the Primary Estimate, a high price trend in the Low Benefits Estimate, and a low price trend in the High Benefits Estimate.

The methods used to derive projected price trends are explained in section IV.F.1. The benefits and costs are based on equipment efficiency distributions as described in sections IV.F.8 and IV.H.1. Purchases of higher efficiency equipment are a result of many different factors unique to each consumer including past purchases, expected usage, and others. For each consumer, all other factors being the same, it would be anticipated that higher efficiency purchases in the no-new-standards case may correlate positively with higher energy prices. To the extent that this occurs, it would be expected to result in some lowering of the consumer operating cost savings from those calculated in this rule. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.
** The interagency group selected four sets of SC-CO_2 SC-CH_4, and SC-N_2O values for use in regulatory analyses. Three sets of values are based on the average social costs from the integrated assessment models, at discount rates of 5 percent, 3 percent, and 2.5 percent. The fourth set, which represents the 95th percentile of the social cost distributions calculated using a 3-percent discount rate, is included to represent higher-than-expected impacts from climate change further out in the tails of the social cost distributions. The social cost values are emission year specific. The GHG reduction benefits are global benefits due to actions that occur nationally. See section IV.L for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.3 for further discussion. For the Primary Estimate and Low Net Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High Net Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.
‡ Total Benefits for both the 3-percent and 7-percent cases are presented using the average social costs with 3-percent discount rate. In the rows labeled "7% plus GHG range" and "3% plus GHG 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 social cost values.
†† Manufacturers are estimated to incur $35.6 million in conversion costs between 2017 and 2020.

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

D. Conclusion

Based on the analyses in this direct final rule, DOE found the benefits to the nation of the 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 end users of this equipment). DOE has concluded that the standards in this direct final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy.

II. Introduction

The following sections briefly discuss the statutory authority underlying this direct final rule, as well as some of the relevant historical background related to the establishment of standards for dedicated-purpose pool pumps.

A. Authority

Title III, Part C[13] of the Energy Policy and Conservation Act of 1975 (EPCA), (42 U.S.C. 6311–6317, as codified) established the Energy Conservation Program for Certain Industrial Equipment, a program covering certain industrial equipment.[14] "Pumps" are listed as a type of covered industrial equipment. (42 U.S.C. 6311(1)(A))

While pumps are listed as a type of covered equipment, EPCA does not define the term "pump." To address this, in January 2016, DOE published a test procedure final rule (January 2016 general pumps test procedure final rule) that established a definition for the term "pump." 81 FR 4086, 4147 (January 25, 2016). In the December 2016 DPPP test procedure final rule ("test procedure final rule"),[15] DOE noted the applicability of the definition of "pump" and associated terms to dedicated-purpose pool pumps.

Pursuant to EPCA, DOE's energy conservation program for covered equipment consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal

[13] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.
[14] All references to EPCA refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Public Law 114-11 (April 30, 2015).
[15] See https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=41

energy conservation standards, and (4) certification and enforcement procedures. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of covered equipment. (42 U.S.C. 6295(o)(3)(A) and 6316(a)) 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 their energy use or efficiency. (42 U.S.C. 6314(d)) Similarly, DOE must use these test procedures to determine whether the equipment complies with standards adopted pursuant to EPCA. Id. The DOE test procedures for dedicated-purpose pool pumps appear at title 10 of the Code of Federal Regulations (CFR) part 431, subpart Y, appendix B.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including dedicated-purpose pool pumps. Any new or amended standard for covered equipment must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(C), 6295(o), and 6316(a)) 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(a)) Moreover, DOE may not prescribe a standard (1) for certain equipment, including dedicated-purpose pool pumps, if no test procedure has been established for the product, or (2) if DOE determines by rule that the standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o) and 6316(a)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

1. The economic impact of the standard on manufacturers and consumers of the equipment subject to the standard;
2. The savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered equipment that are likely to result from the standard;
3. The total projected amount of energy (or as applicable, water) savings likely to result directly from the standard;
4. Any lessening of the utility or the performance of the covered equipment likely to result from the standard;
5. The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard;
6. The need for national energy and water conservation; and
7. Other factors the Secretary of Energy (Secretary) considers relevant.

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

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

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

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of products that has the same function or intended use if DOE determines that equipment within such group (a) consumes a different kind of energy from that consumed by other covered equipment within such type (or class); or (b) has a capacity or other performance-related feature 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(a)) 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 such a feature and other factors DOE deems appropriate. Id. Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2) and 6316(a))

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(a)) DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions set forth under 42 U.S.C. 6297(d).

With particular regard to direct final rules, the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110-140 (December 19, 2007), amended EPCA, in relevant part, to grant DOE authority to issue a type of final rule (i.e., a "direct final rule") establishing an energy conservation standard for a product or equipment (including dedicated-purpose pool pumps) on receipt of a statement submitted jointly by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered equipment, States, and efficiency advocates), as determined by the Secretary. (42 U.S.C. 6295(p)(4)(A)) and 6316(a)) That statement must contain recommendations with respect to an energy or water conservation standard that are in accordance with the provisions of 42 U.S.C. 6295(o). (42 U.S.C. 6295(p)(4)(A)(i)) A notice of proposed rulemaking (NOPR) that proposes an identical energy efficiency standard must be published simultaneously with the direct final rule and a public comment period of at least 110 days provided. (42 U.S.C. 6295(p)(4)(A)-(B)) Not later than 120 days after issuance of the direct final rule, if DOE receives one or more adverse comments or an alternative joint recommendation relating to the direct final rule, the Secretary must determine whether the comments or alternative joint recommendation may provide a reasonable basis for withdrawal under 42 U.S.C. 6295(o) or other applicable law. (42 U.S.C. 6295(p)(4)(C)(i)) If the Secretary makes such a determination, DOE must withdraw the direct final rule and proceed with the simultaneously published NOPR, and publish in the Federal Register the reason why the direct final rule was withdrawn. (42 U.S.C. 6295(p)(4)(C)(ii))

B. Background

Currently, no Federal energy conservation standards exist for dedicated-purpose pool pumps. DOE excluded this category of pumps from its recent consensus-based energy conservation standard final rule for general pumps. 81 FR 4368 (January 26, 2016). The general pumps final rule, which was also the product of a pumps working group that had been created through the ASRAC, examined a variety of pump categories. While dedicated-purpose pool pumps were one of the pump categories that were considered during the working group's discussions, the working group ultimately recommended that DOE initiate a separate rulemaking for dedicated-purpose pool pumps. (Docket No. EERE-2013-BT-NOC-0039, No. 0092 at p. 2)

DOE began the separate rulemaking for dedicated-purpose pool pumps on May 8, 2015, when it issued a Request for Information (RFI) (May 2015 DPPP RFI). 80 FR 26475. The May 2015 DPPP RFI presented information and requested public comment about definitions, metrics, test procedures, equipment characteristics, and typical applications relevant to DPPP equipment. DOE received six written comments in response to the May 2015 DPPP RFI. The commenters included the Association of Pool and Spa Professionals (APSP); Pacific Gas and Electric Company (PG&E), Southern California Gas Company (SCG), Southern California Edison (SCE), and San Diego Gas and Electric Company (SDG&E), collectively referred to herein as the California Investor-Owned Utilities (CA IOUs); the Hydraulic Institute (HI); Ms. Tamara Newman; the National Electrical Manufacturers Association (NEMA); and River City Pool and Spa (River City).

In response to the May 2015 DPPP RFI, APSP, HI, and CA IOUs encouraged DOE to pursue a negotiated rulemaking for dedicated-purpose pool pumps. (Docket. No. EERE-2015-BT-STD-0008, APSP, No. 10 at p. 2; HI, No. 8 at p. 2; CA IOUs, No. 11 at p. 2) Consistent with feedback from these interested parties, DOE began a process through the ASRAC to charter a working group to recommend energy conservation standards and a test procedure for dedicated-purpose pool pumps rather than continuing down the traditional notice and comment route that DOE had already begun. (Docket No. EERE-2015-BT-STD-0008) On August 25, 2015, DOE published a notice of intent to establish a working group for dedicated-purpose pool pumps (the DPPP Working Group) 80 FR 51483. The initial DPPP Working Group charter allowed for 3 months of DPPP Working Group meetings to establish the scope, metric, definitions, and test procedure for dedicated-purpose pool pumps. The charter reserved the discussion of standards for a later set of meetings, after the working group produced a term sheet recommending a scope, metric, definitions, and test procedure for DPPPs. (Docket No. EERE-2013-BT-

NOC-0005, No. 56 at p. 27) On October 15, 2015, DOE published a notice of public open meetings of the DPPP Working Group to establish three additional meetings under the initial charter. 80 FR 61996. DOE selected the members of the DPPP Working Group to ensure a broad and balanced array of interested parties and expertise, including representatives from efficiency advocacy organizations and manufacturers, as well as one representative from a state government organization. Additionally, one member from ASRAC and one DOE representative were part of the group. Table II-1 lists the 13 members of the DPPP Working Group and their affiliations.

Table II-1 DPPP Working Group Members and Affiliations

Member	Affiliation	Abbreviation
John Caskey	National Electrical Manufacturers Association (and ASRAC representative)	NEMA
John Cymbalsky	U.S. Department of Energy	DOE
Kristin Driskell	California Energy Commission	CEC
Scott Durfee	Nidec Motor Corporation	Nidec
Jeff Farlow	Pentair Aquatic Systems	Pentair
Gary Fernstrom	California Investor-Owned Utilities (PG&E, SDG&E, SCG, and SCE)	CA IOUs
Patrizio Fumagalli	Bestway USA, Inc.	Bestway
Paul Lin	Regal Beloit Corporation	Regal
Joanna Mauer	Appliance Standards Awareness Project	ASAP
Ray Mirzaei	Waterway Plastics	Waterway
Doug Philhower	Hayward Industries, Inc.	Hayward
Shajee Siddiqui	Zodiac Pool Systems, Inc.	Zodiac
Meg Waltner	Natural Resources Defense Council	NRDC

The DPPP Working Group commenced negotiations at an open meeting between September 30 and October 1, 2015, and then held three additional meetings to discuss scope, metrics, and the test procedure.[16] The DPPP Working Group completed its initial

[16] Details of the negotiations sessions can be found in the public meeting transcripts that are posted to the docket for the Working Group (www.regulations.gov/#!docketDetail;D=EERE-2015-BT-STD-0008).

charter on December 8, 2015, with a consensus vote to approve a term sheet containing recommendations to DOE on scope, metric, and the basis of test procedure ("December 2015 DPPP Working Group recommendations").[17] The term sheet containing these recommendations is available in the DPPP Working Group docket. (Docket No. EERE-2015-BT-STD-0008, No. 51) ASRAC subsequently voted unanimously to approve the December 2015 DPPP Working Group recommendations during its January 20, 2016 meeting. (Docket No. EERE-2015-BT-STD-0008, No. 0052) The December 2015 DPPP Working Group recommendations pertinent to the test procedure and metric are discussed in section III.C of this document and reflected in DOE's DPPP test procedure final rule, issued in December 2016.[18] DOE's test procedure for dedicated-purpose pool pumps appears at title 10 of the Code of Federal Regulations (CFR) part 431, subpart Y, appendix B.

At the January 20, 2016, ASRAC meeting, the DPPP Working Group also requested more time to discuss potential energy conservation standards for dedicated-purpose pool pumps. In response, ASRAC recommended that the DPPP Working Group continue its work in a second phase of negotiations to recommend potential energy conservation standards for dedicated-purpose pool pumps. (Docket No. EERE-2013-BT-NOC-0005, No. 71 at pp. 20–52) The second phase of meetings commenced on March 21, 2016 (81 FR 10152, 10153) and concluded on June 23, 2016, with approval of a second term sheet (June 2016 DPPP Working Group recommendations). This term sheet

[17] The ground rules of the DPPP Working Group define consensus as no more than three negative votes. (Docket No. EERE-2015-BT-0008-0016 at p. 3) Abstention was not construed as a negative vote.
[18] See https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=41

contained DPPP Working Group recommendations on performance-based energy conservation standard levels, scope of such standards, certain prescriptive requirements, certain labeling requirements, certain definitions, and certain amendments to its previous test procedure recommendations. (Docket No. EERE-2015-BT-STD-0008, No. 82) ASRAC subsequently voted unanimously to approve the June 2016 DPPP Working Group recommendations during a July 29, 2016 meeting. (Docket No. EERE-2013-BT-NOC-0005, No. 87) The energy conservation standards, definitions, and prescriptive requirements established in this direct final rule directly reflect the June 2016 DPPP Working Group recommendations.

In this direct final rule, DOE refers to both formal recommendations of the DPPP Working Group, as well as informal discussion and suggestions that were not formally recommended. All references to approved recommendations are specified with a citation to the June 2016 DPPP Working Group term sheet and noted with the recommendation number (e.g., Docket No. EERE-2015-BT-STD-0008, No. #82 Recommendation #X at p. Y); all references to discussions or suggestions of the DPPP Working Group not found in the June 2016 DPPP Working Group recommendations will have a citation to meeting transcripts and the commenter, if applicable (e.g., Docket No. EERE-2015-BT-STD-0008, [Organization], No. X at p. Y).

In this direct final rule, DOE also refers to certain submitted comments pertaining to the 2015 RFI that have to do with energy conservation standards (e.g., Docket No. EERE-2015-BT-STD-0008, No. X at p. Y). Any RFI comments related to the test procedure or informational in nature are not included here. DOE notes that many of the interested parties that submitted comments pertaining to the 2015 RFI later became members of the DPPP Working Group, or in the case of APSP, several of their members became members of the Working Group. As such, the concerns of these commenters were fully discussed as part of the group's meetings, and their positions may have changed as a result of the compromises inherent in a negotiation. Table II-2 lists the RFI commenters, as well as whether they participated in the DPPP Working Group.

Table II-2 List of RFI Commenters

Commenter	DPPP Working Group Member
APSP	No
CA IOU	Yes
Hydraulic Institute	No
Ms. Newman	No
NEMA	Yes
River City Pool and Spa	No

III. General Discussion

A. Consensus Agreement

As discussed in section II.B, DOE established a working group to negotiate a test procedure and energy conservation standards for dedicated-purpose pool pumps. On June 23, 2016, the Working Group reached unanimous consensus on a term sheet related to performance-based energy conservation standards, scope of such standards, certain definitions, certain prescriptive requirements, certain labeling requirements, and certain test procedure aspects for dedicated-purpose pool pumps. This term sheet included the following recommendations related to energy conservation standards:[19]

<u>Recommendation #1.</u> Each dedicated-purpose pool pump shall be required to meet the applicable minimum energy efficiency standards (WEF) set forth in the following table on and after [**INSERT DATE 54 MONTHS AFTER DATE OF PUBLICATION IN FEDERA REGISTER**]:

Equipment Class	Eff. Level	WEF Equation
Self-priming pool filter pumps <2.5 HHP and >=0.711 HHP	6 (uncorrected)	WEF = – 2.30 * ln (HHP) + 6.59
Self-priming pool filter pumps <0.711 HHP	2	$WEF = \begin{cases} 5.55, & HHP \leq 0.13 \\ -1.30 * \ln(HHP) + 2.90, & HHP > 0.13 \end{cases}$
Non-self-priming pool filter pumps <2.5 HHP	1	$WEF = \begin{cases} 4.60, & HHP \leq 0.13 \\ -0.85 * \ln(HHP) + 2.87, & HHP > 0.13 \end{cases}$
Pressure cleaner booster pumps	1	DOE will recalculate WEF based on the updated test procedure in Recommendation #8 to be equivalent to EL1 (where the EL1 WEF with the previous test procedure was 0.73).

The working group does not recommend standards for: (1) waterfall pumps of any size or (2) self-priming and non-self-priming pool filter pumps greater than or equal to 2.5 HHP.

[19] Note that the recommendations appear as-written in the June 2016 Working Group recommendation (https://www.regulations.gov/document?D=EERE-2015-BT-STD-0008-0082); <u>i.e.,</u> all text and tables are verbatim.

All instances of HHP refer to hydraulic horsepower on Curve C at Max Speed.[20]

Recommendation #2. On and after [**INSERT DATE 54 MONTHS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**, integral cartridge-filter pool pumps and integral sand-filter pool pumps must be distributed in commerce with a timer. Timer may be integral to the pump or a separate component that is shipped with the pump.

Recommendation #3. The scope of the recommended standards for self-priming pool filter pumps are only applicable to self-priming pool filter pumps served by single-phase power.

The recommended test procedure and reporting requirements would be applicable to all self-priming pool filter pumps (served by single- and three-phase power).

The recommended hydraulic horsepower limitation (<2.5 hydraulic hp) still applies.

Recommendation #4. For the purposes of establishing compliance with the standards for integral cartridge-filter and integral sand-filter pool pumps discussed in Recommendation #2, pool pump timer is defined as follows:

[20] The test procedure final rule contains a detailed discussion of the system curves used in pump testing, and section IV.A.1.c of this document describes how system curve C defines the relationship between the power, head, and flow of a pump.

Pool pump timer means a pool pump control that automatically turns off a dedicated-purpose pool pump after a run-time of no longer than 10 hours.

The recommended definition captures the intent of the working group and should be adopted as-written or as modified in a manner that captures the same intent.

Recommendation #6A. All dedicated-purpose pool pumps with freeze protection controls distributed in commerce with the pump shall be shipped with freeze protection disabled or with the following default, user-adjustable settings:

1. The default dry-bulb air temperature setting is no greater than 40 °F
2. The default run time setting shall be no greater than 1 hour (before the temperature is rechecked); and
3. The default motor speed shall not be more than 1/2 of the maximum available speed

As part of certification reporting, manufacturers must include the default dry-bulb air temperature setting (in °F), default run time setting (in minutes), and default motor speed (in rpm).

(Docket No. EERE-2015-BT-STD-0008, No. 82) This term sheet was ultimately submitted to, and accepted by the ASRAC, on July 29, 2016 (Docket No. EERE-2013-BT-NOC-0005, No. 87). All recommendations not shown here are related to test procedure or certification and were addressed in the recently issued test procedure final rule.

After carefully considering the consensus recommendations submitted by the DPPP Working Group and adopted by ASRAC related to energy conservation standards for dedicated-purpose pool pumps, DOE has determined that these recommendations, submitted in the previously discussed term sheet, comprise a statement submitted by interested persons who are fairly representative of relevant points of view on this matter. If compliant with certain statutory requirements, the recommendations could result in issuance of a direct final rule. In reaching this determination, DOE considered that the DPPP Working Group, in conjunction with ASRAC members who approved the recommendations, consisted of representatives of manufacturers of the covered equipment at issue, States, and efficiency advocates—all of which are groups specifically identified by Congress as relevant parties to any consensus recommendation. (42 U.S.C. 6295(p)(4)(A)) and 6316(a)) As discussed above, the term sheet was signed and submitted by a broad cross-section of interests, including the manufacturers who produce the subject equipment, environmental and energy-efficiency advocacy organizations, electric utility companies, and a member representing a State.[21] In addition, the ASRAC Committee approving the DPPP Working Group's recommendations included at least two members representing States, one representing the National Association of State Energy Officials (NASEO) and one representing the State of California.[22] By explicit language of the statute, the Secretary has the discretion to determine when a joint

[21] This individual was Kristen Driskell (CEC).
[22] These individuals were Deborah E. Miller (NASEO) and David Hungerford (CEC).

recommendation for an energy or water conservation standard has met the requirement for representativeness (i.e., "as determined by the Secretary"). (42 U.S.C. 6295(p)(For today's direct final rule, DOE has determined that the DPPP working group represents all relevant points of view of interested parties.

Pursuant to 42 U.S.C. 6295(p)(4), the Secretary must also determine whether a jointly submitted recommendation for an energy or water conservation standard satisfies 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable. In making this determination, DOE has conducted an analysis to evaluate whether the potential energy conservation standards under consideration would meet these requirements. This evaluation is the same comprehensive approach that DOE typically conducts whenever it considers potential energy conservation standards for a given type of product or equipment. DOE applies the same principles to any consensus recommendations it may receive to satisfy its statutory obligation to ensure that any energy conservation standard it adopts achieves the maximum improvement in energy efficiency that is technologically feasible and economically justified and will result in significant conservation of energy. Upon review, the Secretary determined that the term sheet submitted in the dedicated-purpose pool pump rulemaking comports with the standard-setting criteria set forth under 42 U.S.C. 6295(o). Accordingly, the consensus-recommended efficiency levels were included as Trial Standard Level (TSL) 3 for dedicated-purpose pool pumps in this rule (see section V.A for descriptions of all of the considered TSLs). Details regarding how the consensus-recommended TSL complies with the standard-setting criteria are discussed and demonstrated in the relevant sections throughout this document.

In sum, as the relevant criteria under 42 U.S.C. 6295(p)(4) have been satisfied, and the Secretary has determined that it is appropriate to adopt the consensus-recommended energy conservation standards for dedicated-purpose pool pumps through this direct final rule.

As required by the same statutory provision, DOE also is simultaneously publishing a notice of proposed rulemaking (NOPR) proposing that the identical standard levels contained in this direct final rule be adopted. Consistent with the statute, DOE is providing a 110-day public comment period on the direct final rule. While DOE typically provides a comment period of 60 days on proposed standards, DOE is providing a 110-day comment period for this NOPR, which is the same length as the comment period for the direct final rule. Based on the comments received during this period, the direct final rule will either become effective or DOE will withdraw it if one or more adverse comments is received and if DOE determines that those comments, when viewed in light of the rulemaking record related to the direct final rule, provide a reasonable basis for withdrawal of the direct final rule and for DOE to continue this rulemaking under the NOPR. Receipt of an alternative joint recommendation may also trigger a DOE withdrawal of the direct final rule in the same manner. 42 U.S.C. 6295(p)(4)(C). Typical of other rulemakings, it is the substance, rather than the quantity, of comments that will ultimately determine whether a direct final rule will be withdrawn. To this end, the substance of any adverse comment(s) received will be weighed against the anticipated benefits of the jointly submitted recommendations and the likelihood that further consideration of the comment(s) would change the results of the rulemaking. To the extent an adverse issue had been previously raised and addressed in the rulemaking proceeding, such a submission will not typically provide a basis for withdrawal of a direct final rule. Under the statute, withdrawal would occur by the 120th day after the direct final rule's publication.

B. Compliance Date

EPCA does not prescribe a lead time for pumps, or the number of years between the date of publication of a final standards rule and the date on which manufacturers must comply with the new standard. The DPPP Working Group recommended that the standards for dedicated-purpose pool pumps be applicable 54 months following publication of the direct final rule in the Federal Register. (EERE-2015-BT-STD-0008, No. 51, Recommendations #1 and #2 at pp. 1-2) DOE has adopted this date for this direct final rule.

C. Test Procedure

This section discusses DOE's requirements with respect to test procedures as well as summarizes the test procedure for dedicated-purpose pool pumps adopted by DOE.

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6314) Manufacturers of covered equipment must use these test procedures to certify to DOE that their equipment complies with energy conservation standards and to quantify the efficiency of their equipment. As noted, in December 2016, DOE issued the DPPP test procedure final rule to establish test procedures for dedicated-purpose pool pumps. [23] The test procedure for dedicated-purpose pool pumps will appear at title 10 of the CFR part 431, subpart Y, appendix B.

DOE notes that 10 CFR part 430, subpart C, Appendix A established procedures, interpretations, and policies to guide DOE in the consideration and promulgation of new or revised appliance efficiency standards under EPCA. (See section 1.) These procedures are a general guide to the steps DOE typically follows in promulgating energy conservation standards. The guidance recognizes that DOE can and will, on occasion, deviate from the typical process. (See 10 CFR part 430, subpart C, appendix A, section 14(a)) In this particular instance, DOE deviated from its typical process by conducting a negotiated rulemaking process, per the request of multiple key stakeholders and as chartered by ASRAC. The DPPP Working Group initially met four times and successfully reached consensus on the recommended test procedure and metric for different varieties of dedicated-purpose pool pumps. Following ASRAC approval, the DPPP Working Group commenced a second phase of meetings, resulting in consensus on the recommended energy conservation standards as well as certain additional test procedure recommendations. These recommendations are contained in the December 2015 and June 2016 DPPP Working Group term sheets, which ASRAC adopted. (Docket No. EERE-2015-BT-STD-0008, No. 51 and 82, respectively)

As discussed in section III.A, the June 2016 term sheet meets the criteria of a consensus recommendation, and DOE has determined that these recommendations are in

[23] See https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=41

accordance with the statutory requirements of 42 U.S.C. 6295(p)(4) (and 6316(a)) for the issuance of a direct final rule. DOE ultimately adopted the test procedure provisions and recommended standard levels that the DPPP Working Group included in the term sheets, which illustrates that DOE's deviations from the typical rulemaking process in this instance did not adversely impact the manufacturers' ability to understand and provide input to DOE's rulemaking process. The process that DOE used, in this case, was a more collaborative negotiated rulemaking effort resulting in an agreement on recommended standard levels, which DOE is fully implementing in this direct final rule.

Consistent with the recommendations of the DPPP Working Group, in September 2016 DOE published a test procedure notice of proposed rulemaking proposing (September 2016 DPPP TP NOPR) to propose new definitions, a new test procedure, new sampling and rating requirements, and new enforcement provisions for dedicated-purpose pool pumps. DOE held a public meeting on September 26, 2016, to discuss and request public comment on the September 2016 DPPP test procedure NOPR. Subsequently, DOE published a test procedure final rule reflecting relevant recommendations of the DPPP Working Group, as well as input from interested parties received in response to the September 2016 DPPP test procedure NOPR. (Docket No. EERE-2016-BT-TP-0002)

In the test procedure final rule, DOE prescribed a test procedure for measuring the WEF for certain varieties of dedicated-purpose pool pumps. Specifically, the adopted test procedure applies only to self-priming and non-self-priming pool filter pumps,[24] waterfall pumps, and pressure cleaner booster pumps. The test procedure does not apply to integral cartridge filter pool pumps, integral sand filter pool pumps, storable electric spa pumps, or rigid electric spa pumps.

For those applicable varieties of dedicated-purpose pool pumps, DOE prescribed methods to measure and calculate WEF, which is determined as a weighted average of water flow rate over the input power to the dedicated-purpose pool pump at different load points, depending on the variety of dedicated-purpose pool pump and the number of operating speeds with which it is distributed in commerce. The equation for WEF is shown in Equation 1:

$$\mathrm{WEF} = \frac{\sum_{i=1}^{n}\left(w_i \times \frac{Q_i}{1000} \times 60\right)}{\sum_{i=1}^{n}\left(w_i \times \frac{P_i}{1000}\right)}$$

Equation 1

Where:

WEF = weighted energy factor in kgal/kWh;

w_i = weighting factor at each load point i;

Q_i = flow at each load point i in gal/min;

[24] DOE's DPPP test procedure applies to certain varieties of dedicated-purpose pool pumps that are served by both single-phase and three-phase power, whereas this direct final rule only establishes energy conservation standards for self-priming pool filter pumps served by single-phase power.

P_i = input power to the motor (or controls, if present) at each load point i in W;

i = load point(s), defined uniquely for each DPPP variety; and

n = number of load point(s), defined uniquely for each speed configuration.

DOE prescribed unique load points for the different varieties and speed configurations of dedicated-purpose pool pumps, as recommended by the DPPP Working Group. The load points ($\underline{i}$) and weights ($\underline{w_i}$) used in determining WEF for each pump variety are presented in Table III-1.

Table III-1 Load Points and Weights for Each DPPP Variety and Speed Configuration

<table>
<tr><th rowspan="2">DPPP Varieties</th><th rowspan="2">Speed Type</th><th colspan="6">Test Points</th><th rowspan="2">Weight
$\underline{w_i}$</th></tr>
<tr><th># of Points
$\underline{n}$</th><th>Load Point
$\underline{i}$</th><th>Flow Rate
$\underline{Q}$</th><th>Head
$\underline{H}$</th><th>Speed
$\underline{n}$</th></tr>
<tr><td rowspan="5">Self-Priming Pool Filter Pumps

And

Non-Self-Priming Pool Filter Pumps (with hydraulic hp ≤2.5 hp)</td><td>Single*</td><td>1</td><td>High</td><td>$Q_{high}(\text{gpm}) = Q_{max\_speed@C} =$
flow at maximum speed on curve C</td><td>H = 0.0082 × $Q_{high}{}^2$</td><td>Max speed</td><td>1.0</td></tr>
<tr><td rowspan="2">Two-Speed</td><td rowspan="2">2</td><td>Low</td><td>$Q_{low}(\text{gpm})$ = Flow rate associated with specified head and speed that is not below:
• 31.1 gpm if pump hydraulic hp at max speed on curve C is >0.75 or
• 24.7 gpm if pump hydraulic hp at max speed on curve C is ≤0.75
(a pump may vary speed to achieve this load point)</td><td>H ≥ 0.0082 × $Q_{low}{}^2$</td><td>Lowest speed capable of meeting the specified flow and head values, if any</td><td>0.8</td></tr>
<tr><td>High</td><td>$Q_{high}(\text{gpm}) = Q_{max\_speed@C} =$
flow at max speed on curve C</td><td>H = 0.0082 × $Q_{high}{}^2$</td><td>Max speed</td><td>0.2</td></tr>
<tr><td rowspan="2">Multi- and Variable-Speed</td><td rowspan="2">2</td><td>Low</td><td>$Q_{low}(\text{gpm})$
• If pump hydraulic hp at max speed on curve C is >0.75, then $Q_{low} \geq 31.1$ gpm
• If pump hydraulic hp at max speed on curve C is ≤0.75, then $Q_{low} \geq 24.7$ gpm
(a pump may vary speed to achieve this load point)</td><td>H = 0.0082 × $Q_{low}{}^2$</td><td>Lowest speed capable of meeting the specified flow and head values</td><td>0.8</td></tr>
<tr><td>High</td><td>$Q_{high}(\text{gpm}) \geq 0.8 \times Q_{max\_speed@C} \geq$
80% of flow at maximum speed on curve C
(a pump may vary speed to achieve this load point)</td><td>H = 0.0082 × $Q_{high}{}^2$</td><td>Lowest speed capable of meeting the specified flow and head values</td><td>0.2</td></tr>
<tr><td>Waterfall Pumps</td><td>Single</td><td>1</td><td>High</td><td>Flow corresponding to specified head (on max speed pump curve)</td><td>17.0 ft</td><td>Max speed</td><td>1.0</td></tr>
</table>

DPPP Varieties	Speed Type	Test Points					Weight w_i
		# of Points n	Load Point i	Flow Rate Q	Head H	Speed n	
Pressure Cleaner Booster Pumps	All	1	High	10.0 gpm (a pump may vary speed to achieve this load point)	≥60.0 ft	Lowest speed capable of meeting the specified flow and head values, if any	1.0

The test procedure final rule also contains methods to determine the self-priming capability of pool filter pumps to effectively differentiate self-priming and non-self-priming pool filter pumps, and the rated hydraulic horsepower, both of which are necessary to determine the applicable energy conservation standard for certain varieties of dedicated-purpose pool pumps.

D. Scope

In the test procedure final rule, DOE adopted the following definition for dedicated-purpose pool pumps, consistent with that recommended by the DPPP Working Group (EERE-2015-BT-STD-0008, No. 51 Recommendation #4 at p. 3):

“Dedicated-purpose pool pump” means a self-priming pool filter pump, a non-self-priming pool filter pump, a waterfall pump, a pressure cleaner booster pump, an integral sand filter pool pump, an integral cartridge filter pool pump, a storable electric spa pump, or a rigid electric spa pump.

The test procedure final rule also specifically defines several varieties of dedicated-purpose pool pumps, some of which are included in the scope of energy conservation standards. The following sections describe the scope for the adopted performance-based and prescriptive energy conservation standards, respectively, for dedicated-purpose pool pumps.

1. Performance-Based Energy Conservation Standards

The DPPP Working Group recommended energy conservation standards for a subset of dedicated-purpose pool pumps to which the test procedure applies. Specifically, while the test procedure applies to self-priming pool filter pumps, non-self-priming pool filter pumps, pressure cleaner booster pumps, and waterfall pumps, the DPPP Working Group recommended energy conservation standards only for the first three categories, excepting waterfall pumps due to limited economic benefits. (EERE-2015-BT-STD-0008, No. 82 Recommendation #2 at pp. 1-2). DOE agrees with the reasoning of the DPPP Working Group and is establishing energy conservation standards in this direct final rule only for those pump varieties recommended by the DPPP Working Group. Further detail on the economic benefits and burdens for all dedicated-purpose pool pump varieties analyzed, including waterfall pumps, can be found in section V.B. The scope of the performance-based energy conservation standards established in this document is summarized in Table III-2.

Table III-2 Scope of Performance-Based Standards for Dedicated-Purpose Pool Pumps

Pump Variety	Hydraulic Horsepower Range	Power that Pump is Served By
Self-priming pool filter pump	All pumps less than 2.5 hhp	Single Phase

Non-self-priming pool filter pumps	All pumps less than 2.5 hhp	No Restriction
Pressure cleaner booster pumps	No Restriction	No Restriction

DOE notes that in response to the May 2015 DPPP RFI, HI suggested that "auxiliary pool pumps [now referred to as pressure cleaner booster pumps] below 1 hp should be excluded because it will be difficult to adequately differentiate them from other CIP ESCC pumps below 1 hp. Including auxiliary pool pumps below 1 hp could potentially extend the scope of the CIP rulemaking outside the ASRAC working group negotiation. [sic]" (Docket. No. EERE-2015-BT-STD-0008, HI, No. 8 at p. 3) DOE acknowledges the concerns raised by HI, and clarifies that in test procedure rulemaking, DOE proposed, received comment on, and ultimately established, a definition for pressure cleaner booster pumps that effectively differentiated these pumps from end suction close-coupled pumps less than 1 horsepower. Specifically, pressure cleaner booster pump was defined to mean an end suction, dry rotor pump designed and marketed for pressure-side pool cleaner applications, and which may be UL listed under ANSI/UL 1081–2014, "Standard for Swimming Pool Pumps, Filters, and Chlorinators." Because DOE was able to, in the test procedure final rule, develop a definition to adequately differentiate pressure cleaner booster pumps from other end suction close-coupled pump, DOE will not exclude pressure cleaner booster pumps from energy conservation standards, as recommended by HI.

As shown in Table III-2, the DPPP Working Group recommended a scope of standards that restricts self-priming and non-self-priming pool filter pumps to those with a hydraulic output power less than 2.5 horsepower (Docket No. EERE-2015-BT-STD-0008, No. 82, Recommendation #1 at p. 1). DOE notes that the DPPP Working Group first discussed a cutoff point of 2.5 hydraulic horsepower in the March 21, 2016 DPPP Working Group meeting. Initially, the DPPP Working Group members were confused about whether the discussion of pump capacity was using terms of hydraulic horsepower, nameplate horsepower, or shaft horsepower. DOE clarified that capacity discussions are in terms of hydraulic horsepower. (Docket No. EERE-2015-BT-STD-0008, No. 94 at p. 38-42) In a subsequent April 19 Working Group meeting, DOE again clarified that the scope metric is in terms of hydraulic horsepower. (Docket No. EERE-2015-BT-STD-0008, No. 79 at p. 34-39)

Ultimately, the DPPP Working Group recommendation for horsepower limitations is consistent with the scope of self-priming and non-self-priming pool filter pumps established in the test procedure final rule. The DPPP Working Group recommended this restriction based on the combination of three key reasons: (1) low shipments volume, (2) low potential for energy savings (due to the prevalence of motors already regulated by DOE), and (3) lack of performance data. (Docket No. EERE-2015-BT-STD-0008, No. 79 at p. 36-47) DOE agrees with the reasoning of the DPPP Working Group and is adopting this scope restriction in this direct final rule.

DOE notes that prior to the formation of the DPPP Working Group, APSP responded to the May 2015 DPPP RFI and recommended that DOE define scope using total horsepower, noting that it was also open to discussing and developing alternative or additional methods in which we can rate covered pump systems by total input power draw. (Docket. No. EERE-2015-BT-STD-0008, APSP, No. 10 at p. 5) APSP provided no further rationale for their option. APSP's recommendation conflicts with the use of hydraulic horsepower recommended by the DPPP Working Group and discussed in the previous paragraphs. DOE notes that five members of APSP (Waterway Plastics, Hayward Industries, Inc., Zodiac Pool Systems, Inc., Pentair Aquatic Systems, and Bestway USA, Inc.) participated in the DPPP Working Group and unanimously supported the term sheet recommendations enumerated in the previous paragraphs. (EERE-2015-BT-STD-0008, No. 51) Further, DOE notes that a representative of APSP was present at the final DPPP Working Group meeting, and offered no public comment in opposition to the term sheet adopted by the DPPP Working Group. (Docket No. EERE-2015-BT-STD-0008, June 23 DPPP Working Group Meeting, No. 92, at p. 3) For these reasons, DOE believes that the interests of APSP were sufficiently satisfied by the recommendations unanimously agreed upon by the DPPP Working Group.Also as shown in Table III-2, the DPPP Working Group recommended that the scope of the recommended standards for self-priming pool filter pumps only be applicable to self-priming pool filter pumps served by single-phase power. The DPPP Working Group clarified that the recommended test procedure and reporting requirements would still be applicable to all self-priming pool filter pumps—both those served by single-phase power and those served by three-phase power. (Docket No. EERE-2015-BT-STD-0008, No. 82 Recommendations #3 at p. 2) Regardless of whether the pump is supplied by single- or three-phase power, the recommended hydraulic horsepower limitation of 2.5 rated hydraulic horsepower would still apply to such self-priming pool filter pumps.

The DPPP Working Group recommended this restriction based on low shipments volume and low potential for energy savings (due to the prevalence of motors already regulated by DOE) (Docket No. EERE-2015-BT-STD-0008, No. 91 at p. 171). DOE agrees with the reasoning of the DPPP Working Group and is adopting this scope restriction in this direct final rule.

Finally, consistent with the test procedure scope, standards do not apply to submersible pumps. In the test procedure final rule, DOE defined a submersible pump as a pump that is designed to be operated with the motor and bare pump fully submerged in the pumped liquid. As discussed in the test procedure final rule, DOE determined that some end suction submersible pond pumps may meet the definition of self-priming or non-self-priming pool filter pump, but were not reviewed by the DPPP Working Group and were not intended by the DPPP Working Group to be in the scope of this rulemaking. In order to exclude these pumps from this regulation, DOE excluded submersible pumps from the scope of the test procedure final rule, and is in turn excluding them from the scope of this direct final rule.

2. Prescriptive Energy Conservation Standards

Consistent with the DPPP Working Group recommendations, DOE is setting prescriptive energy conservation standards for integral cartridge filter pool pumps and integral sand filter pool pumps. This equipment is specifically defined in the test procedure final rule.

DOE notes that before the formation of the DPPP Working Group, APSP responded to the May 2015 DPPP RFI and generally recommended that DOE pursue a performance-based metric versus a prescriptive regulation. (Docket. No. EERE-2015-BT-STD-0008, APSP, No. 10 at p. 11) APSP provided no further rationale for their option.

APSP's recommendation conflicts with the mix of performance-based and prescriptive standards recommended by the DPPP Working Group and enumerated in section III.A. DOE notes that five members of APSP (Waterway Plastics, Hayward Industries, Inc., Zodiac Pool Systems, Inc., Pentair Aquatic Systems, and Bestway USA, Inc.) participated in the DPPP Working Group and unanimously supported the term sheet recommendations enumerated in section III.A. (EERE-2015-BT-STD-0008, No. 51) Further, DOE notes that a representative of APSP was present at the final DPPP Working Group meeting, and offered no public comment in opposition to the term sheet adopted by the DPPP Working Group. (Docket No. EERE-2015-BT-STD-0008, June 23 DPPP Working Group Meeting, No. 92, at p. 3) For these reasons, DOE believes that the interests of APSP were sufficiently satisfied by the recommendations unanimously agreed upon by the DPPP Working Group.

3. Dedicated-Purpose Pool Pump Motor

In response to the May 2015 DPPP RFI, NEMA recommended that DOE consider proposing a replacement motor standard for pool pumps, as has been done in the California Title 20 Appliance Efficiency Program. NEMA asserted that the replacement pool filter pump motor subject is one that requires nationwide uniformity of compliance and enforcement through specific language regarding replacement motors within the pool filter pump system. (Docket. No. EERE-2015-BT-STD-0008, NEMA, No. 9 at p. 2) DOE acknowledges that replacement dedicated-purpose pool pump motors may have an impact on national energy consumption. However, establishing energy conservation standards or prescriptive requirements for dedicated-purpose pool pump motors is outside of the scope of authority of this rulemaking, as replacement motors do not meet the definition of "dedicated-purpose pool pump" or "pump," as defined in part 431 of title 10 of the Code of Federal Regulations. For this reason, in this direct final rule, DOE will not establish energy conservation standards for replacement dedicated-purpose pool pump motors.

However, DOE notes that in the test procedure final rule, DOE established an optional test procedure for rating replacement dedicated-purpose pool pump motors. DOE believes that this optional test procedure will aid the industry in moving towards uniformity in the rating and labeling of replacement dedicated-purpose pool pump motors.

E. Technological Feasibility

1. General

In each energy conservation standards rulemaking, DOE conducts a screening analysis based on information 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 an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, industry experts, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i)

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, and 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) Additionally, it is DOE policy not to include in its analysis any proprietary technology that is a unique pathway to achieving a certain efficiency level. Section IV.B of this notice discusses the results of the screening analysis for dedicated-purpose pool pumps, particularly the designs DOE considered, those it screened out, and those that are the basis for the standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the direct final rule technical support document (TSD).

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt or amend a standard for a type or class of covered equipment, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) and 6316(a)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (max-tech) improvements in energy efficiency for dedicated-purpose pool pumps based on the most efficient equipment available on the market for certain equipment classes, and theoretical maximum attainable efficiency for others. The max-tech levels that DOE determined for this rulemaking are described in section IV.C.4 of this direct final rule and in chapter 5 of the direct final rule TSD.

F. Energy Savings

1. Determination of Savings

For each trial standard level (TSL), DOE projected energy savings from application of the TSL to pool pumps purchased in the 30-year period that begins in the year of compliance with any new standards (2021-2050).[25] The savings are measured over the entire lifetime of equipment purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-standards case. The no-standards case represents a projection of energy consumption that reflects how the market for equipment would likely evolve in the absence of energy conservation standards.

DOE used its national impact analysis (NIA) spreadsheet model to estimate national energy savings (NES) from potential standards for pool pumps. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by equipment at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. DOE also calculates NES in terms of full-fuel-cycle (FFC) energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (i.e., coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[26]

[25] DOE also presents a sensitivity analysis that considers impacts for equipment shipped in a 9-year period.
[26] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012).

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

G. Economic Justification

1. Specific Criteria

As noted , 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)(I)(VII)) and 6316(a)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

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

For individual consumers, measures of economic impact include the changes in LCC and 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 (LCC and PBP)

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

The LCC is the sum of the purchase price of equipment (including its installation) and the operating cost (including energy, maintenance, and repair expenditures) discounted over the lifetime of the equipment. The LCC analysis requires a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as equipment lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

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

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

c. Energy Savings

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

d. Lessening of Utility or Performance of Equipment

In establishing equipment classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered equipment. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) and 6316(a)) DOE reviewed performance data and characteristics for dedicated-purpose pool pump models that are currently available on the market, including models that meet the standards adopted in this final rule and models that do not meet the standards adopted in this final rule. For these models, DOE examined characteristics such as the capacity, controls, and physical size of the pumps. DOE was unable to identify any DPPP features or associated end-user utility that would become unavailable following the adoption of the standards in this final rule. Consequently, DOE concludes that the standards adopted in this direct final rule would not reduce the utility or performance of the equipment subject to this rulemaking. DOE's assessment of available technology options (see section IV.A.6) discusses, in detail, the features and technologies associated with the select standard level.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, which is likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) and 6316(a)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) and 6316(a)) DOE will transmit a copy of this direct final rule to the Attorney General with a request that the Department of Justice (DOJ) provide its determination on this issue. DOE will consider DOJ's comments on the rule in determining whether to proceed with the direct final rule. DOE will also publish and respond to the DOJ's comments in the Federal Register in a separate notice.

f. Need for National Energy Conservation

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

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The adopted standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (GHGs) associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L.

g. Other Factors

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

2. Significance of Savings

To adopt standards for a covered product or equipment, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 6295(o)(3)(B)) and 6316(a)) Although EPCA does not define the term "significant," in Natural Resources Defense Council v. Herrington, the U.S. Court of Appeals for the District of Columbia indicated that Congress intended "significant" energy savings in the context of EPCA to be savings that are not "genuinely trivial." 768 F.2d 1355, 1373 (D.C. Cir. 1985). The energy savings for all the TSLs considered in this rulemaking, including the adopted standards, are not trivial, and, therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

3. Rebuttable Presumption

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

IV. Methodology and Discussion of Related Comments

This section addresses the rulemaking analyses DOE performed for this direct final rule. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the standards considered in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation standards. The national impacts analysis uses a second spreadsheet set that provides shipments forecasts and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (GRIM), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking:

https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=67. Additionally, DOE used output from the Energy Information Administration (EIA)'s Annual Energy Outlook 2016 (AEO2016), a widely known energy forecast for the United States, for the emissions and utility impact analyses.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for dedicated-purpose pool pumps, including purpose of the equipment, industry structure, manufacturers, market characteristics, and technologies used in the equipment. This activity includes both quantitative and qualitative assessments, based primarily on publicly available information (e.g., manufacturer specification sheets and industry publications) and data submitted by manufacturers, trade associations, and other stakeholders. The market and technology assessment for this rulemaking addresses: (1) equipment classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends, and (6) technologies or design options that could improve the energy efficiency of dedicated-purpose pool pumps. The key findings of DOE's market assessment are summarized below. See chapter 3 of the direct final rule TSD for further discussion of the market and technology assessment.

1. Equipment Classes and Distinguishing Features

When evaluating and establishing energy conservation standards, DOE divides covered equipment into equipment classes by the type of energy used, by capacity, or by other performance-related features that justify differing standards. In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (42 U.S.C. 6295(q) and 6316(a))

In the test procedure final rule, DOE defined different varieties of DPPP equipment. A pool filter pump is an end suction pump that either: (1) includes an integrated basket strainer, or (2) does not include an integrated basket strainer, but requires a basket strainer for operation, as stated in manufacturer literature provided with the pump; and may be distributed in commerce connected to, or packaged with, a sand filter, removable cartridge filter, or other filtration accessory, as long as the bare pump and filtration accessory are connected with consumer-removable connections that allow the pump to be plumbed to bypass the filtration accessory for testing.

A self-priming pool filter pump is a pool filter pump that is certified under NSF/ANSI 50–2015 to be self-priming or is capable of re-priming to a vertical lift of at least 5 feet with a true priming time less than or equal to 10 minutes, when tested in accordance with NSF/ANSI 50–2015, “Equipment for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities.”

A non-self-priming pool filter pump is a pool filter pump that is not certified under NSF/ANSI 50-2015 to be self-priming and is not capable of re-priming to a vertical lift of at least 5 feet with a true priming time less than or equal to 10 minutes, when tested in accordance with NSF/ANSI 50–2015.

A pressure cleaner booster pump is an end suction, dry rotor pump designed and marketed for pressure-side pool cleaner applications, and which may be UL listed under ANSI/UL 1081–2014, "Standard for Swimming Pool Pumps, Filters, and Chlorinators."

A waterfall pump is a pool filter pump with maximum head less than or equal to 30 feet, and a maximum speed less than or equal to 1,800 rpm.

An integral cartridge filter pool pump is a pump that requires a removable cartridge filter, installed on the suction side of the pump, for operation; and the pump cannot be plumbed to bypass the cartridge filter for testing.

An integral sand filter pool pump is a pump distributed in commerce with a sand filter that cannot be bypassed for testing.

The DPPP varieties defined above serve as the basis for the DPPP equipment classes established in this direct final rule. Further, the class of self-priming pool filter pumps is being subdivided into two classes based on pump capacity. In this direct final rule, DOE is establishing DPPP equipment classes based on the following performance-related features:

- strainer or filtration accessory
- self-priming ability
- pump capacity (flow, head, and horsepower)
- rotational speed

Stakeholder comments regarding equipment classes, the specific separation of equipment classes based on the listed factors, and the final list of proposed equipment classes are discussed further in sections IV.A.1.a through IV.A.1.d.

a. Strainer or Filtration Accessory

Dedicated-purpose pool pumps employ several different varieties of strainer and filtration accessories, each providing a different utility to the end user. As defined in the test procedure final rule, a pool filter pump either includes a basket strainer or requires a basket strainer for operation. A basket strainer is a specific component that the test procedure final rule defines as “a perforated or otherwise porous receptacle that prevents solid debris from entering a pump, when mounted within a housing on the suction side of a pump. The basket strainer receptacle is capable of passing spherical solids of 1 mm in diameter, and can be removed by hand or with simple tools. Simple tools include but are not limited to a screwdriver, pliers, and an open-ended wrench.” The basket strainer provides a direct utility to the pool filter pump end user, as it protects the pump from debris that would otherwise enter the impeller and cause damage to the pump. However, this utility comes at the cost of pump efficiency. The basket strainer has head-loss associated with it, which means a measurable amount of hydraulic power is lost as water traverses the basket strainer and the basket strainer housing. Ultimately, this reduces efficiency for pumps that include or require a basket strainer, compared to those that do not. Based on this relationship between end-user utility and achievable efficiency, DOE concludes that the presence of or requirement for a basket strainer is an appropriate feature to differentiate and establish pool filter pump equipment classes (including standard-size and small-size self-priming pool filter pumps, non-self-priming pool filter pumps, and waterfall pumps).

Typically, if a pool utilizes a pool filter pump, the filtration of particulates less than 1mm in diameter takes place in a separate filtration device, which is either installed separately from the pump, or is attached to the pump and may be removed using simple tools. Alternatively, integral cartridge filter and integral sand filter pump varieties include a filtration accessory, designed to remove particulates less than 1mm in diameter, which is integrally and permanently mounted to the pump. These integral filter pump varieties are typically distributed in commerce with a storable pool (e.g., inflatable or collapsible pools) or as a replacement pump for such a pool. These storable pools are intended for temporary or seasonal use, and their application and usage profile are unique from other dedicated-purpose pool pump varieties. The end user is required to assemble the pump and pool at the beginning of the season and disassemble the pump and pool for storage at the end of the season. Combining the pump and filtration equipment into one integral piece of equipment enables the user to assemble, disassemble, and store the equipment more easily than if the pump and filter were separate components. Thus, the integral nature of the filtration accessory provides utility to the end user.

Similar to the basket strainer, the integral filtration accessory has head-loss associated with it, which means a measurable amount of hydraulic power is lost as water traverses the integral filtration accessory. However, due to the finer filtering capability of the integral filtration accessory (designed to remove particulates less than 1 mm in diameter), the integral filtration accessory will experience a larger head-loss than a comparably sized strainer basket. Ultimately, this translates to a reduced efficiency for integral cartridge filter and integral sand filter pool pumps, as compared to similarly sized pool filter pumps and other pumps not requiring a basket strainer. Based on this relationship between end-user utility and achievable efficiency, DOE concludes that the presence of an integral filtration accessory is an appropriate feature to differentiate and establish integral pump equipment classes (including integral cartridge filter and integral sand filter pumps)

The two specific varieties of integral filter pumps (integral cartridge and integral sand) offer different utility to end users. Sand filter pumps typically weigh more (when filled with sand media), but require less ongoing intervention and attention by the end user than cartridge filters. However, integral sand filter pool pumps typically have a greater head-loss across the filtration accessory than integral cartridge filter pool pumps. Ultimately, this translates to a reduced efficiency for integral sand filter pumps, compared to integral cartridge filter pumps. Based on this relationship between end-user utility and achievable efficiency, DOE concludes that the variety of integral filtration accessory (sand filter versus cartridge filter) is an appropriate feature to differentiate integral pumps into two equipment classes, integral cartridge and integral sand filter pumps.

b. Self-Priming Ability

All pool filter pumps on the market are either self-priming or non-self-priming. The test procedure final rule defines a self-priming pool filter pump as, “a pool filter pump that is certified under NSF/ANSI 50–2015 to be self-priming or is capable of re-priming to a vertical lift of at least 5 feet with a true priming time less than or equal to 10 minutes, when tested in accordance with NSF/ANSI 50–2015.” Self-priming pumps are able to lift liquid that originates below the centerline of the pump inlet and, after initial manual priming, are able to subsequently re-prime without the use of external vacuum sources, manual filling, or a foot valve. In contrast, non-self-priming pumps must be re-primed in order to operate after an idle period. This re-priming may be achieved by manually filling the pump with water, or re-priming may be induced by placing the pump at a lower vertical height than the surface of the water it will pump. The self-priming capability of a pool filter pump affects typical applications for which the pump is appropriate, and thus the utility to the end user. For example, typical inground pool constructions consist of a pump at ground level (above the water level), and main and skimmer drains below the water level. In this configuration, when the pump is cycled off (which will typically happen during the day), prime is lost. A self-priming pump provides the end user with the ability to restart the pump (typically using a timer) without any need for manual intervention. Alternatively, a non-self-priming pump would require the end user to manually refill the pump casing (re-prime) the pump, each time the end user wanted to restart the pump.

To achieve self-priming capability, self-priming pumps are constructed in a different manner than non-self-priming pumps. Specifically, self-priming pool filter pumps typically incorporate diffusers and reservoirs that work together to remove air from the suction side of the pump and regain the prime after an idle period. Prime is achieved by recirculating water that is trapped in the reservoir. The water in the pump mixes with air entering the pump from the suction line, and that mixture is discharged back into the reservoir, where air is released out of the pump discharge. Once all of the air is removed from the suction line, the pump is primed. However, once the self-priming pump is primed and running, the diffuser and reservoir configuration, by design, results in significant water recirculation within the bare pump, compared to a non-self-priming pump, where there is less internal recirculation. Internal water recirculation means that a portion of the hydraulic output of the pump is recirculated back to the reservoir of the pump, and is not immediately discharged out of the pump; as such, recirculation reduces the efficiency of the pump. Based on this relationship between end-user utility and achievable efficiency, DOE concludes that self-priming capability is an appropriate feature to differentiate equipment classes (self-priming versus non-self-priming pool filter pumps).[27]

c. Pump Capacity (Flow, Head, and Power)

The capacity of a dedicated-purpose pool pump can be expressed using measurements of head, flow, and hydraulic power. These three parameters define the useful output to the end user and are interrelated and bound by the Equation 2:

[27] More information on the construction and capabilities of self-priming and non-self-priming pumps is available at Hayward Industries' web page of frequently asked questions. In particular, the descriptions of inground and aboveground pump operations discuss priming. These descriptions are available at:https://www.hayward-pool.com/shop/en/pools/faqs#q188, and at https://www.hayward-pool.com/shop/en/pools/faqs#q192.

$$P_{hydro} = \frac{Q * H}{3956}$$

Equation 2

Where:

$\underline{P_{hydro}}$ = hydraulic power (hp)

$\underline{Q}$ = volumetric flow (gpm), and

$\underline{H}$ = total dynamic head (feet of water)

The requirements of a pool (or any water system), can be expressed in terms of a system curve. When a pump is tested on a system curve (such as curve C),[28] any one of these three measurements can be used to calculate the other two measurements. Equation 3 and Equation 4 illustrate this relationship.

$$H_{CurveC} = 0.0082 * Q_{CurveC}^{2}$$

Equation 3

Where:

$\underline{Q_{CurveC}}$ = volumetric flow on system curve C (gpm) and

$\underline{H_{CurveC}}$ = head on system curve C (feet of water)

$$P_{hydro,CurveC} = \frac{0.0082 * Q_{CurveC}^{3}}{3956}$$

[28] The test procedure final rule contains a detailed discussion of the system curves used in pump testing.

Equation 4

Where:

$\underline{P_{hydro,CurveC}}$ = hydraulic power on system curve C (hp)

In this direct final rule, in agreement with DPPP Working Group recommendations, DOE is subdividing self-priming pool filter pumps into two equipment classes based on capacity, or more specifically, hydraulic horsepower at maximum speed on curve C (which is also referred to as rated hydraulic horsepower in test procedure final rule).

During meetings, some DPPP Working Group members commented that small pool filter pumps are inherently more efficient than large pool filter pumps, and the group considered introducing a breakpoint to divide the self-priming pool filter pump variety into two equipment classes based on capacity. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 DPPP Working Group Meeting, at pp. 78-87) Initially, several DPPP Working Group members proposed to set this breakpoint at a level such that pumps rated above 0.75 thp would fall in a larger equipment class. (Docket No. EERE-2015-BT-STD-0008-0091, June 22 DPPP Working Group Meeting, at pp. 44-50) DPPP manufacturers commented that pumps rated below 1.0 thp make up a small portion of total pool filter pump shipments, and manufacturers proposed a higher breakpoint for the equipment classes, at a hydraulic horsepower corresponding to 1.25 thp. (Docket No. EERE-2015-BT-STD-0008-0091, June 22 DPPP Working Group Meeting, at pp. 54) To aid discussion, DPPP manufacturers provided pool filter pump shipment data to DOE's contractor and DOE presented aggregated shipment data to the DPPP Working Group. The aggregated shipment data showed that approximately 10 percent of pool filter pump shipments are rated below 1.0 thp and approximately 5 percent of pool filter pump shipments are rated below 0.75 thp. (Docket No. EERE-2015-BT-STD-0008-0092, June 23 DPPP Working Group Meeting, at pp. 233-239) Based on these shipment data, the DPPP Working Group agreed on a recommendation to set the breakpoint between small-size and standard-size self-priming pool filter pumps at 0.711 hhp, so that most of the currently available pool filter pumps rated at 1.0 thp and below would fall below the 0.711-hhp breakpoint. (Docket No. EERE-2015-BT-STD-0008-0092, June 23 DPPP Working Group Meeting, at pp. 276-277; No. 82 Recommendation #1 at p. 1) Equation 4 dictates that 0.711 hhp corresponds to a flow rate of 70 gpm on curve C.

As discussed earlier in this subsection, pump capacity may also be considered in terms of pump head (or total dynamic pressure). In this direct final rule, DOE is distinguishing waterfall pump equipment from other pool filter pump varieties using head limitations. Specifically, as discussed by the DPPP Working Group, pumps used in waterfall applications do not need to produce high heads because waterfall pumps are typically not connected to pool circulation plumbing or to ancillary pool components like heaters and chlorinators (Docket No. EERE-2015-BT-STD-0008-0056, December 7 DPPP Working Group Meeting, at p. 237). Therefore, the DPPP Working Group recommended distinguishing the waterfall pump equipment class by establishing a maximum pump head of 30 feet (inclusive) for the waterfall pump equipment class. (Docket No. EERE-2015-BT-STD-0008, No. 51 Recommendation #4 at p. 3)

Finally, in this direct final rule, DOE is distinguishing pressure cleaner booster pumps from other pumps based on their unique flow and head output. DPPP Working Group members asked whether pressure cleaner booster pumps would be covered by the energy conservation standard for general pumps. DOE clarified that the pressure cleaner booster pumps would not be covered by the general pumps standard since the general pumps standard has a lower bound of 25 gpm at the pump's best efficiency point, and the best efficiency point of pressure cleaner booster pumps is typically less than 25 gpm. (Docket No. EERE-2015-BT-STD-0008-0058, October 19 Working Group Meeting, at pp. 76-81) As discussed by the DPPP Working Group, pressure cleaner booster pumps must provide a high amount of head at a low flow rate to propel pressure-side pool cleaners along the bottom of the pool and to remove debris as the cleaner moves. Specifically, pressure-side pool cleaners (and associated piping and hoses) require a pump that provides at least 60 feet of head at approximately 10 gpm of flow; noting that the actual head requirements vary with each specific system, but will not typically be lower than 60 feet of head. (Docket No. EERE-2015-BT-STD-0008, March 22 Working Group Meeting, at pp. 207-210) Figure IV.1 illustrates the performance of four pressure cleaner booster pump models from the three largest manufacturers (representing the majority of the pressure cleaner booster pump market) and highlights the range of head and flow rates for which these pumps are currently designed.

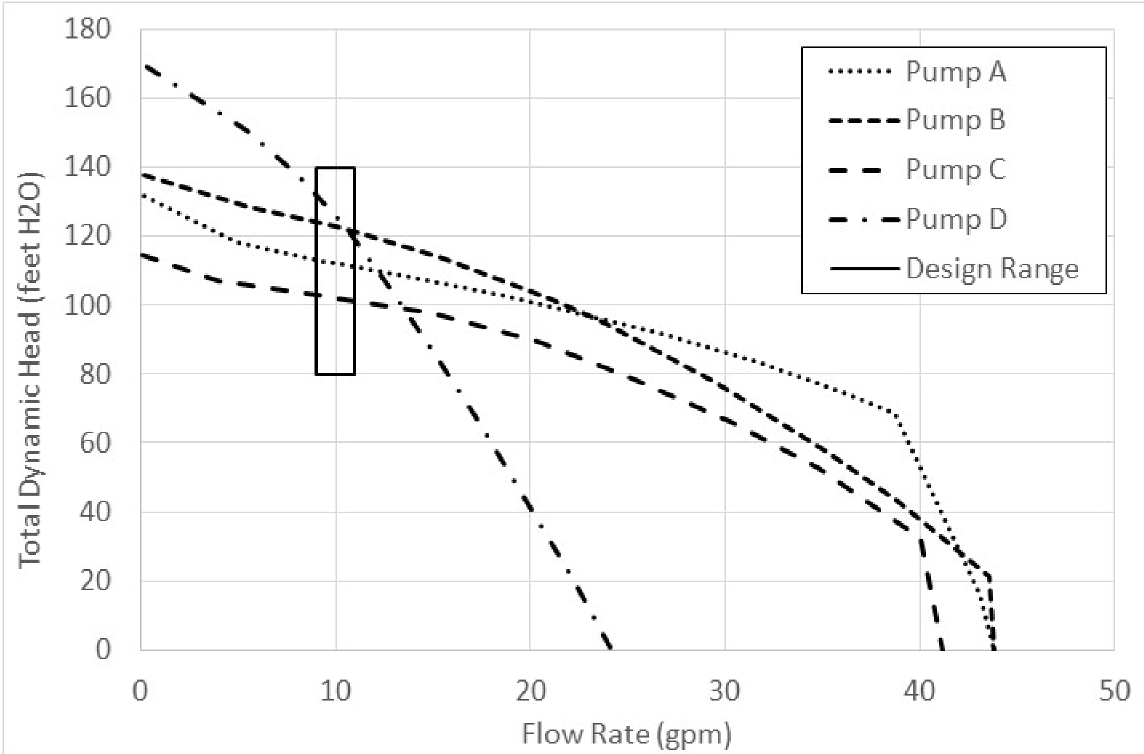

Figure IV.1 Head-Flow Chart for Four Pressure Cleaner Booster Pumps, Highlighting Design Range

Although the pumps in Figure IV.1 all provide between 100 and 127 feet of head at 10 gpm, the DPPP Working Group concluded that certain systems require less head (down to 60 feet of head). DPPP Working Group members expressed a desire that the test procedure allow better ratings for variable-speed pressure cleaner pumps that are able to reduce speed and energy consumption to avoid supplying (and wasting) excess pressure beyond what is required to drive the cleaner. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 49) The DPPP Working Group recommended that, for the test procedure, pressure cleaner booster pumps be evaluated at the lowest speed that can achieve 60 feet of head at a flow rate of 10 gpm. (Docket No. EERE-2015-BT-STD-0008, No. 82 Recommendation #8 at pp. 4) Consequently, DOE has concluded that the aforementioned capacity range provides a specific utility to the consumer, or end user, and is therefore appropriate to use as the basis for distinguishing pressure cleaner booster pumps from other pump equipment classes.

d. Rotational Speed

For dedicated-purpose pool pumps, DOE has determined that rotational speed is not a sufficient differentiator to establish an equipment class without adding specific utility. However, the DPPP Working Group recommended DOE define waterfall pumps as “a pool filter pump with maximum head less than or equal to 30 feet, and a maximum speed less than or equal to 1,800 rpm” and establish an equipment class for this variety of pool filter pump (Docket No. EERE-2015-BT-STD-0008, No. 44, Recommendation #4 at p. 3). Waterfall pumps are used in applications with low head and high flow requirements; i.e., applications that require “flat” head versus flow performance curves. This is because waterfall pumps are not typically plumbed through a filter or other auxiliary equipment, and thus do not have a large amount of head to overcome.

Pumps running at 1,800 rpm typically exhibit the fairly flat head versus flow operating curve that is usually required by waterfall applications. Figure IV.2 illustrates this property in contrast to the steeper head-versus-flow curves that are typical for self-priming pool filter pumps.

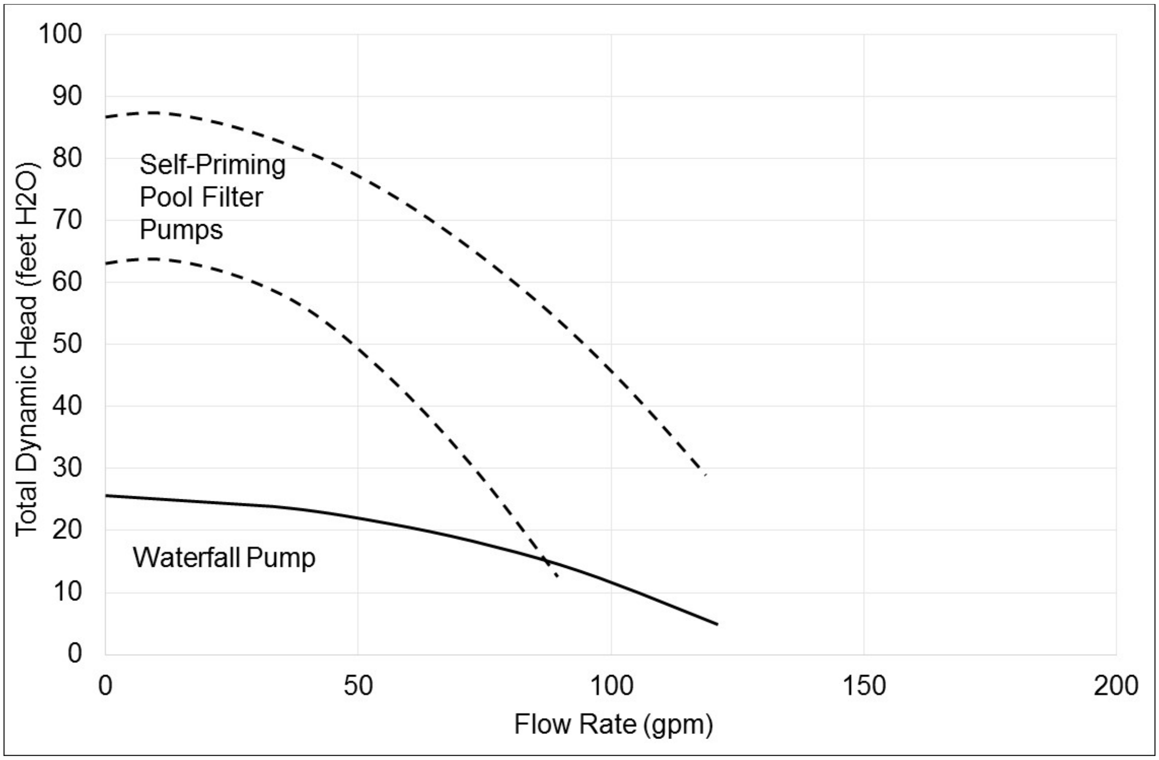

Figure IV.2 Head-Flow Curves of a Waterfall Pump and Self-Priming Pool Filter Pumps

Due to the inherent curve shape of 1,800 rpm pumps, this rotational speed limitation in conjunction with the 30-foot head limitation serves to establish a capacity differentiation. The limitations recommended by the DPPP Working Group effectively categorize a set of pumps with similar performance curves (heads, flows, and hydraulic horsepowers) into one equipment class–waterfall pumps. Figure IV.3 illustrates this phenomenon.

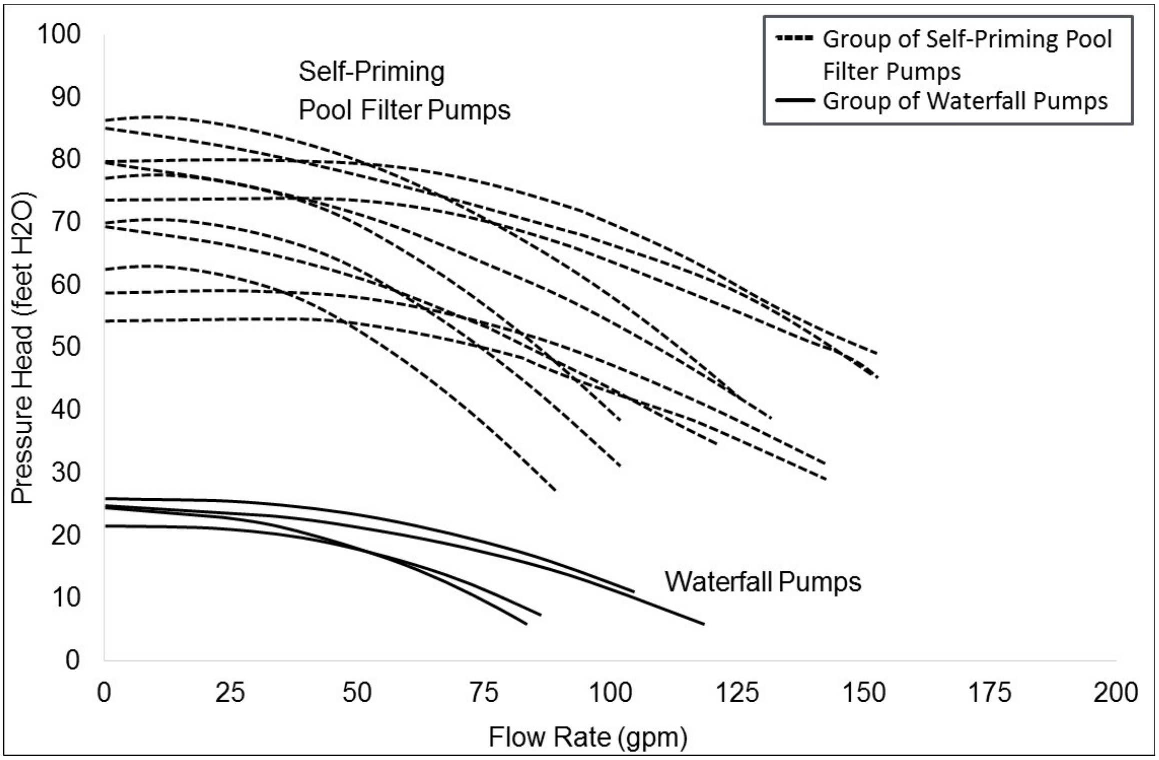

Figure IV.3 Head-Flow Curves of Multiple Waterfall Pumps and Self-Priming Pool Filter Pumps

e. End User Safety

Pressure cleaner booster pumps share many similar design features with end suction close-coupled pumps. However, dedicated-purpose pool pumps (including pressure cleaner booster pumps) must specifically consider the safety of the pool operator (typically a homeowner or renter) in their design (e.g., reduced electrocution or injury risk). To do so, the dedicated-purpose pool pump industry relies on the safety requirements established in the voluntary standard ANSI/UL 1081–2014, "Standard for Swimming Pool Pumps, Filters, and Chlorinators."[29] Based on DPPP Working Group discussion, DOE concludes that most pool filter pumps and all pressure cleaner booster pumps comply with and are currently listed to ANSI/UL 1081-2014. Conversely, general

[29] ANSI/UL 1081-2014 is available for purchase at http://ulstandards.ul.com/standard/?id=1081_6

purpose end suction close-coupled pumps are typically installed in commercial and industrial applications and do not need to account for the same specific safety concerns. Differences in safety consideration result in differences in design choices that ultimately affect the performance of the pump. Consequently, DOE concludes that safety considerations are appropriate features to differentiate pressure cleaner booster pumps from end suction close-coupled pumps.

f. List of Proposed Equipment Classes

Based on the performance-related features and distinguishing characteristics described from section IV.A.1.a to section IV.A.1.d, DOE is establishing the following equipment classes, listed in Table IV-1 and Table IV-2:

Table IV-1 DOE Equipment Classes for Pool Filter Pumps

Strainer or Filtration Accessory	Priming Capability	Pump Capacity		Rotational Speed	Equipment Class Designation
		Pump Power	Pump Head		
Basket strainer	Self-priming	<2.5 hhp, >0.711 hhp	n/s*	n/s*	Self-priming pool filter pump, standard-size
		≤0.711 hhp	n/s*	n/s*	Self-priming pool filter pump, small-size
	Non-self-priming	<2.5 hhp	n/s*	n/s*	Non-self-priming pool filter pump**
	n/s*	n/s*	≤30 ft.	≤1800 rpm	Waterfall pump

*n/s indicates not specified.
** DOE analyzed non-self-priming pool filter pumps as two equipment classes: extra-small (less than 0.13 hhp) and standard-size (less than 2.5 hhp and greater than 0.13 hhp). These two equipment classes were ultimately merged into one after DOE selected the same efficiency level for both extra-small and standard-size non-self-priming pool filter pumps.

Table IV-2 DOE Equipment Classes for Other Dedicated-Purpose Pool Pumps

Distinguishing Feature(s)	Equipment Class Designation
Integrated cartridge filter	Integral cartridge filter pool pump
Integrated sand filter	Integral sand filter pool pump

• Capacity (designed and marketed for pressure-side pool cleaner applications) • End User Safety (UL listed under ANSI/UL 1081–2014)	Pressure cleaner booster pump

2. Manufacturers and Industry Structure

Manufacturers of dedicated-purpose pool pumps can be categorized into two distinct segments: (1) those that primarily offer pool filter pumps greater than 0.40 hhp and varieties of auxiliary pumps such as waterfall and pressure cleaner booster pumps, (the pool filter pump industry) and (2) those that offer integral filter pumps and pool filter pumps smaller than 0.40 hhp, but not other auxiliary pumps (the integral filter pump industry). The former typically offers larger self-priming pool filter pumps, non-self-priming pool filter pumps, waterfall pumps, and pressure cleaner booster pumps. The latter typically offers very small pool filter pumps, as well as integral cartridge and sand filter pumps that are sold as a package with a seasonal pool, or as a replacement for a pump sold with a seasonal pool. DOE is unaware of any manufacturers that participate in both segments. Consequently, the two categories are discussed separately.

In the pool filter pump industry, DOE identified 17 manufacturers. Of the 17, DOE found that three large manufacturers hold approximately 90 percent of the market in terms of equipment shipments: Hayward Industries, Inc.; Pentair Aquatic Systems; and Zodiac Pool Systems, Inc. These manufacturers primarily produce equipment at manufacturing facilities in the United States. The remaining 10 percent of the market is held by AquaPro Systems; Aquatech Corp.; Asia Connection LLC; Bridging China International, Ltd.; Carvin Pool Equipment, Inc.; ECO H2O Tech, Inc.; Fluidra USA, LLC; Hoffinger Industries; Raypak; Speck Pumps; SpectraLight Technologies; Waterway Plastics, Inc.; Waterco Ltd.; and Wayne Water Systems.

DOE identified four manufacturers in the integral filter pump industry: Bestway (USA), Inc.; Great American Merchandise and Events (GAME); Intex Recreation Corp.; and Polygroup. Based on public records found in Hoovers,[30] DOE determined that all four manufacturers are U.S.-based entities. During the DPPP Working Group meeting on April 19, 2016, DOE presented the assumption that none of the integral cartridge and integral sand filter pumps are manufactured domestically. (See EERE-2015-BT-STD-0008-0067, at p. 104) When this information was presented to the DPPP Working Group, there were no objections to this assumption. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 Working Group Meeting, at pp. 132-134) DOE therefore concludes that all manufacturers in the integral filter pump industry produce equipment abroad and import it for sale in the United States.

3. Existing Efficiency Programs

DOE reviewed several existing and proposed regulatory and voluntary energy conservation programs for pool pumps. These programs are described in the following sections.

a. U.S. State-Level Programs

The CEC first issued standards for residential pool pumps under the California Code of Regulations (CCR) 2006.[31] See 20CCR section 1601–1608 (2013). The CEC

[30] Hoovers Inc., Company Profiles, Various Companies (Available at www.hoovers.com/).
[31] California Energy Commission. "Appliance Efficiency Regulations." December 2006. CEC–400–2006–002–REV2. Available at www.energy.ca.gov/2006publications/CEC-400-2006-002/CEC-400-2006-002-REV2.PDF.

standards (or similar variations) were subsequently adopted by a number of other states.[32] The CEC's regulations cover all residential pool pump and motor combinations, replacement residential pool pump motors, and portable electric spas.

The CEC's current standard (amended in 2008) has prescriptive design requirements, rather than performance-based regulations for residential pool pump and motor combinations. See 20CCR section 1605.3(g)(5). The CEC defines "residential pool pump and motor combination" as a residential pool pump motor coupled to a residential pool pump. "Residential pool pump" is defined as an impeller attached to a motor that is used to circulate and filter pool water in order to maintain clarity and sanitation. "Residential pool pump motor" refers to a motor that is used as a replacement residential pool pump motor or as part of a residential pool pump and motor combination. (Motors used in these applications are electrically driven.) The CEC imposes a design standard that prohibits the use of split-phase start[33] and capacitor-start-induction-run[34] motor designs in residential pool pump motors manufactured on or after January 1, 2006. (Id. section 1605.3(g)(5)(A)) The CEC also requires that residential pool pump motors with a motor capacity[35] of 1 hp or greater manufactured on or after January 1, 2010, have the capability of operating at two or more speeds. The low speed must have a rotation rate

[32] See, e.g. Ariz. Rev. Stat. § 44–1375 (2015); Conn.Agencies Regs. § 16a–48.4 (2015); Fla. Stat. Ann. § 533.909 (2015); and Wash. Rev. Code Ann. § 19.260.040 (2015).

[33] Defined as: A motor that employs a main winding with a starting winding to start the motor. After the motor has attained approximately 75 percent of rated speed, the starting winding is automatically disconnected by means of a centrifugal switch or by a relay. 20 CCR1602 (g).

[34] Defined as: A motor that uses a capacitor via the starting winding to start an induction motor, where the capacitor is switched out by a centrifugal switch once the motor is up to speed. 20 CCR1602(g).

[35] Defined as a value equal to the product of motor's nameplate hp and service factor and also referred to a "total hp," where "service factor (of an AC motor)" means a multiplier which, when applied to the rated hp, indicates a permissible hp loading which can be carried under the conditions specified for the service factor. 20 CCR 1602(g).

that is no more than one-half of the motor's maximum rotation rate, and must be operated with an applicable multi-speed pump control. (Id. section 1605.3(g)(5)(B))

The CEC also prescribes design requirements for pump controls. Pump motor controls that are manufactured on or after January 1, 2008, and are sold for use with a pump that has two or more speeds are required to be capable of operating the pool pump at a minimum of two speeds. The default circulation speed setting shall be no more than one half of the motor's maximum rotation rate, and high speed overrides should be temporary and not for a period exceeding 24 hours. (Id. section 1605.3 (g)(5)(B))[36]

In addition to these prescriptive design requirements, the CEC also requires manufacturers of residential pool pump and motor combinations and manufacturers of replacement residential pool pump motors[37] to report certain data regarding the characteristics of their certified equipment. This includes information necessary to verify compliance with the requirements of Section 1605.3(g)(5), as well as the tested flow and input power of the equipment at several specific load points. Manufacturers must also submit the pool pump and motor combinations' energy factor (EF) in gallons per watt-hour (gal/Wh) when tested in accordance with the specified test procedure for residential pool pumps. See 20CCR 1604(g)(3).

[36] California Energy Commission, 2014 Appliance Efficiency Regulations, available at www.energy.ca.gov/2014publications/CEC-400-2014-009/CEC-400-2014-009-CMF.pdf.

[37] Defined as a replacement motor intended to be coupled to an existing residential pool pump that is used to circulate and filter pool water in order to maintain clarity and sanitation. Cal. Code Regs., tit. 20, § 1602, subd. (g).

The CEC is considering revising its pool pump regulations. A recent CEC report[38] proposes updated regulations for all single-phase dedicated-purpose pool pump motors under 5 total horsepower[39] (thp). This report recommends that pool pump motors be covered regardless of whether they are sold with a new pump, or sold as replacement for use with an existing pump wet-end. The report recommends a timer requirement for integral filter pool pumps, and a requirement for freeze protection for pool filter pumps. Additionally, the report recommends that the CEC move to performance-based standards, rather than prescriptive design standards. The prescriptive standards that exist under the 2008 rule prohibit the use of certain motor technologies, and the 2016 proposal would allow these previously-prohibited technologies as long as they meet minimum efficiency standards. Using the modified CSA C747-09 test procedure, the CEC recommends that single-speed motors less than 0.5 thp use motors that are at least 70 percent efficient. Single-speed pumps greater than or equal to 0.5 thp and less than 1 thp must use motors that are at least 75 percent efficient. Variable-, multi-, and two-speed pumps greater than or equal to 1 and less than or equal to 5 thp must use motors with nameplate efficiency of at least 80 percent efficient at full speed and at least 65 percent efficient at half speed.[40] The CEC presented portions of this report that are related to dedicated-purpose pool pumps to the DPPP Working Group. Members of the DPPP Working Group asked

38
Revised Analysis of Efficiency Standards for Pool Pumps and Motors, and
Spas-Draft Staff Report, June 2016. Available at http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-02/TN211842_20160616T124038_Revised_Analysis_of_Efficiency_Standards_for_Pool_Pumps_and_Mot.pdf

39 Total hp is the product of motor service factor and motor nameplate (rated) hp.

40 Revised Analysis of Efficiency Standards for Pool Pumps and Motors, and Spas-Draft Staff Report. http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-02/TN211842_20160616T124038_Revised_Analysis_of_Efficiency_Standards_for_Pool_Pumps_and_Mot.pdf

clarifying questions to confirm that with the proposed changes (1) California's reporting requirements for pumps will not change, (2) previously disallowed motor types would be allowed, provided they meet the minimum CEC motor efficiency requirements. (Docket No. EERE-2015-BT-STD-0008-0091, June 22 Working Group Meeting, at pp. 6-12) The DPPP Working Group had no further comments or objections. DOE also notes that the DPPP CEC regulations are preempted following the compliance date of this DFR.

b. Voluntary Standards

In response to the May 2015 DPPP RFI, APSP recommended that "DOE should rely on and reference, or recite the applicable language from the ANSI/APSP/ICC -15 2013 standard for residential swimming pool and spa energy efficiency." (Docket. No. EERE-2015-BT-STD-0008, APSP, No. 10 at p. 2) In response DOE thoroughly reviewed the 2013 version of the American National Standards Institute (ANSI), APSP, and the International Code Council (ICC) published standard ANSI/APSP/ICC-15a-2013, "American National Standard for Residential Swimming Pool and Spa Energy Efficiency." Similar to the CEC's current standard (amended in 2008), ANSI/APSP/ICC-15a-2013 has prescriptive design requirements, rather than performance-based regulations for residential pool pump and motor combinations. This voluntary standard prohibits split-phase, shaded-pole, or capacitor start-induction run motors in dedicated-purpose pool pumps, with the exception of motors that are powered exclusively by onsite electricity generation from renewable energy sources. The standard also requires that pool pump motors with a capacity of 1.0 total horsepower or greater have the capability of operating at two or more speeds, with the low speed having a rotation rate that is no more than one-half of the motor's maximum rotation rate. Ultimately, for the reasons discussed throughout this document, DOE is adopting a mix of performance-based and prescriptive standards that differ from those established in ANSI/APSP/ICC-15a-2013. DOE notes that five members of APSP (Waterway Plastics, Hayward Industries, Inc., Zodiac Pool Systems, Inc., Pentair Aquatic Systems, and Bestway USA, Inc.) participated in the DPPP Working Group and unanimously supported the term sheet that serves as the basis for the standards established in this direct final rule. (EERE-2015-BT-STD-0008, No. 51)

4. Shipments Information

DOE gathered annual DPPP shipment data from two general sources: (1) Veris Consulting and PK Data; and (2) interviews with individual manufacturers that were conducted under non-disclosure agreements with DOE's contractors.[41] The Veris Consulting and PK Data information included industrywide shipment information for certain dedicated-purpose pool pump varieties. This data was previously aggregated by Veris Consulting and PK Data for use within the industry, DOE gathered and aggregated shipments information for all varieties of dedicated-purpose pool pump, specifically for this rulemaking. DOE used both sources to shape its initial shipment estimates. These shipments estimates were presented to the DPPP Working Group throughout the negotiation process and were revised based on the group's feedback.

DOE's final estimates of historical shipments by equipment class are shown in Table IV-3. The estimates show that the shipments of all classes of dedicated-purpose

[41] In developing standards, DOE may choose to contract with third party organizations who specialize in various functions.

pool pumps have increased over the past 5 years. In 2015, the shipments of self-priming pool filter pumps were nearly double the shipments of non-self-priming pool filter pumps. Waterfall pumps made up a small portion of the industry, less than 0.5 percent of total shipments in 2015. Since 2013, the integral cartridge filter and integral sand filter pump classes have totaled over one million shipments per year.

Table IV-3 Estimates of Historical Dedicated-Purpose Pool Pump Shipments, by Equipment Class (Thousands)

Equipment Class	2011	2012	2013	2014	2015
Self-Priming Pool Filter Pump, standard-size	543.8	561.1	578.9	597.3	616.3
Self-Priming Pool Filter Pump, small-size	70.6	72.8	75.1	77.5	80.0
Non-Self-Priming Pool Filter Pump	329.0	339.5	350.2	361.4	372.9
Waterfall Pump	8.8	9.1	9.4	9.7	10.0
Pressure Cleaner Booster Pump	121.6	123.3	125.0	126.8	128.6
Integral Cartridge Filter Pool Pump	843.2	860.4	878.0	895.9	914.2
Integral Sand Filter Pool Pump	130.3	133.0	135.7	138.4	141.3

5. Market and Industry Trends

DOE gathered data on DPPP market and industry trends. Several of DOE’s observations and conclusions are noted in the following sections.

a. Equipment Efficiency

DOE assembled a Pool Pump Performance Database that describes the capacity, speed configuration, and estimated efficiency of the majority of dedicated-purpose pool pumps that are available on the market.[42] Using data from the database, Table IV-4 lists the ranges of efficiency that are available for the different speed configurations of standard-size self-priming pool filter pumps. In terms of total annual energy

[42] See section IV.C.1.a for more information regarding the Pool Pump Performance Database.

consumption, standard-size self-priming pool filter pumps are the largest equipment class covered by this rulemaking.[43]

Table IV-4 Ranges of Dedicated-Purpose Pool Pump Efficiency Available for Standard-Size Self-Priming Pool Filter Pumps

Speed Configuration of Self-Priming Pool Filter Pump, Standard-Size (0.711 to 2.5 hydro hp)	**Efficiency Range Available in the Pool Pump Performance Database WEF**
Single-Speed	1.81 to 3.73 kgal/kWh
Two-speed	3.41 to 5.45 kgal/kWh
Variable-Speed	5.81 to 10.25 kgal/kWh

The engineering analysis, found in section IV.C of this document, provides a full discussion of DPPP efficiency data for all of the equipment classes, from the lowest performing pump available on the market to the highest performing pump that is technologically feasible.

b. Pump Sizing

Based on manufacturer interviews, DOE concluded that approximately 76 percent of the installed base of dedicated-purpose pool pumps are single-speed and two-speed pumps that use single-phase induction motors. These pumps come in a wide range of nominal horsepower ratings. Single-phase induction motor pumps are typically available in a wide variety of nominal horsepower ratings, such as 0.5 hp, 0.75 hp, 1 hp, 1.5 hp, 2 hp, 2.5 hp, and 3 hp, as well as other ratings above, below, and in between. This variety gives a pump installation contractor the ability to select a pump that is appropriately sized for the application. The contractor can make this decision based on the volume of water the pump needs to circulate (related to the pool volume) and the head that the pump needs

[43] The self-priming pool filter pump equipment class is defined in section IV.A.1 of this document.

to overcome (related to the piping and ancillary pool equipment such as heaters and chlorinators).

The remainder of the installed base of dedicated-purpose pool pumps are variable-speed pool pumps that use electronically commutating motors (ECMs) or other variable-speed motor technologies. These variable-speed pumps are typically only available in a small number of nominal horsepower ratings, such as 1.65 hp, 2.40 hp, 2.70 hp, and 3.45 hp. Due to the limited number of nominal horsepower ratings available, it is common for variable-speed dedicated-purpose pool pumps to be oversized for their application, when evaluated at maximum speed capability. A variable-speed pump can be programmed by the installer or end user to operate at an appropriate speed that is less than 100 percent.

6. Technology Options

This section describes the technology options that can be used to reduce the energy consumption of DPPP equipment. The technology options are divided into two categories: options relevant to DPPP equipment classes that are analyzed for performance standards (e.g., varieties of pool filter pumps, pressure cleaner booster pumps, and waterfall pumps) and options relevant to DPPP equipment classes that are analyzed for prescriptive standards (e.g., integral cartridge filter pool pumps and integral sand filter pool pumps).

In the May 2015 RFI, DOE requested comments on technology options that could be considered to improve the energy efficiency of dedicated-purpose pool pumps. 80 FR 26483 (May 8, 2015). APSP commented that APSP-15 and California Title 20 capture many of the technology options that are available to the industry. APSP asked DOE to reference these programs. (APSP, No. 10 at p. 13) The following technologies are described in the APSP and California standards:

- APSP-15 and California Title 20 identify motor performance as a technology option to reduce energy consumption, and both standards prohibit the sale of pool pumps that incorporate particular motor constructions. See ANSI/APSP/ICC-15a-2013, section 4.1.1.1; and 20CCR section 1605.3 (g)(5)(A).

- APSP-15 and California Title 20 identify two-speed, multi-speed, and variable-speed pumps as a technology to reduce energy consumption. See ANSI/APSP/ICC-15a-2013, section 4.1.1.2; and 20CCR section 1605.3 (g)(5)(B).

- APSP-15 requires a time switch or similar control mechanism to control the pool pump's operation schedule. See ANSI/APSP/ICC-15a-2013, section 5.3.3.

Based on the DPPP Working Group's review of the APSP and California standards and independent research, DOE identified three technology options that can be used to reduce the energy consumption of the DPPP equipment classes for which performance standards were being analyzed (i.e., self-priming pool filter pumps, non-self-priming pool filter pumps, pressure cleaner booster pumps, and waterfall pumps). Specifically, those performance standard technology options are:

- improved motor efficiency;
- ability to operate at reduced speeds; and
- improved hydraulic design.

DOE identified one technology option, a pool pump timer, which could be used to reduce the energy consumption of the DPPP equipment classes for which prescriptive standards were being analyzed (i.e., integral cartridge filter pool pumps and integral sand filter pool pumps).

The DPPP Working Group reviewed both sets of technology options (Docket No. EERE-2015-BT-STD-0008-0053, November 12 DPPP Working Group Meeting, at pp. 51-78; Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 37-38) and offered no objections to DOE’s approach. The DPPP Working Group ultimately evaluated standards based on efficiency levels determined by these options.

Each technology option is addressed separately in the sections that follow.

a. Improved Motor Efficiency

Different varieties (or constructions) of motors have different achievable efficiencies. Two general motor constructions are present in dedicated-purpose pool pump market: single-phase induction motors and electronically commutated motors (ECMs).[44] Single-phase induction motors may be further differentiated and include split phase, capacitor-start induction-run (CSIR), capacitor-start capacitor-run (CSCR), and permanent split capacitor (PSC) motors.

The majority of pool filter pumps available on the market come equipped with single-phase induction motors. According to manufacturer interviews, very few pool filter pumps on the market use split phase or CSIR motors. This is partly due to the regulatory prohibition of these motor constructions in California and other states. Most pool filter pumps on the market use CSCR or PSC motors; both have similar attainable efficiencies, although CSCR motors are typically able to provide greater starting torque.

ECMs are typically used in variable-speed pool filter pump applications. However, induction motors, coupled to a proper variable speed drive, can also be used in variable-speed pool filter pump applications. ECMs are inherently more efficient than single-phase induction motors because their construction minimizes slip losses between the rotor and stator components. Unlike single-phase induction motors, ECMs require an

[44] Three-phase induction motors also are found on certain self-priming pool filter pumps; however this motor construction is specifically excluded from the scope of this rulemaking for self-priming pool filter pumps (as described in section III.C)

electronic drive to function. This electronic drive consumes electricity, and variations in drive losses and mechanical designs lead to a range of ECM efficiencies.

As part of the engineering analysis (section IV.C), DOE assessed the range of attainable motor efficiency for certain representative motor capacities and constructions. As motor capacity increases, the attainable efficiency of the motor at full load also increases. Higher horsepower motors also operate close to their peak efficiency for a wider range of loading conditions.[45] Table IV-5 presents these ranges, based on nameplate (or nominal) motor efficiencies listed in the Pool Pump Performance Database. Motor efficiency data submitted by pump and motor manufacturers to DOE confirms the ranges reported in this table.

Table IV-5 Ranges of Nameplate Motor Efficiencies Reported for Three Capacities of Self-Priming Pool Filter Pumps

Motor Total Horsepower thp*	Hydraulic Horsepower on Curve C of a Typical Dedicated-Purpose Pool Pump with This Motor	Range of Full Speed Motor Nameplate Efficiencies Reported in the Pool Pump Performance Database, by Motor Construction* %*		
		CSCR†	**PSC†**	**ECM†**
0.75	0.44	64 - 79	51 - 75	77
1.35	0.95	65 - 81	61- 78	78 - 86
3.45	1.88	75 - 81	74 - 82	77 - 92

* The three pump capacities described in this table align with the representative unit capacities that are defined in section IV.C.2 and used throughout the engineering analysis in section IV.C.
** Neither split phase nor CSIR motors are listed in this table because no self-priming pool filter pumps in the Pool Pump Performance Database utilize these motor types.
† Members of the DPPP Working Group stated that there may be small errors in the motor nameplate efficiency data reported for pumps in the CEC database that DOE incorporated into the Pool Pump Performance Database. (Docket No. EERE-2015-BT-STD-0008-0056, December 7 DPPP Working Group Meeting, at pp. 38-40)

[45] U.S. DOE Building Technologies Office. Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment. December 2013. Prepared for the DOE by Navigant Consulting. pp. 4. Available at http://energy.gov/sites/prod/files/2014/02/f8/Motor%20Energy%20Savings%20Potential%20Report%202013-12-4.pdf

DPPP manufacturers do not typically manufacture motors inhouse. Instead, they purchase complete or partial motors from motor manufacturers and/or distributors. As such, improving the nameplate motor efficiency of the pump is typically achieved by swapping a less efficient purchased motor component for a more efficient one.

b. Ability to operate at reduced speeds

<u>Self-priming and non-self-priming pool filter pumps</u>

Self-priming and non-self-priming pool filter pumps at or above 49.4 gpm max flow on curve C can achieve a higher (more favorable) WEF value if they have the ability to operate at reduced speeds. As discussed previously in section III.C, the WEF metric is a weighted average of energy factors, measured at one or more test points. The DPPP test procedure allows WEF values for two-, multi-, and variable-speed pumps to be calculated as the weighted average of performance at both high and reduced speeds, while WEF for single-speed pumps is calculated based only on performance at high speed. Due to pump affinity laws, most pumps will achieve higher energy factors at lower rotational speeds, compared to higher rotational speeds. As such, the WEF efficiency metric confers benefits on pool filter pumps that are able to operate at reduced rotational speeds.

Specifically, pump affinity laws describe the relationship of pump operating speed, flow rate, head, and hydraulic power. According to the affinity laws, speed is proportional to flow such that a relative change in speed will result in a commensurate change in flow, as described in Equation 5. The affinity laws also establish that pump total head is proportional to speed squared, as described in Equation 6, and pump hydraulic power is proportional to speed cubed, as described in Equation 7.

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$

Equation 5

$$\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$$

Equation 6

$$\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$$

Equation 7

Where:

Q_1 and Q_2 = volumetric flow rate at two operating points

H_1 and H_2 = pump total head at two operating points

N_1 and N_2 = pump rotational speed at two operating points

P_1 and P_2 = pump hydraulic power at two operating points

This means that a pump operating at half speed will provide one half of the pump's full-speed flow and one eighth of the pump's full-speed power.[46] However, pump affinity laws do not account for changes in hydraulic and motor efficiency that may occur as a pump's rotational speed is reduced. Typically, hydraulic efficiency and motor efficiency will be reduced at lower operating speeds. Consequently, at reduced speeds, power consumption is not reduced as drastically as hydraulic output power. Even so, the efficiency losses at low-speed operation are typically outweighed by the exponential reduction in hydraulic output power at low-speed operation; this results in a higher (more beneficial) energy factor at low speed operation.

Self-priming and non-self-priming pool filter pumps with a two-speed motor configuration that produce less than 49.4 gpm maximum flow on curve C cannot achieve higher WEF score through reduced speed operation. This is because the test procedure final rule specifies two load points for two-speed self-priming and non-self-priming pool filter pumps—one at 100 percent of maximum speed and one 50 percent of maximum speed. Further, the test procedure final rule specifies that the lower of the two load points cannot be below 24.7 gpm, and that the pump will be tested at the "lowest speed capable of meeting the specified flow and head values." Consequently, a two-speed pump that delivers less than 49.4 gpm of flow at maximum speed on curve C would deliver less than 24.7 gpm of flow at half of the maximum, which mean the half-speed setting would

[46] A discussion of reduced-speed pump dynamics is available at https://www.regulations.gov/document?D=EERE-2015-BT-STD-0008-0099.

not be considered in the calculation of the pump's WEF.[47] Such a two-speed pump would effectively be tested as a single-speed pump.

Self-priming and non-self-priming pool filter pumps with a variable- or multi-speed motor configuration that produce less than 49.4 gpm max flow on curve C could conceivably achieve a higher WEF score through reduced speed operation. However, DOE did not apply the "ability to operate at reduced speeds" technology option to pumps that provide less than 49.4 gpm at maximum speed on curve C. A flow of 49.4 gpm at maximum speed on curve C is equivalent to a hydraulic power of 0.25 hhp; such a pump would typically require a motor shaft power of approximately 0.60 horsepower. Comparatively, the smallest currently available variable-speed pool pump motor is 1.65 thp. Due to the mismatch in physical size and performance of such a wet end and motor combination, DOE concludes that it is not technologically feasible to pair a 1.65-thp motor with a pump wet end that provides only 49.4 gpm at maximum speed on curve C. For this reason, DOE's analysis assumes that that the design option described as "ability to operate at reduced speeds" does not apply to self-priming or non-self-priming pool filter pumps that are below 49.4 gpm at maximum speed on curve C.

<u>Pressure cleaner booster pumps</u>

In the field, pressure cleaner booster pumps are only operated at one speed and therefore the test procedure final rule specifies only one load point for testing pressure cleaner booster pumps. However, the test procedure final rule specifies that pressure

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[47] The DOE DPPP test procedure final rule specifies that flow be measured to the nearest tenth of a gpm.

cleaner booster pumps are tested at the lowest speed that can achieve 60 feet of head at the 10 gpm test condition. Consequently, a pressure cleaner booster pump can see benefits from the ability to operate at reduced speeds as the pump may vary its speed to achieve this load point.[48] For instance, a pressure cleaner booster pump equipped with a variable-speed motor may produce more than 60 feet of head when operated at maximum speed at the 10 gpm test point. Such a pump could be tested at a reduced speed that produces exactly 60 feet of head at 10 gpm, while consuming less power than it would at maximum speed. In this case, testing at a reduced speed would result in a higher (more beneficial) WEF value.

Waterfall pumps

The test procedure final rule specifies that waterfall pumps are only tested at 100 percent speed. Consequently, waterfall pumps cannot achieve a higher (more beneficial) WEF value if they have the ability to operate at reduced speeds. Consequently, DOE did not consider the "ability to operate at reduced speeds" as a technology option for the waterfall pump equipment class.

c. Improved hydraulic design

The performance characteristics of a pump, such as flow, head, and efficiency, are a direct result of the pump's hydraulic design. For purposes of the DOE analysis, "hydraulic design" is a broad term DOE used to describe the system design of the wetted

[48] The DPPP Working Group requested that DOE examine variable-speed pumps as a design option for pressure cleaner booster pumps. (Docket No. EERE-2015-BT-STD-0008-0095, March 22 DPPP Working Group Meeting, at pp. 197-203)

components of a pump. Although hydraulic design focuses on the specific hydraulic characteristics of the impeller and the volute/casing, it also includes design choices related to bearings, seals, and other ancillary components.

Impeller and volute/casing geometries, clearances, and associated components can be redesigned to a higher efficiency (at the same flow and head) using a combination of historical best practices and modern computer-aided design (CAD) and analysis methods. The wide availability of modern CAD packages and techniques now enables pump designers to more quickly reach designs with improved vane shapes, flow paths, and cutwater designs, all of which work to improve the efficiency of the pump as a whole.

Self-priming pool filter pumps

For self-priming pool filter pumps, DOE used empirical data from the Pool Pump Performance Database to estimate the potential efficiency gains available from improved hydraulic design. DOE used hydraulic power, line input power, and nameplate motor efficiency to estimate the hydraulic efficiency of these pumps and to observe the range of hydraulic efficiencies available for self-priming pool filter pumps at pump capacities less than 2.5 hhp. For any given capacity less than 2.5 hhp, DOE found that the best hydraulic efficiency of self-priming pool filter pumps at maximum speed on curve C could be 116.2 percent of the baseline hydraulic efficiency. Chapter 3 of the direct final rule TSD contains more details regarding the hydraulic improvements estimated for self-priming pool filter pumps.

Non-self-priming pool filter pumps

For non-self-priming pool filter pumps, DOE attempted to follow a similar methodology to self-priming pumps. While DOE's Pool Pump Performance Database contains few records of non-self-priming pool filter pumps, these records were sufficient to establish a baseline hydraulic efficiency, which DOE identified as 51.5 percent. In the May 2015 DPPP RFI, DOE requested information regarding the magnitude of efficiency improvements available from any potential technology options. 80 FR 26483 (May 8, 2015). DOE did not receive public comment regarding the range of hydraulic efficiency improvements that are available to pool filter pumps. With limited data, DOE was not able to use this database to empirically identify the maximum hydraulic efficiency that is technologically feasible, nor estimate the range of hydraulic efficiency improvements that are available to non-self-priming pool filter pumps.

Instead, DOE referred to empirical data gathered during the 2016 general pumps[49] rulemaking. During the general pumps rulemaking, DOE estimated the maximum technologically feasible hydraulic efficiency for end suction, close-coupled pumps as a function of flow and specific speed.[50] For this dedicated-purpose pool pumps direct final rule, DOE evaluated a 0.52-hhp, end suction, close-coupled pump that is optimized for curve-C flow and head using equations from the general pumps rulemaking analysis, and

[49] The pumps energy conservation standard rulemaking docket EERE-2011-BT-STD-0031 contains all notices, public comments, public meeting transcripts, and supporting documents pertaining to this rulemaking.

[50] Specific speed is a dimensionless index describing the geometry of a pump impeller and provides an indication of the pump's pressure/flow ratio at the pump's best efficiency point. For more details, see chapter 3 of the general pumps rulemaking final rule TSD, at https://www.regulations.gov/document?D=EERE-2011-BT-STD-0031-0056.

found that such a pump can achieve a hydraulic efficiency of up to 69.7 percent.[51] This pump has a configuration that is nearly identical to a non-self-priming pool filter pump, with the exception that non-self-priming pool filter pumps are defined by the presence (or requirement of) a basket strainer. As discussed in section IV.A, the addition of a basket strainer and strainer housing reduce a pump's hydraulic efficiency by a measurable amount. Based on discussions with pump industry professionals, the impact may be in the range of 1 to 3 points of hydraulic efficiency. Consequently, DOE conservatively established a maximum hydraulic efficiency of 67 percent for non-self-priming pool filter pumps. This represents an improvement of 30 percent over the baseline hydraulic efficiency. At the April 18, 2016, Working Group meeting, DOE presented the DPPP Working Group with values for motor efficiency and wire-to-water efficiency of representative units at each efficiency level. This data enables the calculation of hydraulic efficiency, since wire-to-water efficiency equals the product of motor efficiency multiplied by hydraulic efficiency. (Docket No. EERE-2015-BT-STD-0008-0078, April 18, 2016 DPPP Working Group Meeting, at p. 20-30) At subsequent meetings, DOE presented max tech wire-to-water efficiency results, based on the aforementioned 67 percent hydraulic efficiency. DPPP Working Group members offered no objections to DOE's hydraulic efficiency assumptions. The DPPP Working Group ultimately evaluated standards based on efficiency levels determined by these assumptions. (Docket No. EERE-2015-BT-STD-0008-0100, May 18 DPPP Working Group Meeting, at p. 140-149)

[51] See the discussion of efficiency levels for general pumps equipment in the general pumps final rule TSD, available at www.regulations.gov/document?D=EERE-2011-BT-STD-0031-0056. In particular, DOE calculates the standard pump efficiency η_{STD} of 69.7% for the max-tech level of the ESCC.3600 equipment class at a flow rate Q of 63 GPM, a constant C of 125.3, and a specific speed, N_S, of 2,760.

Chapter 3 of the direct final rule TSD contains more details regarding the hydraulic improvements estimated for non-self-priming pool filter pumps.

Pressure cleaner booster pumps

DOE's contractor received motor specifications and test data for pressure cleaner booster pumps from manufacturers, which DOE used to calculate the total pump efficiency and the hydraulic efficiency for several pumps at the pressure cleaner booster pump test point of 10 gpm flow. DOE found that the best available hydraulic efficiency of pressure cleaner booster pumps, at the test point of 10 gpm, could be 112.2 percent of the baseline hydraulic efficiency. Chapter 3 of the direct final rule TSD contains more details regarding the hydraulic improvements estimated for pressure cleaner booster pumps.

Waterfall pumps

DOE's contractor used manufacturer-supplied motor specifications and test data for waterfall pumps to calculate the total pump efficiency and the pump hydraulic efficiency for several pumps at the waterfall pump test point of 17 feet of head. DOE found that the best available hydraulic efficiency of waterfall pumps at this test point could be 111.5 percent of the baseline hydraulic efficiency. Chapter 3 of the direct final rule TSD contains more details regarding the hydraulic improvements estimated for waterfall pumps.

d. Pool Pump Timer

Pool pump timers can reduce the energy consumed by dedicated-purpose pool pumps by reducing the number of hours that the pump is operated unnecessarily.

Many smaller-size pools do not require a dedicated-purpose pool pump to operate 24 hours per day to achieve the desired turnover of pool water. DOE initially surveyed recommendations for pool turnover rates collected by the Consortium for Energy Efficiency.[52] DOE stated that California recommends one turnover every 12 to 14 hours. (EERE-2015-BT-STD-0008-0059, October 20 DPPP Working Group Meeting, at p. 88) Several members of the DPPP Working Group commented that the California recommendation cited by DOE pertains to commercial pools, and that the pool industry recommends one turnover per day for residential applications. (EERE-2015-BT-STD-0008-0059, October 20 DPPP Working Group Meeting, at p. 134-135; EERE-2015-BT-STD-0008-0053, November 12 DPPP Working Group Meeting, at p. 134) DOE only considered the pool pump timer design option for the integral cartridge filter pump and integral sand filter pump equipment classes. Pump models in these equipment classes are marketed exclusively to residential end users. Therefore, DOE assumed that the pool pump timer design option applies only to pumps that must provide a minimum of one turnover per day. In support of the DPPP Working Group, DOE reviewed the integral pump products on the market and the pool volumes that they are recommended to service. DOE concluded that, when paired with the appropriate size pool, integral filter

[52] Consortium for Energy Efficiency. 2012. "CEE High Efficiency Residential Swimming Pool Initiative." Boston, MA. https://library.cee1.org/sites/default/files/library/9986/cee_res_swimmingpoolinitiative_07dec2012_pdf_10557.pdf

pumps should achieve one turnover in 8 hours or less. If a pool pump timer turned off the pump after 10 hours, DOE concluded that it would have allowed at least one full turnover to occur (thus meeting the industry recommendation for daily turnovers and maintaining end user utility), and it would prevent the pump for running unnecessarily for the remainder of the day.

DOE initially suggested that a pool pump timer be defined as a pool pump control that automatically turns a dedicated-purpose pool pump on and off based on a pre-programmed user-selectable schedule. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 112) In response, Bestway requested that the pool pump timer be defined instead as a type of countdown timer, where the end user turns on the pump, the pump runs for a set amount of time, and then the pump shuts off automatically and remains off until the end user starts the pump again. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 39-40) Bestway commented that this style of timer is what currently exists in the market for integrated cartridge and integrated sand filter pumps. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 124-125)

DOE also asked the DPPP Working Group whether end users should be able to program the run time of the pool pump timer or whether the pool pump timer should ship with a preprogrammed run-time that cannot be adjusted by the end user. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 113-115) The DPPP Working Group clarified that integrated cartridge filter pumps and integrated sand filter pumps are typically sold in a package with the pool that they are meant to service, so the pump run-time necessary to achieve one turnover may be determined prior to sale based upon the relative sizes of the pump and the pool. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 116-117) Therefore, the Working Group agreed that there would be little benefit to allowing end users to modify the pump run-time that the pool pump timer allows.

The DPPP Working Group also discussed whether end users might be burdened by a pool pump timer that cannot automatically turn on a pump, since end users would be required to initiate the pump operation on a daily basis to maintain a sanitary pool. Bestway commented that the burden, if any, on the end user to activate their pump on a daily basis would be minimal. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 116-119) A DPPP Working Group member speculated that if an end user were to leave their home for a week, a simple countdown timer would not be able to activate the pump on a daily basis to maintain sanitary pool conditions while the end user is away. Bestway commented that the pool pump timer definition Bestway proposed does not prevent manufacturers from offering a pool pump timer with automatic start and stop functionality. Bestway commented that, with their proposed definition, manufacturers could offer more advanced timers as a selling feature for their pumps. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 119-121)

The DPPP Working Group voted, and did not reach consensus on a pool pump timer definition that included automatic on-off functionality and user-selectable scheduling. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group

Meeting, at pp. 124) Instead, the DPPP Working Group voted to recommend defining a pool pump timer to mean a pool pump control that automatically turns off a dedicated-purpose pool pump after a run-time of no longer than 10 hours. (EERE-2015-BT-STD-0008, No. 82 Recommendation #4 at p. 2) DOE agrees with this reasoning and is adopting the definition recommended by the DPPP Working Group in this direct final rule.

B. Screening Analysis

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

1. Technological feasibility. Technologies that are not incorporated in commercial products or in working prototypes will not be considered further.

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

3. Impacts on product utility or product availability. If it is determined that a technology would have significant adverse impact on the utility of the

product to significant subgroups of consumers or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

4. Adverse impacts on health or safety. If it is determined that a technology would have significant adverse impacts on health or safety, it will not be considered further.

See 10 CFR part 430, subpart C, appendix A, 4(a)(4) and 5(b).

Technologies that pass through the screening analysis are referred to as "design options" in the engineering analysis. The screening analysis and engineering analysis are discussed in detail, respectively, in chapters 4 and 5 of the direct final rule TSD.

1. Screened-Out Technologies

Of the identified technology options, DOE was not able to identify any that would fail the screening criteria.

2. Remaining Technologies

After reviewing each technology, DOE concluded that all of the identified technologies listed in section IV.A.6 met all four screening criteria to be examined further as design options in DOE’s analysis. In summary, DOE continued its analysis for the following technology options:

- improved motor efficiency
- ability to operate at reduced speeds
- improved hydraulic design
- pool pump timers

DOE determined that these technology options are technologically feasible because they are being used or have been used in commercially available products or working prototypes. DOE also found that these technology options met the other screening criteria (i.e., practicable to manufacture, install, and service; and do not result in adverse impacts on consumer utility, equipment availability, health, or safety). For additional details, see chapter 4 of the direct final rule TSD.

C. Engineering Analysis

In the engineering analysis, DOE describes the relationship between manufacturer production cost (MPC) and improved DPPP efficiency. This relationship serves as the basis for cost-benefit calculations for individual end users, manufacturers, and the Nation. The following sections describe methods DOE used to conduct the engineering analysis.

1. Summary of Data Sources

For the engineering analysis, DOE used two principal data sources: (1) the Pool Pump Performance Database; and (2) the manufacturer production cost dataset. The following subsections provide a brief description of each data source. Complete details are found in chapter 5 of the direct final rule TSD.

a. Pool Pump Performance Database

DOE assembled a database of pool pump performance data by collecting current and archived records of pool pump performance from public databases maintained by the CEC,[53]APSP,[54] and the ENERGY STAR program.[55] The Pool Pump Performance Database also includes historic records from prior CEC database versions, which were provided to DOE by stakeholders. These historic records include pumps that met previous CEC efficiency standards but do not meet the current CEC standards.

The CEC, APSP, and ENERGY STAR databases contain third-party test data that manufacturers submit as a means of certifying their pump equipment to the relevant entity's standards. The database records contain pump performance information such as motor horsepower, flow and head on pump performance curves, and pump speed configuration. DOE added records to the database based on pump data published in manufacturer specification sheets. These specification sheets typically publish motor horsepower and performance curves but they do not typically provide information regarding the pump's electrical performance or efficiency.

[53] Appliance Efficiency Database: Public Search, California Energy Commission. Available at https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx
[54] Energy Efficiency Pool Pumps, APSP. Available at http://apsp.org/resources/energy-efficient-pool-pumps.aspx
[55] ENERGY STAR Certified Pool Pumps. Available at www.energystar.gov/productfinder/product/certified-pool-pumps/results

DOE filtered the collected data to remove duplicate entries, entries that only represented a replacement motor (but no pump), and entries with incomplete data. To allow for easier analysis, DOE combined and reformatted the databases into a user-friendly format. DOE performed a regression analysis to estimate the part-load efficiencies of variable-speed pumps at the test points specified in the test procedure final rule. DOE then calculated the WEF value of each pump record in the database, according to the calculation method described in section III.C. Chapter 5 of the direct final rule TSD contains more detail regarding the regression analysis and the calculation of WEF values.

b. Manufacturer Production Cost Dataset

DOE collected MPC and performance data from manufacturers for pool pumps and motors across a range of capacities and equipment classes. Data collected for individual DPPP models included the nominal horsepower and efficiency of the pump motor; the MPC of the motor and the finished pump; and the efficiency, flow rate, head, and input power of the pump at full load and partial loads.

DOE also collected retail price data for DPPPs and replacement motors sold by the online retailers Leslie's Swimming Pool Supplies,[56] INYO Pools,[57] and Pool Supply World.[58] These retail price data are publicly available on each retailer's website. DOE estimated MPCs for various pump models using this retail price data and several

[56] www.lesliespool.com/
[57] www.inyopools.com/
[58] www.poolsupplyworld.com/

assumptions about supply chain markups (see section IV.D for a discussion of markups). DOE primarily used this retail price data analysis to supplement and validate the individual MPCs submitted by manufacturers.

2. Representative Equipment

For the engineering analysis, DOE analyzed the MPC-efficiency relationships for the equipment classes specified in section IV.A.1. Generally, the manufacturing cost and the attainable efficiency of dedicated-purpose pool pumps vary as a function of pump capacity (i.e., hydraulic horsepower). Because it is impractical to assess the MPC-efficiency relationship for all dedicated-purpose pool pump capacities available on the market, DOE selected a set of representative units to analyze. These representative units exemplify typical capacities in each equipment class and are used to quantify the manufacturing costs and the energy savings potential for each equipment class. In general, to determine representative capacities for each equipment class, DOE analyzed the distribution of available models and/or shipments and discussed its finding with the DPPP Working Group. The following subsections discuss each equipment class in further detail.

a. Self-Priming Pool Filter Pumps

The scope of this direct final rule includes self-priming pool filter pumps with capacities less than 2.5 hhp at maximum speed on curve C. As described in section IV.A.1.c of this document, the DPPP Working Group recommended that this range be subdivided into two equipment classes, with a breakpoint of 0.711 hhp. This breakpoint divides the range of self-priming pool filter pumps into a standard-size equipment class and a small-size equipment class. DOE used shipment distributions provided by manufacturers, distributions of models listed in the Pool Pump Performance Database, and feedback from the DPPP Working Group to select representative capacities for these equipment classes.

For the standard-size self-priming pool filter pumps, DOE selected two representative units, with 1.88 hhp and 0.95 hhp. At the baseline efficiency level (discussed further in section IV.C.3), a 1.88-hhp pump and a 0.95-hhp pump require 3.0 hp and 1.6 hp shaft input power from the motor, respectively. Typically, these pumps are equipped with motors rated between 3.5-3.9 thp and 1.7-2.2 thp, respectively.

b. For the small-size self-priming pool filter pump equipment class, DOE selected one representative unit with hydraulic horsepower of 0.44 hhp. DOE reviewed an initial selection of representative units with the DPPP Working Group. (Docket No. EERE-2015-BT-STD-0008-0078, April 18 DPPP Working Group Meeting, at pp. 12-19) The DPPP Working Group recommended a break point capacity of 0.711 hhp to separate the small- and standard-size self-priming pool filter pump equipment classes (see section IV.A.1.c for discussion of this break point). DOE revised the capacities of the representative units after this break point was introduced, to include a representative capacity of 0.44 hhp for the small size self-priming pool filter pump equipment class.Non-Self-Priming Pool Filter Pumps

The scope of this direct final rule also includes non-self-priming pool filter pumps with capacities less than 2.5 hhp at maximum speed on curve C. However, the majority of non-self-priming pool filter pump models on the market deliver less than 1.0 hhp at maximum speed on curve C. Accordingly, the representative capacities DOE used to analyze the non-self-priming pool filter pump equipment class were different from the representative capacities used to analyze the self-priming pool filter pump equipment classes. Specifically, DOE selected two representative capacities for non-self-priming pool filter pumps, 0.52 hhp and 0.09 hhp at maximum speed on curve C. The smaller unit (at 0.09 hhp) is representative of pumps that are typically sold with (or as replacements for) seasonal pools. These pumps are typically distributed in commerce on a skid with a sand filter, where the pump and the sand filter are connected with removable hoses. The larger representative unit (at 0.52 hhp) is representative of pumps that are typically sold for applications where the pump is installed and operated below the waterline of the pool that it services, such as in aboveground pool applications. These pumps are typically distributed in commerce as standalone pumps. DOE presented the larger representative capacity (at 0.52 hhp) and the smaller representative capacity (at 0.09 hhp) to the DPPP Working Group. (Docket No. EERE-2015-BT-STD-0008-0078, April 18 DPPP Working Group Meeting, at pp. 27-29; and Docket No. EERE-2015-BT-STD-0008-0091, June 22 DPPP Working Group Meeting, at pp. 115-118) The DPPP Working Group did not offer any opposition to the selected representative capacities and ultimately evaluated standards based on the analysis of these representative capacities.

c. Pressure Cleaner Booster Pumps

The pressure cleaner booster pumps on the market are clustered in a small range of capacities. For this equipment class, DOE selected a capacity that is representative of the cluster of models on the market.

Specifically, DOE selected a representative capacity of 10 gpm of flow and 112 feet of head, which equates to 0.28 hhp. Ten gpm aligns with the testing load point specified in the test procedure final rule for pressure cleaner booster pumps. The DPPP Working Group recommended that pressure cleaner booster pumps be tested at the load point of 10 gpm and a head greater than 60 feet, to represent the typical pressure cleaner booster pump operation.[59] (Docket No. EERE-2015-BT-STD-0008, No. 82 Recommendation #8 at pp. 4-5)

At 10 gpm, the pressure cleaner booster pump models from the three largest manufacturers (representing the majority of the pressure cleaner booster pump market) all achieve a similar head in a range from 100 feet to 127 feet of head. To represent the average performance of the pressure cleaner booster pump models available on the market, DOE selected a head value of 112 feet as the value the representative unit would achieve at the test condition of 10 gpm.

d. Waterfall Pumps

The waterfall pumps on the market are clustered in a small range of capacities. For this equipment class, DOE selected a capacity that is representative of the cluster of

[59] The DPPP Working Group initially recommended that pressure cleaner booster pumps be tested at 90 feet of head and a volumetric flow rate that corresponds to 90 feet of head. (Docket No. EERE-2015-BT-STD-0008, No. 51 Recommendation #6 at pp. 5) However, the DPPP Working Group discussed that the minimum pressure requirement to drive a pressure cleaner is approximately 60 feet of head. (Docket No. EERE-2015-BT-STD-0008-0095, March 22 Working Group Meeting, at pp. 207-210) ASAP expressed a desire that the test procedure allow better ratings for variable-speed pressure cleaner pumps that are able to reduce speed to avoid supplying (and wasting) excess pressure beyond what is required to drive the cleaner. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 Working Group Meeting, at pp. 49) The DPPP Working Group subsequently revised its recommendation to recommend that pressure cleaner booster pumps be tested at a flow rate of 10 gpm and the minimum head the pump can achieve that is greater than or equal to 60 feet. (Docket No. EERE-2015-BT-STD-0008, No. 82 Recommendation #8 at pp. 4)

models on the market. Specifically, DOE selected a representative capacity of 93 gpm of flow and 17 feet of head, which equates to 0.40 hhp. Seventeen feet of head aligns with the testing load point specified in the test procedure final rule for pressure cleaner booster pumps. The DPPP Working Group recommended the testing load point of 17 feet of head (and flow corresponding to 17 feet of head on the pump curve) to represent the typical waterfall pump operation. (Docket No. EERE-2015-BT-STD-0008, No. 51 Recommendation #6 at p. 5)

e. Integral Sand and Cartridge Filter Pool Pump

In this direct final rule, DOE is establishing a prescriptive design standard, rather than a performance standard, for integral sand and cartridge filter pool pumps. The DPPP Working Group considered two alternatives for this analysis: (1) a prescriptive standard that would require a timer for integrated cartridge and integrated sand filter pumps, and (2) a performance standard that would likely be achieved through the use of advanced motors. To help evaluate these alternatives, DOE developed cost-efficiency relationships for integrated cartridge and integrated sand filter pool pumps that describe (1) the use of a timer on all pumps, and (2) the use of advanced motors where possible. The DPPP Working Group reviewed these cost-efficiency relationships. DPPP Working Group members commented that a prescriptive standard requiring a timer may be economically justified, but that a performance standard with advanced motors would not be economically justified. A DPPP Working Group member commented that a prescriptive standard requiring a timer may not be beneficial because some end users may choose to disable or circumvent the timer mechanism. DOE clarified that the analytical results will account for such instances of misuse, since the rulemaking analysis of a prescriptive standard takes into account that a certain percentage of end users may not use the prescribed technology properly. (Docket No. EERE-2015-BT-STD-0008-0053, November 12 DPPP Working Group Meeting, at pp. 45-78)

As such, in the test procedure final rule, DOE did not establish a test method for these equipment classes. However, as a part of this direct final rule, DOE still evaluated the incremental MPC-efficiency relationship for the prescriptive standard. To do so, DOE established representative models based on performance characteristics of these pumps on system curve C.

DOE examined model availability in the integral sand and cartridge filter pool pumps and selected one representative equipment capacity (0.03 hhp at maximum speed on curve C) for integral sand filter pool pumps, and two representative equipment capacities (0.02 hhp and 0.18 hhp at maximum speed on curve C) for integral cartridge filter pool pumps. The DPPP Working Group reviewed the representative equipment capacities for integral filter pumps and offered no objections. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 54-58)

f. Summary of Representative Units

DOE's representative dedicated-purpose pool pump capacities are summarized in Table IV-6.

Table IV-6 Characteristics of Representative Units, by Equipment Class

DPPP Equipment Class	Test Point	Performance at Test Point at 100% Speed		
		Power hhp	**Head feet**	**Flow gpm**
Self-priming pool filter pump, standard-size	Curve C	1.88	76.8	96.8
	Curve C	0.95	48.7	77.1
Self-priming pool filter pump, small-size	Curve C	0.44	29.2	59.7
Non-self-priming pool filter pump	Curve C	0.52	32.6	63.1
	Curve C	0.09	10.1	35.1
Pressure cleaner booster pump	10 gpm flow	0.28	110.0	10.0
Waterfall pump	17 ft. head	0.40	17.0	93.0
Integral sand filter pool pump	n/a*	0.03	4.9	24.4
Integral cartridge filter pool pump	n/a*	0.18	16.1	44.3
	n/a*	0.02	3.7	21.3

* DOE did not establish a test procedure for integral sand filter pool pumps or integral cartridge filter pool pumps, because these equipment classes are not subject to performance standards. However, the performance reported for integral pumps in this table is measured on curve C.

3. Baseline Configuration and Performance

The baseline configuration defines the lowest efficiency equipment in each analyzed equipment class. DOE established baseline configurations by reviewing the configurations and performance of pumps listed in the Pool Pump Performance Database. DOE determined that, for pool filter pumps (including all sub-varieties) and pressure cleaner booster pumps, the baseline configuration has the following characteristics:

- single-speed
- low-efficiency motor
- low hydraulic efficiency

To determine an appropriate level of performance for each representative pool filter pump unit at the baseline, DOE identified pumps in the Pool Pump Performance

Database that have similar hydraulic capacity to the representative units, and that share the baseline equipment characteristics. DOE adopted the estimated WEF values of these identified pumps as the baseline performance level for each representative unit. Pressure cleaner booster pumps and waterfall pumps are not listed in the Pool Pump Performance Database. Manufacturers provided test data for several models of pressure cleaner booster pumps and waterfall pumps, and these test data enabled DOE to estimate the performance of representative units at the baseline.

The baseline configuration for integral filter pumps for which prescriptive standards were considered is characterized by median performance and lack of a timer mechanism.

Table IV-7 summarizes the baseline configurations and performance levels for the representative units used in this analysis. These baseline configurations ultimately define the energy consumption and associated costs for the lowest efficiency equipment analyzed in each equipment class.

Table IV-7 Baseline Configurations and Performance for DPPP Representative Units

DPPP Representative Unit	Baseline Configuration	Baseline Performance WEF
Self-priming pool filter pump, 1.88 hhp	Single-speed, low efficiency motor, low hydraulic efficiency	1.74
Self-priming pool filter pump, 0.95 hhp		2.13
Self-priming pool filter pump, 0.44 hhp		2.69
Non-self-priming pool filter pump, 0.52 hhp		2.77
Non-self-priming pool filter pump, 0.09 hhp		3.93
Pressure cleaner booster pump		0.34
Waterfall pump		7.46
Integral sand filter pool pump	No timer	n/a
Integral cartridge filter pool pump, 0.18 hhp		n/a
Integral cartridge filter pool pump, 0.02 hhp		n/a

Chapter 5 of the direct final rule TSD describes the process that DOE used to select the baseline configuration for each equipment class and discusses the baseline in greater detail.

4. Efficiency Levels

For each equipment class, DOE established and analyzed a set of efficiency levels above the baseline configuration to assess the relationship between MPC and DPPP efficiency. These efficiency levels are discrete tiers of energy efficiency that can be represented by the WEF test metric.

a. Design Option Applicability and Ordering

For pool filter pump varieties, DOE considered incremental improvements that could be applied to the baseline configuration; these improvements are related to the three design options discussed in section IV.A.6: (1) improved motor efficiency, (2) ability to operate at reduced speeds, and (3) improved hydraulic design.

Specifically, for the “improved motor efficiency” design option, DOE considered three tiers or motor efficiency (low, medium, and high efficiency) for both single-speed and two-speed pump motors. The specific nameplate motor efficiency associated with these tiers varied by pump variety and capacity. For the “ability to operate at reduced speeds” design option, DOE considered three motor speed configurations: single-speed, two-speed, and variable-speed. Finally, for the “improved hydraulic design” design option, DOE considered two hydraulic efficiencies (low and high efficiency). The specific hydraulic efficiencies associated with these tiers varied by pump variety and capacity.

For pressure cleaner booster pumps, DOE evaluated the same design options as pool filter pumps. However, DOE did not consider two-speed motors because pressure cleaner booster pumps only operate at one speed and cannot benefit from the ability to switch between two discrete speeds. Alternatively, DOE did consider variable-speed motors for pressure cleaner booster pumps, as the WEF metric accounts for energy savings available from adjusting the pump speed to reach the minimum required pressure, i.e., 60 feet.

For waterfall pumps, DOE evaluated the same improved motor efficiency and improved hydraulic efficiency design options as pool filter pumps, but did not evaluate the ability to operate at reduced speeds. This is because DOE determined that waterfall pumps only operate at one speed and therefore cannot benefit from the ability to switch speeds.

To order the design options for each equipment class, DOE considered all of the costs (both incremental MPCs and one-time product conversion costs) that would be incurred with each design option. Based on data from manufacturer interviews, as well as DPPP Working Group discussions (Docket No. EERE-2015-BT-0008, March 21 DPPP Working Group Meeting, at pp. 108-122), DOE concluded that a direct relationship exists between motor MPC and pump WEF score, while a flat relationship exists between motor-related conversion costs and WEF score, i.e., better performing motors cost more, but manufacturers face similar conversion costs for all motor-related design options, regardless of whether they are substituting on the basis of motor efficiency or on the basis of motor speed configuration. DPPP Working Group members clarified that the motor-related conversion costs associated with upgrading a pump motor include the costs of sourcing and qualifying the pump motor as a purchased component, but they do not include the costs that motor manufacturers would incur (e.g., the costs of designing, testing, and marketing a motor model). (Docket No. EERE-2015-BT-0008-0094, March 21 DPPP Working Group Meeting, at pp. 113-114; Docket No. EERE-2015-BT-0008-0100, May 18 DPPP Working Group Meeting, at pp. 89-90) DPPP Working Group members also clarified that the conversion costs associated with upgrading motors are not cumulative across multiple efficiency levels, i.e., if a manufacturer pays a conversion cost to upgrade from EL 0 to EL 2, they do not pay the conversion cost associated with an interim upgrade to EL 1. (Docket No. EERE-2015-BT-STD-0008-0100, May 18 DPPP Working Group Meeting, at pp. 102)

In discussions with the DPPP Working Group, DOE stated the assumption that MPC does not increase as hydraulic efficiency increases. Hayward commented that the addition of a diffuser would change the efficiency and the MPC of a pump wet end, but DOE noted that the analysis already accounts for this effect. The addition of a diffuser would change a pump's ability to self-prime and thus, would change the pump's equipment class, and DOE already determined the MPCs and efficiencies of the different equipment classes on the basis of these design differences. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 117-118) Based on data from manufacturer interviews and these Working Group discussions, DOE concluded that hydraulic redesign has a negligible effect on MPC, but results in significant conversion costs–much greater than those incurred for motor-related improvement. The DPPP Working Group did not object to these conclusions. Complete discussions of incremental MPC and conversion costs are found in sections IV.C.5 and IV.J.2, respectively.

Ultimately, DOE ordered its design options to first employ all motor-related design options, based on ascending incremental MPC, followed by improved hydraulic design to reach the maximum technologically feasible efficiency level. This ordering was reviewed by the DPPP Working Group (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 58-105), which offered no objections, and ultimately evaluated standards based on efficiency levels resulting from this ordering. Table IV-8 describes the design options applied to each equipment class at each efficiency level from the baseline up to the max-tech level.

Table IV-8 Design Options by Efficiency Level for Pump Varieties Subject to Performance Standards

<table>
<tr><th rowspan="3">Efficiency Level</th><th colspan="4">DPPP Variety</th></tr>
<tr><th colspan="3">Pool Filter Pumps</th><th rowspan="2">Pressure Cleaner Booster Pump</th></tr>
<tr><th>Self-Priming</th><th>Non-Self-Priming*</th><th>Waterfall Pump</th></tr>
<tr><td>0 (Baseline)</td><td colspan="2">1-speed motor,
Low efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
Low efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
Low efficiency motor,
Low hydraulic efficiency</td></tr>
<tr><td>1</td><td colspan="2">1-speed motor,
Medium efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
Medium efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
Medium efficiency motor,
Low hydraulic efficiency</td></tr>
<tr><td>2</td><td colspan="2">1-speed motor,
High efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
High efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
High efficiency motor,
Low hydraulic efficiency</td></tr>
<tr><td>3</td><td colspan="2">2-speed motor,
Low efficiency motor,
Low hydraulic efficiency</td><td>1-speed motor,
High efficiency motor,
High hydraulic efficiency</td><td>Variable-speed motor,
Low hydraulic efficiency</td></tr>
<tr><td>4</td><td colspan="2">2-speed motor,
Medium efficiency motor,
Low hydraulic efficiency</td><td></td><td>Variable-speed motor,
High hydraulic efficiency</td></tr>
<tr><td>5</td><td colspan="2">2-speed motor,
High efficiency motor,
Low hydraulic efficiency</td><td></td><td></td></tr>
<tr><td>6</td><td colspan="2">Variable-speed motor,
Low hydraulic efficiency</td><td></td><td></td></tr>
<tr><td>7
(max tech)</td><td colspan="2">Variable-speed motor,
High hydraulic efficiency</td><td></td><td></td></tr>
</table>

* As described in section IV.A.6.b, DOE did not consider efficiency levels above EL2 for non-self-priming pool filter pumps that produce less than 49.4 gpm maximum flow on curve C.

DOE analyzed one design option for the integral cartridge filter pool pump and integral sand filter pool pump classes that are subject to prescriptive standards. Table IV-9 presents the two efficiency levels considered for those classes: the baseline (without a pool pump timer), and EL1 (with a pool pump timer). Chapter 5 of the direct final rule TSD contains more details on the development of efficiency levels.

Table IV-9 Design Options by Efficiency Level for DPPP Varieties Subject to a Prescriptive Standards

Efficiency Level	DPPP Variety	
	Integral Cartridge Filter Pumps	**Integral Sand Filter Pumps**
0 (Baseline)	Does not include pool pump timer	Does not include pool pump timer
1	Includes pool pump timer	Includes pool pump timer

b. Summary of Available Motor Efficiencies

For the improved motor efficiency design option, DOE selected a discrete motor efficiency (or efficiencies, for two-speed motors) for each representative unit at each efficiency level. DOE presented initial motor efficiency assumptions to the DPPP Working Group. These initial figures showed full-speed nameplate motor efficiency ranging from 55 percent to 81 percent for motors used in small self-priming pool filter pumps and in 0.52-hhp non-self-priming pool filter pumps; ranging from 75 percent to 92 percent for motors used in 1.88-hp self-priming pool filter pumps; ranging from 55 percent to 77 percent for motors used in pressure cleaner booster pumps; and ranging from 38 percent to 50 percent for motors used in waterfall pumps. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 58-65) DPPP Working Group members commented that certain manufacturers offer a wider variety of two-speed motors than were represented in DOE's initial assumptions. In particular, certain manufacturers offer two-speed motors that are designed to have improved efficiency at low speed. The DPPP Working Group requested DOE revise the motor efficiency assumptions to include a new efficiency level representing a two-speed motor with an improved low-speed motor efficiency. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 76-77) DOE subsequently added an efficiency level (specifically, EL 4) that incorporates a motor with high-speed efficiency of 68 percent and low-speed efficiency of 48 percent.

DPPP Working Group members also commented that the efficiency range DOE assumed for waterfall pumps was lower than what exists in the market. DPPP Working Group members suggested that DOE examine typical motor efficiencies for dedicated 1725-rpm motors. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 96-99) DOE reviewed motor catalog data and subsequently revised its waterfall motor efficiency assumptions upward. DOE revised the baseline waterfall pump motor efficiency from 38 percent to 65 percent efficient, and the max tech waterfall pump motor efficiency from 50 percent to 78 percent efficient.

Based on motor efficiency data in the CEC pool pump database, DOE initially assumed that variable-speed ECM motors are available with nameplate efficiency of 92 percent. Members of the DPPP Working Group commented that 92 percent would be too high for a nameplate motor efficiency, and suggested that the 92 percent figure did not account for efficiency losses in the motor's electronic drive. DPPP Working Group members requested that DOE review its assumption for variable-speed nameplate motor efficiency and revise it appropriately. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 80-82) DOE subsequently revised its assumption of typical variable-speed motor efficiency at high-speed from 92 percent downward to 82 percent. The DPPP Working Group did not object to this assumption.

DOE also initially assumed that smaller 48-frame motors typically used in non-self-priming pumps would be able to achieve the same nameplate motor efficiency as the larger 56-frame motors typically used in self-priming pool filter pumps. DOE initially assumed that both 48-frame and 56-frame single-speed motors would be available ranging from 55 percent efficiency to 77 percent efficiency. DPPP Working Group members commented that, due to constraints of their smaller frame size, 48-frame motors could not always achieve the same efficiency as 56-frame motors at the same capacity, and that 48-frame motors likely could not achieve the 77 percent nameplate efficiency that DOE initially assumed. (Docket No. EERE-2015-BT-STD-0008-0091, June 22 DPPP Working Group Meeting, pp. 132-138 and pp. 189-191) DOE subsequently revised its assumption regarding the nameplate efficiency from 77 percent to 72 percent for the larger (0.52-hhp) non-self-priming pool filter pump representative unit, which used a 48-frame motor. The DPPP Working Group did not object to this assumption.

Table IV-10 presents the revised motor efficiencies for each combination of motor efficiency and motor configuration described in Table IV-8. DOE selected these motor efficiencies based on data listed in the Pool Pump Performance Database, publicly available catalog data, and motor data that manufacturers submitted to DOE. Motor components with the efficiencies listed in Table IV-10 are currently available on the market at the appropriate frame sizes and capacities to drive the representative unit pumps.

Table IV-10 Motor Nameplate Efficiencies for Representative Units with Different Motor Configurations*

Motor Description	Motor Efficiencies (and Corresponding ELs) for Representative Units at High Speed Except as Noted						
	Self-Priming Pool Filter Pump			**Non-Self-Priming Pool Filter Pump**		**Pressure Cleaner Booster Pump**	**Water-fall Pump**
	0.44 hhp	0.95 hhp	1.88 hhp	0.09 hhp	0.52 hhp		
1-speed, low efficiency (Baseline)	55% (EL0)	55% (EL0)	75% (EL0)	55% (EL0)	55% (EL0)	55% (EL0)	65% (EL0)
1-speed, mid efficiency	69% (EL1)	69% (EL1)	79% (EL1)	69% (EL1)	69% (EL1)	67% (EL1)	70% (EL1)
1-speed, high efficiency	76% (EL2)	77% (EL2)	84% (EL2)	72% (EL2)	72% (EL2)	72% (EL2)	78% (EL2-3)
2-speed, low efficiency	64% high, 38% low (EL3)	64% high, 38% low (EL3)	74% high, 49% low (EL3)	n/a**	61% high, 38% low (EL3)	n/a[††]	n/a[††]
2-speed, mid efficiency	70% high, 46% low (EL4)	71% high, 46% low (EL4)	76% high, 55% low (EL4)	n/a**	68% high, 48% low (EL4)	n/a[††]	n/a[††]
2-speed, high efficiency	73% high, 51% low (EL5)	73% high, 51% low (EL5)	83% high, 62% low (EL5)	n/a**	72% high, 51% low (EL5)	n/a[††]	n/a[††]
Variable Speed	81% (EL6-7)	81% (EL6-7)	82% (EL6-7)	n/a[†]	81% (EL6-7)	81% (EL3-4)	n/a[††]

* The integral cartridge filter pool pump and integral sand filter pool pump equipment classes are not included in this table because DOE did not separately consider the motor costs for these equipment classes.
** As discussed in section IV.A.6.b this analysis does not consider two-speed motor configurations for the extra-small non-self-priming pool filter pump representative unit. According to the test procedure final rule, this representative unit would always be subject to the single-speed test procedure because the half-speed flow rate for a 0.09 hhp pump would be 17.8 gpm, which is less than the test procedure minimum flow rate of 24.7 gpm.
[†] As discussed in section IV.A.6.b, this analysis does not consider variable-speed motor configurations for the extra-small non-self-priming pool filter pump representative unit.
[††] Two-speed motors were not considered for waterfall pumps or pressure cleaner booster pumps, and variable-speed motors were not considered for waterfall pumps, because DOE assumes these pump varieties are always operated at a single-speed.

c. Summary of Available Hydraulic Efficiencies

For the “improved hydraulic design” design option, DOE evaluated two discrete hydraulic efficiencies (“low” and “high”) for each representative unit. The low hydraulic efficiency represents the pump hydraulic efficiency of a baseline unit that has not been optimized. The high hydraulic efficiency represents the hydraulic efficiency of a pump that has been hydraulically redesigned to improve hydraulic efficiency, as described in section IV.A.6.c.

Table IV-11 presents the selected hydraulic efficiencies at each efficiency level described in Table IV-8. DOE selected these hydraulic efficiencies based on data listed in the Pool Pump Performance Database, publicly available catalog data, and pump test data submitted by manufacturers.[60]

Table IV-11 Hydraulic Efficiencies for Representative Units

Hydraulic Efficiency Descriptor	Hydraulic Efficiencies and Corresponding Efficiency Levels for Representative Units at Maximum Speed						
	Self-Priming Pool Filter Pump			Non-Self-Priming Pool Filter Pump		Pressure Cleaner Booster Pump	Water-fall Pump
	0.44 hhp	0.95 hhp	1.88 hhp	0.09 hhp	0.52 hhp		
Low Hydraulic Efficiency (Applicable ELs)	45% (EL0-EL6)	59% (EL0-EL6)	62% (EL0-EL6)	23% (EL0-EL2)	51% (EL0-EL6)	24% (EL0-EL3)	61% (EL0-EL2)
High Hydraulic Efficiency (Applicable ELs)	49% (EL7)	63% (EL7)	72% (EL7)	n/a*	67% (EL7)	27% (EL4)	67% (EL3)

* DOE did not have sufficient data to evaluate a 0.09-hhp non-self-priming pool filter pump with high hydraulic efficiency.

d. Representative Unit Performance at Each Efficiency Level

In the previous sections of this direct final rule, DOE described efficiency levels and the available improvements in motor and hydraulic efficiency for different equipment classes. This section describes how DOE used that information to calculate the WEF value of each representative unit at each efficiency level.

[60] For further information regarding the estimation of hydraulic efficiencies, refer to chapter 5 of the direct final rule TSD.

The DPPP equipment classes within the scope of this direct final rule are varied in terms of the number of pump models that are offered on the market and in terms of the amount of data available for those models. Because of these variations, DOE calculated WEF values using slightly different methodologies for each equipment class. The following sections describe the methodologies that DOE used for each equipment class.

Self-Priming Pool Filter Pumps

This subsection describes how DOE used the baseline and incremental performance data presented in sections IV.C.3 through IV.C.4.c to determine the WEF value for three representative self-priming pool filter pump units (0.44 hhp, 0.95 hhp, and 1.88 hhp) from efficiency levels one through max tech.

Efficiency levels one and two represent single-speed pumps. For EL1 and EL2, DOE held hydraulic efficiency constant and replaced the baseline maximum speed motor efficiency with the EL1 and EL2 maximum speed motor efficiencies (presented in Table IV-10). In doing so, DOE was able to calculate the wire-to-water efficiency, input power, and ultimately the WEF at maximum speed on curve C. Chapter 5 of the direct final rule TSD provides full details regarding the calculations and estimations presented in this section.

Efficiency levels three through five represent two-speed pumps. For EL3, EL4, and EL5, DOE used the same method as described for EL1 and EL2 to determine pump performance at maximum speed on curve C. However, a dedicated-purpose pool pump operating at half-speed will exhibit lower hydraulic efficiency and lower motor efficiency compared to its full speed operation. To characterize the performance of pumps at half-speed, DOE referred to the Pool Pump Performance Database, which includes half-speed performance data for listings of two-speed self-priming pool filter pumps. For all three representative units, DOE identified pumps in the Pool Pump Performance Database that exemplify EL3, with design characteristics of low motor efficiency, two-speed motor, and low hydraulic efficiency. DOE used the half-speed motor efficiency and input power for these EL3 units to estimate a representative baseline half-speed hydraulic efficiency.[61] Then DOE calculated the total efficiency and the input power for EL4 and EL5 at half speed by holding the half-speed hydraulic efficiency constant at baseline and substituting the half-speed motor efficiencies assumed for EL4 and EL5 (presented in Table IV-10). DOE calculated WEF for representative units at EL4 and EL5 by combining the half-speed performance with the max-speed performance, as specified in the test procedure final rule.

Efficiency levels 6 and 7 describe variable-speed pumps. Similar to previous ELs, DOE assumed that the baseline motor would be replaced with the EL6 and EL7 motors presented in Table IV-10. Unlike two-speed pumps, the high-speed test point for variable speed pumps is at 80 percent of maximum speed on curve C, and the low-speed test point is at either 24.7 gpm flow or 31.1 gpm flow on curve C (depending on the pump capacity). Although the Pool Pump Performance Database contains performance data for many variable-speed pumps, data for these pumps is not typically reported at these specific test points. Consequently, DOE used the variable-speed performance data

[61] For further information on this method of calculating the half-speed hydraulic efficiency and WEF for two-speed pumps, refer to chapter 5 of the direct final rule TSD.

available for other speeds to estimate performance for the representative units at the specific variable-speed test points.

Based on examination of power-flow curves for many variable-speed pumps and variable-speed motor performance data, DOE concluded that total efficiency at 80 percent of maximum speed is approximately equal to the pump's total efficiency at maximum speed. As such, the hydraulic and motor efficiency of each variable-speed representative unit remains constant, between 100 percent and 80 percent of maximum speed.[62]

However, examination of the same power-flow curves and variable-speed motor performance data indicated that that pump's total efficiency will be lower at the low-speed test point, as hydraulic and motor efficiency tend to be significantly reduced at low speeds. DOE constructed a regression of these power-flow data to quantify the relationship between wire-to-water efficiency and speed reduction. This relationship allowed DOE to estimate wire-to-water efficiency, and thus input power, for each representative unit, based on each unit's wire-to-water efficiency at maximum speed on curve C. The DPPP Working Group reviewed this method of estimating low-speed performance and certain members expressed explicit agreement with the results of this low-speed estimation methodology. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 26-35 and Docket No. EERE-2015-BT-STD-0008-0095, March 22 DPPP Working Group Meeting, at pp. 4-5) None of the DPPP

[62] See chapter 5 of the direct final rule TSD for more details regarding the estimation of variable-speed pump performance at the 80-percent-speed and the low-speed test points.

Working Group members expressed disagreement with this method of estimating low-speed performance. The remainder of the DPPP Working Group offered no objections, and ultimately evaluated standards based on this methodology. Details regarding this regression and the estimation of low-speed performance is included in chapter 5 of the direct final rule TSD.

At EL6, DOE also estimated representative baseline low-speed and high-speed hydraulic efficiency using data from the Pool Pump Performance Database. To do so, DOE identified pumps in the Pool Pump Performance Database that exemplify EL6, (those with variable-speed motor and low hydraulic efficiency) and referenced the low-speed and high-speed motor efficiencies and input power values that DOE estimated for those units. DOE used these estimated values to calculate the representative hydraulic efficiency of these pumps at low speed and at high speed. Details regarding this estimation of hydraulic efficiency are included in chapter 5 of the direct final rule TSD.

Then DOE calculated the total efficiency and the input power for EL7 at low speed by holding the low-speed motor efficiency constant at its EL6 level and substituting an improved hydraulic efficiency at maximum speed on curve C, up to the values specified in Table IV-11. DOE calculated the high-speed performance at EL7 in the same way, by calculating total efficiency and input power holding the high-speed motor efficiency constant and substituting an improved hydraulic efficiency. Ultimately, DOE calculated WEF for representative units at EL6 and EL7 by combining low-speed performance with the high-speed performance, as specified in the test procedure final rule.

Non-Self-Priming Pool Filter Pumps

This subsection describes how DOE used the baseline and incremental performance data presented in sections IV.C.3 through IV.C.4.c to determine the WEF values for two representative non-self-priming pool filter pump units (0.09 hhp and 0.52 hhp) from efficiency levels 1 through max tech. DOE analyzed the 0.09-hhp non-self-priming representative unit separately from the 0.52-hhp non-self-priming representative unit.[63]

DOE did not analyze any efficiency levels above EL2 for the 0.09-hhp non-self-priming pool filter pump representative unit. As discussed in section IV.A.6.b, the design option described as "ability to operate at reduced speeds" does not benefit pool filter pumps that are below 49.4 gpm at maximum speed on curve C. The representative unit characteristics in Table IV-6 show that the 0.09-hhp non-self-priming representative unit achieves a flow rate of 35.1 gpm at maximum speed on curve C. This flow rate is below the 49.4 gpm threshold, so DOE analyzed only single-speed efficiency levels (EL0 through EL2) for the 0.09-hhp non-self-priming pool filter pump. DOE discussed this point with the DPPP Working Group and the group did not offer any comments or objections. (Docket No. EERE-2015-BT-STD-0008-0091, June 22 DPPP Working Group Meeting, pp. 115-116)

[63] The DPPP Working Group ultimately determined that separate standard levels were not appropriate for standard-size non-self-priming and extra-small non-self-priming pool filter pumps (Docket No. EERE-2015-BT-STD-0008-0092, June 23 DPPP Working Group Meeting, pp. 277-280), and the two representative capacities are regulated together in one equipment class.

To calculate the WEF of non-self-priming pool filter pumps at EL1 and EL2 at maximum speed on curve C, DOE used the same methods as those described for self-priming pool filter pumps at EL1 and EL2

To calculate the WEF of 0.52-hhp non-self-priming pool filter pumps at EL3, EL4, and EL5, DOE used the same methods as those described for self-priming pool filter pumps at EL3, EL4, and EL5.

Efficiency levels 6 and 7 describe variable-speed pumps. Similar to previous ELs, DOE assumed that the baseline motor would be replaced with the EL6 and EL7 motors presented in Table IV-10. As described in the discussion of self-priming pool filter pumps, the high-speed test point for variable-speed pumps is at 80 percent of maximum speed on curve C, and the low-speed test point is at either 24.7 gpm flow or 31.1 gpm flow on curve C (depending on the pump capacity). However, the Pool Pump Performance Database does not contain performance data for any variable-speed non-self-priming pool filter pumps, and DOE is not aware of any non-self-priming pool filter pumps on the market that incorporate a variable-speed motor. To characterize EL6 and EL7, DOE estimated the performance of a hypothetical variable-speed non-self-priming pool filter pump. Based on examinations of power-flow curves for self-priming and non-self-priming pool filter pumps, DOE concluded that these two pump varieties experience similar degradation of motor and hydraulic efficiency as pump flow is reduced. DOE estimated the low-speed efficiencies of non-self-priming pumps using the same relationship between wire-to-water efficiency and speed reduction that was determined by regression of self-priming pool filter pump data. DOE applied this relationship to the

0.52-hhp representative non-self-priming unit to this representative unit at 80-percent speed and at low speed.

DOE then calculated the total efficiency and the input power for EL7 at low speed by holding the low-speed motor efficiency constant at its EL6 level and substituting an improved hydraulic efficiency at maximum speed on curve C, up to the values specified in Table IV-11. Ultimately, DOE calculated WEF for representative units at EL6 and EL7 by combining low-speed performance with the high-speed performance, as specified in the test procedure final rule.

Pressure Cleaner Booster Pumps

This subsection describes how DOE used the baseline and incremental performance data presented in sections IV.C.3 through IV.C.4.c to determine the WEF value for one representative pressure cleaner booster pump (at 0.28 hhp at the test point of 10 gpm flow) from efficiency levels 1 through max tech.

To calculate the WEF of pressure cleaner booster pumps at EL1 and EL2 at the pressure cleaner booster pump test point of 10 gpm of flow, DOE used the same methods as those described for self-priming pool filter pumps at EL1 and EL2.

EL 3 represents a variable-speed pump. As described in section IV.A.6.b, pressure cleaner booster pumps are tested at 100 percent speed or (for variable-speed pumps) at the lowest speed that can achieve 60 feet of head at the 10 gpm test condition.[64] DOE assumed that the representative unit's motor efficiency would improve from EL2 to EL3, as the shift from single speed to variable speed would likely be achieved by switching from induction motor technology to the more efficient ECM technology.[65] For EL3, DOE held hydraulic efficiency constant and replaced the EL2 motor efficiency with the EL3 maximum speed motor efficiency (presented in Table IV-10). DOE used pump affinity laws[66] to calculate the input power that the representative unit would consume at 60 feet of head at 10 gpm flow.[67] In doing so, DOE was able to calculate the wire-to-water efficiency and ultimately WEF at the waterfall pump test point of 10 gpm flow.

Efficiency level four represents a variable-speed pressure cleaner booster pump with improved hydraulic design. DOE calculated the total efficiency and the input power for EL4 by holding the motor efficiency constant at its EL3 level and substituting an improved hydraulic efficiency at maximum speed on curve C, up to the value specified in Table IV-11. Chapter 5 of the direct final rule TSD provides full details regarding the calculations and estimations presented in this section.

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[64] The DPPP Working Group requested that DOE examine variable-speed pumps as a design option for pressure cleaner booster pumps. (Docket No. EERE-2015-BT-STD-0008-0095, March 22 DPPP Working Group Meeting, at pp. 197-203)

[65] As noted in section IV.A.6.a, ECMs are inherently more efficient than induction motors because their construction minimizes slip losses between the rotor and stator components.

[66] The pump affinity laws relevant to this calculation are stated in Equation 5, Equation 6, and Equation 7.

[67] DOE calculated that, for the representative pressure cleaner booster pump, this operating point represents 73 percent of the pump's maximum speed. Based on examination of power-flow curves for many variable-speed self-priming pool filter pumps and variable-speed motor performance data, DOE concluded that this reduced-speed operation would incur negligible motor efficiency and hydraulic efficiency losses. Thus, DOE assumed that the representative pressure cleaner booster pump operating at 73 percent speed would exhibit the same motor efficiency and hydraulic efficiency as it would when operating at 100 percent speed.

Waterfall Pumps

This subsection describes how DOE used the baseline and incremental performance data presented in sections IV.C.3 through IV.C.4.c to determine the WEF value for one representative waterfall pump (at 0.40 hhp at the test point of 17 feet of head) from efficiency levels 1 through max tech.

To calculate the WEF of waterfall pumps at EL1 and EL2 at the waterfall pump test point of 17 feet of head, DOE used the same methods as those described for self-priming pool filter pumps at EL1 and EL2.

Efficiency level three represents a single-speed pump with improved hydraulic design. DOE calculated the total efficiency and the input power for EL3 by holding the motor efficiency constant at its EL2 level and substituting an improved hydraulic efficiency at maximum speed on curve C, up to the values specified in Table IV-11. Chapter 5 of the direct final rule TSD provides full details regarding the calculations and estimations presented in this section.

Summary of Representative Unit Performance at Each Efficiency Level

Table IV-12 presents the performance in terms of WEF calculated for each of the representative units at each efficiency level.

Table IV-12 Performance of Representative Units at Each Efficiency Level

Efficiency Level	Representative Units						
	Self-Priming			Non-Self-Priming		Water-fall WEF	Pressure Cleaner WEF
	0.44 hhp WEF	0.95 hhp WEF	1.88 hhp WEF	0.09 hhp WEF	0.52 hhp WEF		
0 (Baseline)	2.69	2.13	1.74	3.93	2.77	7.46	0.34
1	3.37	2.67	2.03	4.93	3.47	7.95	0.42
2	3.72	2.98	2.16	5.14	3.62	8.95	0.45
3	4.68	3.98	3.45	n/a*	4.62	9.85	0.51
4	5.38	4.60	3.66	n/a*	5.47	n/a**	0.56
5	5.77	4.88	4.18	n/a*	5.80	n/a**	n/a**
6	8.78	6.89	5.21	n/a*	7.42	n/a**	n/a**
7 (Max Tech)	11.71	8.59	6.97	n/a*	11.96	n/a**	n/a**

* DOE evaluated 0.09-hhp non-self-priming pool pumps at single-speed efficiency levels only.
** The max-tech efficiency level is EL3 for waterfall pumps and EL4 for pressure cleaner booster pumps.

e. Efficiency Level Structure for All Pump Capacities

The previous section summarizes the performance of the representative units at each efficiency level. However, the market for self-priming and non-self-priming pool filter pumps is more diverse than these representative units. The self-priming and non-self-priming pool filter pump classes include pumps less than 2.5 hhp, and the range of available pump efficiencies (as measured by WEF) decreases as pump capacity increases. To reflect this variation, DOE developed efficiency levels for these equipment classes in the form of equations to specify the WEF performance of equipment across the range of hydraulic power.

For self-priming and non-self-priming pool filter pumps, DOE constructed mathematical functions that fit the performance of the representative units at each efficiency level. DOE observed that the natural logarithm function provides curves with the best fit (i.e., the least error) when comparing the calculated curve values to the performance values that DOE estimated for representative units. DOE constructed scatterplots (Figure IV.4 and Figure IV.5) to visualize the performance of the self-priming and non-self-priming pool filter pumps listed in the Pool Pump Performance Database, along with the representative unit performance at each efficiency level and the efficiency level curve equations.

DOE manually adjusted coefficients in the efficiency level curves to shape the curves to meet the needs of the DPPP Working Group. For instance, DOE adjusted the EL6 curve for self-priming pool filter pumps so that all variable-speed self-priming pool filter pumps listed in the Pool Pump Performance Database would meet a standard set at EL6. The development of the finished efficiency level curve equations is described further in chapter 5 of the direct final rule TSD. After DOE adjusted the efficiency level curves, the DPPP Working Group reviewed them (Docket No. EERE-2015-BT-STD-0008-0078, April 18 DPPP Working Group Meeting, at pp. 17-18), offered no objections, and ultimately evaluated standards based on these efficiency levels. DOE presented an alternate curve for EL 6 that accounted for the statistical error inherent in the estimation of WEF scores.[68] (Docket No. EERE-2015-BT-STD-0008-0100, May 18 DPPP Working Group Meeting, at pp. 118-120) The DPPP Working Group ultimately reached consensus, with no dissenting votes, to recommend the original EL 6 curve that does not include corrections for statistical error. (Docket No. EERE-2015-BT-STD-0008-0092, June 23 DPPP Working Group Meeting, at pp. 282-283)

[68] DOE did not have access to performance data for variable-speed pool filter pumps at the load points prescribed in the test procedure final rule. DOE estimated the performance of pool filter pumps at these load points using statistical regression analysis, as described in section IV.C.1.a. DOE estimated that the regression analysis introduces statistical error of about 8 percent for the WEF scores calculated for representative pool filter pump units.

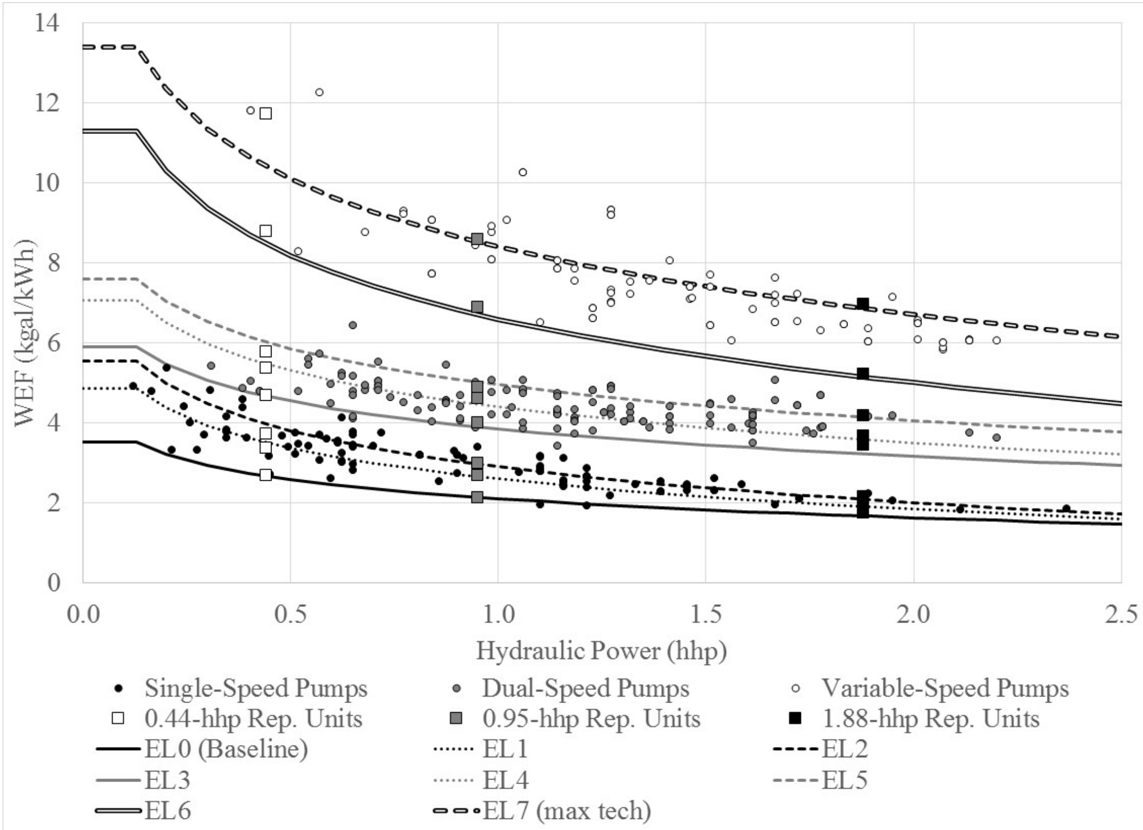

Figure IV.4 WEF versus Hydraulic Power for Self-Priming Pool Filter Pumps, Representative Units, and Efficiency Levels

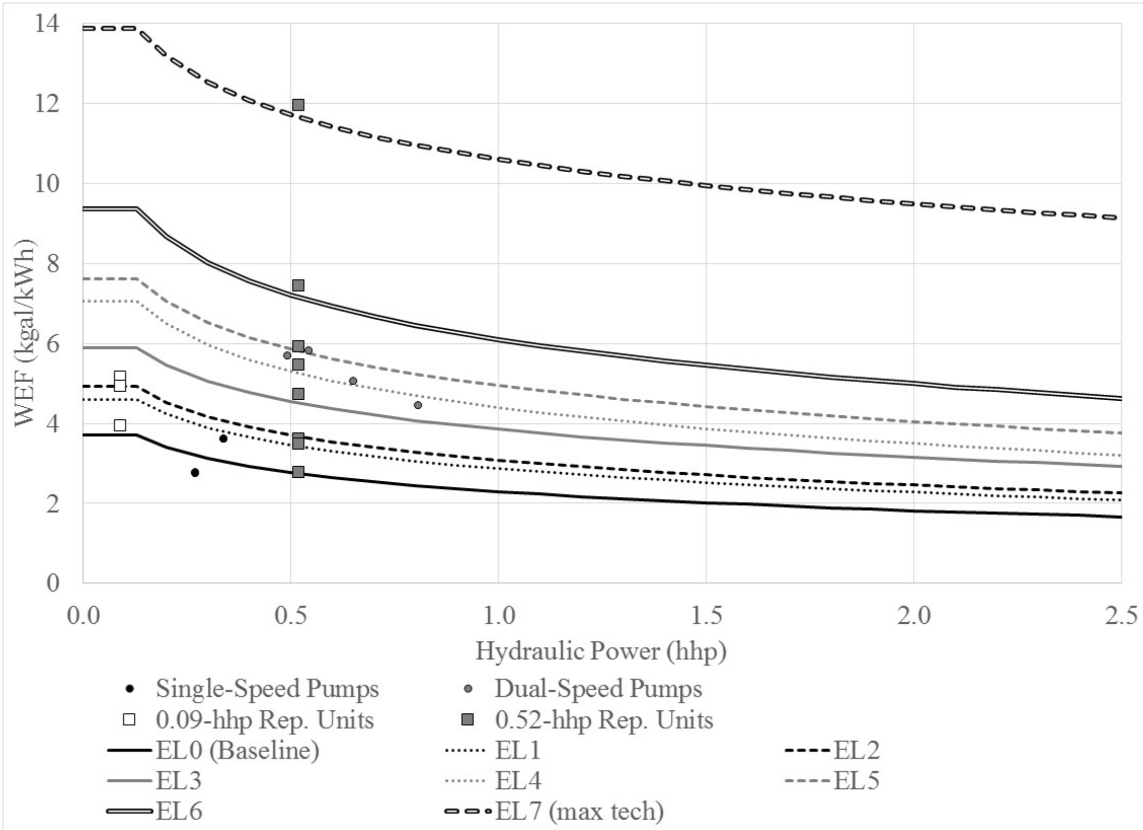

Figure IV.5 WEF versus Hydraulic Power for Non-Self-Priming Pool Filter Pumps, Representative Units, and Efficiency Levels

As evidenced in Figure IV.4 and Figure IV.5, the DPPP Working Group ultimately requested that each efficiency level curve become a flat line at 40 gpm (which is equivalent to 0.13 hhp on curve C) so that for each curve, all flow values below 40 gpm correspond to the WEF score for the efficiency level at 40 gpm. (Docket No. EERE-2015-BT-STD-0008-0092, June 23 DPPP Working Group Meeting, at pp. 277-280) The DPPP Working Group made this request for both self-priming and non-self-priming pool filter pumps.

The pressure cleaner booster pumps on the market are clustered in a small range of capacities, with hydraulic power ranging from 0.26 hhp to 0.32 hhp at the test point of 10 gpm flow. Due to the limit range of available capacities, DOE did not use equations to describe the efficiency levels for pressure cleaner booster pumps. Instead, DOE selected fixed WEF values to represent the efficiency levels. The DPPP Working Group reviewed this method and recommended that DOE set a standard level for pressure cleaner booster pumps that is a single value. (EERE-2015-BT-STD-0008, No. 82, Recommendation #1 at pp. 1-2) Chapter 5 of the direct final rule TSD contains complete details regarding the development of efficiency levels for pressure cleaner booster pumps.

For waterfall pumps, DOE performed the economic analyses on the waterfall pump representative units from baseline to max tech and presented the results to the DPPP Working Group. DOE’s analytical results showed that EL 1 and EL 2 would have negative LCC savings. Many DPPP Working Group members commented that the energy savings for the waterfall class would be small and thus not economically justifiable to pursue standards for waterfall pumps. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 DPPP Working Group Meeting, at pp. 35-36 and pp. 45-46) Consequently, DOE did not establish detailed potential standard levels for waterfall pumps beyond the aforementioned representative units.

Table IV-13 presents the equations used to calculate the WEF at each efficiency level as a function of hydraulic horsepower for self-priming and non-self-priming pool filter pumps. Table IV-14 presents the fixed WEF values at each efficiency level for pressure cleaner booster pumps.

Table IV-13 Efficiency Level WEF Equations for Self-Priming and Non-Self-Priming Pool Filter Pumps

Efficiency Level	Equipment Class			
	Self-Priming Pool Filter Pumps, Small and Standard Classes		**Non-Self-Priming Pool Filter Pumps****	
	WEF*		**WEF ***	
	≤ 0.13 hhp	**> 0.13 hhp**	**≤ 0.13 hhp**	**> 0.13 hhp**
0 (Baseline)	3.51	–0.69 × *ln*(hhp) + 2.10	3.71	–0.69 × *ln*(hhp) + 2.30
1	4.84	–1.10 × *ln*(hhp) + 2.60	4.60	–0.85 × *ln*(hhp) + 2.87
2	5.55	–1.30 × *ln*(hhp) + 2.90	4.92	–0.90 × *ln*(hhp) + 3.08
3	5.89	–1.00 × *ln*(hhp) + 3.85	5.89	–1.00 × *ln*(hhp) + 3.85
4	7.05	–1.30 × *ln*(hhp) + 4.40	7.05	–1.30 × *ln*(hhp) + 4.40
5	7.60	–1.30 ×*ln*(hhp) + 4.95	7.60	–1.30 × *ln*(hhp) + 4.95
6	11.28	–2.30 × *ln*(hhp) + 6.59	9.36	–1.60 × *ln*(hhp) + 6.10
7 (Max Tech)	13.40	–2.45 × *ln*(hhp) + 8.40	13.86	–1.60 × *ln*(hhp) + 10.60

* hhp represents the hydraulic horsepower of the pump, measured at maximum speed on system curve C and reported in units of horsepower.
** As described in section IV.A.6.b, DOE did not consider efficiency levels above EL2 for non-self-priming pool filter pumps that produce less than 49.4 gpm maximum flow on curve C.

Table IV-14 Efficiency Level WEF Values for Pressure Cleaner Booster Pumps

Efficiency Level	Equipment Class
	Pressure Cleaner Booster Pumps, at 10 gpm flow
	WEF
0 (Baseline)	0.34
1	0.42
2	0.45
3	0.51
4	0.56

5. Manufacturer Production Costs

This section present the MPCs at each efficiency level, for each equipment class, and discusses the analytical methods used to develop these MPCs. This section contains six subsections. The first subsection describes the principal drivers of manufacturing costs. The second and third subsections focus on the motor costs and non-motor costs for pool filter pumps and pressure cleaner booster pumps. The fourth subsection focuses specifically on the costs of integral sand filter and integral cartridge filter pumps. The final two subsections present cost-efficiency tables and MPC breakdowns for all DPPP equipment classes.

a. Principal Drivers of DPPP Manufacturing Costs

For most models of pool filter pumps and pressure cleaner booster pumps, the motor is the most expensive component of the pump. As discussed previously, for these equipment classes, all efficiency levels except max tech are defined by a motor substitution. In a motor substitution, the pump motor of a representative baseline (low efficiency, single-speed) unit is exchanged with a motor that will provide improved performance (e.g., improved efficiency or ability to operate at reduced speed).

DOE researched the design and engineering constraints associated with motor substitution, examining manufacturer interview responses and holding discussions with the DPPP working group. In particular, Hayward commented that manufacturers would incur costs, such as costs associated with testing, packaging, and labeling, when substituting the motor component of a pump. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at pp. 105-106) Zodiac commented that manufacturers would incur costs for motor substitutions associated with qualification testing, reliability testing, and updating catalogs and marketing materials. (Docket No. EERE-2015-BT-STD-0008-0100, May 18 DPPP Working Group Meeting, at pp. 78) DOE included the cost items described by Hayward and Zodiac in the product conversion costs (discussed in section IV.J.2.c) in the MIA and did not account for them in the MPC figures estimated for dedicated-purpose pool pumps. DOE concluded that for the representative equipment capacities being considered, a given DPPP wet end could be paired with a range of motors of various efficiencies and speed configurations without significant changes to the per-unit costs associated with manufacturing the wet end. In other words, a motor swap results in negligible incremental MPC to the non-motor components of the dedicated-purpose pool pump. Thus, DOE concluded that the incremental MPC of the motor swap design options (improved motor efficiency and ability to operate at reduced speeds) may be considered equivalent to the incremental MPC of the motor component being swapped.

Consequently, DOE broke the equipment MPCs for pool filter pumps and pressure cleaner booster pumps into two categories–motor costs and non-motor costs–and estimated the MPC of each separately. However, DOE did not break out the motor costs of the integral cartridge and integral sand filter pool pump classes because no motor design options were considered for these equipment classes.

b. Pool Filter Pump and Pressure Cleaner Booster Pump Motor Costs

DOE quantified pump motor MPCs at each efficiency level, for each representative unit. These MPCs represent the cost incurred by DPPP manufacturers to either purchase the motors or assemble them in house.

DOE estimated motor costs using two data sources: (1) estimates provided by manufacturers, and (2) publicly available motor catalogs. DOE presented initial motor cost estimates to the DPPP Working Group and received feedback from the group. (Docket No. EERE-2015-BT-0008-0094, March 21 DPPP Working Group Meeting, at pp. 108-122) Hayward commented that the motor MPCs that DOE initially presented for variable-speed pump motors were extremely low, and Hayward asked DOE to ensure that these MPC figures include the cost of all three components (the motor, the motor drive, and the user interface) that are required to replace a single-speed or two-speed motor. (Docket No. EERE-2015-BT-0008-0100, May 18 DPPP Working Group Meeting, at pp. 130-131) DOE's contractor subsequently received new motor cost data and revised the MPC assumptions for variable-speed motors based on those numbers.

The revised motor component costs presented in Table IV-15 represent aggregate cost estimates for the dedicated-purpose pool pump industry, and do not represent the costs incurred by any one pump manufacturer. The costs in Table IV-15 include all of the costs incurred to deliver finished motor components that are ready for assembly into a pump.[69] For variable-speed motors, the listed costs include the cost of controls (which include a motor driver and a user interface), as variable-speed motors require this equipment to operate. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at pp. 207-208)

As discussed in section IV.A.5.b, variable-speed motors are not currently available in capacities smaller than 1.65 thp. Initially, DOE assumed that motor manufacturers would begin to offer variable-speed motors smaller than 1.65-thp, and DOE estimated the costs of these smaller motors by extrapolating the costs of larger variable-speed motors that are currently available. (Docket No. EERE-2015-BT-STD-

[69] For manufacturers that purchase third-party motors, these costs include shipping and delivery costs, as well as the overhead associated with ordering and inventory. For manufacturers that assemble motors in house, these costs include the components, labor, and depreciation associated with motor assembly.

0008-0078, April 18 DPPP Working Group Meeting, at pp. 31-32) The DPPP Working Group recommended that DOE consider only motors that that are currently available on the market. (EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at pp. 109-112) Specifically, the DPPP Working Group did not find it reasonable to assume that motor suppliers would develop smaller variable-speed motor that are not are already available on the market. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at pp. 109) Thus, DOE modeled a 1.65-thp variable-speed motor that would be the motor of choice for smaller representative units at efficiency levels that are defined by variable-speed motors.

DPPP Working Group members commented that smaller DPPP models may require additional design changes to accommodate a 1.65-thp variable-speed motor. DOE requested comments on the product conversion costs that would be required to adapt smaller DPPP models to use 1.65-thp variable-speed motors. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at pp. 108-113) DOE incorporated manufacturer feedback into the product conversion cost assumptions, which are discussed in section IV.J.2.c.

DOE presented the revised motor costs in Table IV-15 to the DPPP Working Group and the DPPP Working Group did not offer any comments in opposition. (Docket No. EERE-2015-BT-STD-0008-0100, May 18 DPPP Working Group Meeting, at pp. 115-116; Docket No. EERE-2015-BT-0008-0101, May 19 DPPP Working Group Meeting, at pp. 6-10)

Table IV-15 MPC of DPPP Motor Components*

Motor Description	Representative Units						
	Self-Priming Pool Filter Pump			Non-Self-Priming Pool Filter Pump		Pressure Cleaner Booster Pump $	Water-fall Pump $
	0.44 hhp $	0.95 hhp $	1.88 hhp $	0.09 hhp $	0.52 hhp $		
(Baseline) 1-speed low efficiency	55	66	142	24	46	53	58
1-speed, mid efficiency	68	85	177	30	50	63	69
1-speed, high efficiency	87	101	198	36	64	83	88
2-speed, low efficiency	90	102	226	n/a**	68	n/a††	n/a††
2-speed, mid efficiency	100	119	239	n/a**	82	n/a††	n/a††
2-speed, high efficiency	111	137	253	n/a**	96	n/a††	n/a††
Variable Speed	273	273	367	n/a†	273	273	n/a††

* The integral cartridge filter pool pump and integral sand filter pool pump equipment classes are not included in this table because DOE did not separately consider the motor costs for these equipment classes.

** As discussed in section IV.A.6.b this analysis does not consider two-speed motor configurations for the 0.09-hhp non-self-priming pool filter pump representative unit. According to the test procedure final rule, this representative unit would always be subject to the single-speed test procedure because the half-speed flow rate for a 0.09-hhp pump would be 17.8 gpm, which is less than the test procedure minimum flow rate of 24.7 gpm.

† As discussed in section IV.A.6.b, this analysis does not consider variable-speed motor configurations for the 0.09-hhp non-self-priming pool filter pump representative unit.

†† Two-speed motors were not considered for waterfall pumps or pressure cleaner booster pumps, and variable-speed motors were not considered for waterfall pumps, because DOE assumes these pump varieties are always operated at a single-speed.

c. Pool Filter Pump and Pressure Cleaner Booster Pump Non-Motor Costs

The non-motor costs of manufacturing pool filter pumps and pressure cleaner booster pumps include the costs associated with manufacturing the wet end of the pump and the costs associated with assembling and packaging the pump. To determine the MPC of non-motor components, DOE developed a comprehensive spreadsheet model itemizing all component parts and their associated costs. The spreadsheet model took inputs from virtual teardowns as well as data obtained through manufacturer interviews and independent research. For the virtual teardowns, DOE referenced catalogs of replacement pump parts and analyzed the materials and the manufacturing processes used to produce the various pump components. With this information, DOE calculated the amount a DPPP manufacturer would pay to produce each representative unit. Chapter 5 of the direct final rule TSD includes further detail on the inputs and methods used to determine MPC, including material, labor, and overhead breakdowns.

Table IV-16 presents the non-motor MPCs associated with producing representative units in the pool filter pump and pressure cleaner booster pump equipment classes. DOE presented these costs to the DPPP Working Group (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 117-118) and received no objections.

Table IV-16 Non-Motor MPC for Pool Filter Pump and Pressure Cleaner Booster Pump Classes*

	Representative Units						
	Self-Priming Pool Filter Pump			Non-Self-Priming Pool Filter Pump		Pressure Cleaner Booster Pump	Water -fall Pump
	0.44 hhp	0.95 hhp	1.88 hhp	0.09 hhp	0.52 hhp		
Non-Motor Costs	$47	$47	$50	$23	$24	$35	$42

*The integral cartridge filter pool pump and integral sand filter pool pump equipment classes are not included in this table because DOE did not separately consider the motor costs for these equipment classes.

DOE investigated the incremental MPC associated with manufacturing a pool filter pump with high hydraulic efficiency compared to a pool filter pump with low hydraulic efficiency. To do this, DOE identified several pairs of pool filter pumps that had identical capacities and motor efficiencies, but one pump had higher total efficiency than the other at maximum speed on curve C. DOE used a manufacturing cost model to individually model the MPCs of the higher efficiency wet end and the lower efficiency wet end. DOE determined that the MPC of producing a higher efficiency wet end would be approximately equal to the MPC of producing a low efficiency wet end. Thus, DOE concluded that there would be no incremental MPC associated with improving the hydraulic efficiency of a pool filter pump.[70] DOE presented this conclusion to the DPPP Working Group, which raised no objections. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 117-118)

d. Cost Analysis of Integral Filter Pool Pump Equipment Classes

DOE did not break out the motor component costs for integral filter pool pump equipment classes estimating MPCs for that class. DOE first estimated the MPC of the three representative units associated with these classes at the baseline efficiency level. DOE then estimated the incremental cost of the sole design option (pool pump timer) considered for these classes.

<u>Baseline MPCs of Integral Filter Pump Classes</u>

DOE used several data sources to estimate the MPC of integral filter pumps at the baseline efficiency level:

- DOE received MPC estimates from manufacturers, including estimates of the MPC of integral filter pumps at the baseline level.
- DOE retrieved retail price data for integral filter pumps that are commercially available on the market. These retail prices represent the

[70] DOE notes that manufacturers would still likely incur costs for component design, prototyping, tooling, and testing. These costs are not included in the per-unit MPC figures described in this section. Instead, these one-time conversion costs are discussed in the manufacturer impact analysis discussed in section IV.J of this direct final rule.

MPC of producing a unit plus the various markups and taxes that are applied along the distribution chain.[71] DOE aggregated retail price data for representative integral filter pump units and divided by a set of assumed markups to estimate the MPCs of representative units.

- DOE conducted a reverse-engineering teardown as a bottom-up approach to estimate the MPC of a representative unit. DOE purchased and disassembled an integral filter pump and created a manufacturing cost model to estimate the manufacturing costs associated with producing the pump at the same volumes as integral pump manufacturers.

DOE aggregated the cost data from these sources. Table IV-17 presents the estimated MPC for the three representative units of integral filter pool pumps. DOE presented the MPCs in Table IV-17 to the DPPP Working Group and the DPPP Working Group did not offer any opposition or additional comments. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 132-133).

Table IV-17 MPCs for Integral Filter Pump Equipment Classes

	Representative Equipment		
	Integral Sand Filter Pool Pump	**Integral Cartridge Filter Pool Pump**	
	0.03 hhp	**0.02 hhp**	**0.18 hhp**
Baseline MPC	$57	$17	$92

[71] Markups are discussed in section IV.D of this notice and markup assumptions are presented in chapter 6 of the direct final rule TSD.

Incremental Cost of Pool Pump Timer Design Option

The only design option considered for the integral cartridge filter pool pump and integral sand filter pool pump equipment classes is the addition of a pool pump timer. The DPPP Working Group recommended that the prescriptive standard for including a timer with integral filter pumps should be fulfilled by a timer that is either integral to the pump or that is a separate component shipped with the pump. (Docket No. EERE-2015-BT-STD-0008-0082, Recommendation #2 at p. 2) Based on manufacturer interviews, DOE concluded that the incremental cost of adding a pool pump timer would be approximately the same for all three representative units associated with the integral filter pump equipment classes.

DOE separately evaluated the costs of integrating a timer into an existing integral filter pump and the costs of including a timer with an existing pump. To estimate the cost of integrating a timer into an existing pump, DOE used MPC estimates provided by pump manufacturers. These data included manufacturer estimates of the incremental MPC of integrating a timer into existing integral pump products. To estimate the cost of including a timer with an existing pump, DOE conducted a retail price analysis of timers that are available off the shelf. DOE retrieved retail prices for off-the-shelf timers that would meet the criteria required for servicing an outdoor integral filter pump (e.g., timer is waterproof, timer is electrically grounded, and is rated to an amperage greater than what the pump requires). DOE then derated the retail price to estimate the price of timers purchased in bulk.

DOE aggregated the cost data from these sources, and estimated that the industry average incremental cost of adding a pool pump timer to an integral filter pump is $6.67 per unit. DOE presented this incremental cost to the DPPP Working Group and the DPPP Working Group did not oppose it or offer additional comments. (Docket No. EERE-2015-BT-STD-0008-0094, March 21 DPPP Working Group Meeting, at pp. 132).

e. Cost-Efficiency Results

This subsection presents the cost-efficiency tables that result from the combination of motor and wet end costs at each efficiency level. Table IV-18 through Table IV-22 present results for each representative unit.

Table IV-18 MPCs for Self-Priming Pool Filter Pump Representative Units

Efficiency Level	Representative Unit Capacity on System Curve C		
	0.44 hhp	0.95 hhp	1.88 hhp
	MPC $	MPC $	MPC $
0 (Baseline)	102	113	192
1	115	132	227
2	134	148	248
3	137	149	276
4	147	166	290
5	158	184	303
6	320	320	417
7 (Max Tech)	320	320	417

Table IV-19 MPCs for Non-Self-Priming Pool Filter Pump Representative Units

Efficiency Level	Representative Unit Capacity on System Curve C	
	0.09 hhp	0.52 hhp
	MPC $	MPC $
0 (Baseline)	47	69
1	53	74
2	59	87
3	n/a*	91
4	n/a*	105
5	n/a*	119
6	n/a*	297
7 (Max Tech)	n/a*	297

* DOE did not analyze any efficiency levels above EL2 for the 0.09-hhp non-self-priming pool filter pump representative unit, as discussed in section IV.C.4.d.

Table IV-20 MPCs for Pressure Cleaner Booster Pump Representative Units

Efficiency Level	Representative Unit Capacity 0.28 hhp at 10 gpm of flow MPC $
0 (Baseline)	88
1	99
2	118
3	308
4 (Max Tech)	308

Table IV-21 MPCs for Waterfall Pump Representative Units

Efficiency Level	Representative Unit Capacity 0.40 hhp at 17 feet of head MPC $
0 (Baseline)	100
1	110
2	130
3 (Max Tech)	130

Table IV-22 MPCs for Integral Filter Pump Representative Units

Efficiency Level	Representative Unit Capacity on System Curve C		
	Integral Sand Filter Pool Pump	Integral Cartridge Filter Pool Pump	
	0.03 hhp	0.02 hh	0.18 hhp
	MPC $	MPC $	MPC $
0 (Baseline)	57	17	92
1 (With Timer)	64	23	99

f. MPC Cost Components

The MIA requires MPCs to be disaggregated the MPCs into material, labor, depreciation, and overhead costs. DOE estimated MPC breakdowns using the manufacturing cost model tool described in section IV.C.5.c, and the estimated MPC breakdowns during interviews with manufacturers. The MPC cost components are reported in the manufacturer impact analysis described in chapter 9 of the direct final rule TSD.

6. Other Analytical Outputs

As discussed previously in section III.C, the DOE test procedure specifies test points for the pool filter pump, waterfall pump, and pressure cleaner booster pump equipment classes covered by this direct final rule. For instance, the test points for self-priming and non-self-priming pool filter pumps are at specified pump speeds on system curve C, and the test point for pressure cleaner booster pumps is at 10 gpm of flow. In the field, the conditions in which these pumps operate will not exactly match the test points. For instance, some pumps may service pools with plumbing that approximates system curve A instead of curve C, and some variable-speed pumps will be programmed to operate at speeds that are higher or lower than the test point speeds specified in the DOE test procedure. These variations in installation conditions are modeled in the energy use analysis, which is discussed in section IV.D. To facilitate the energy use analysis, DOE estimated the power consumption of representative units across a variety of potential installation conditions.

For self-priming and non-self-priming pool filter pumps, DOE estimated the flow and energy factor of representative units operating on system curves A, B, and C. DOE developed these estimates using actual pump performance data on curves A, B, and C from the Pool Pump Performance Database, combined with the motor substitution methodology described in section IV.C.4.c. For efficiency levels with single-speed motor configurations, DOE estimated flow and EF at 100-percent speed. For efficiency levels with two-speed motor configurations, DOE estimated flow and EF at 100 percent speed and at 50 percent speed. For efficiency levels with variable-speed motor configurations, DOE estimated flow and EF at 80 percent speed and at a low-speed test point of either

24.7 gpm or 31.1 gpm, depending on the pump capacity. For these variable-speed units, DOE also developed equations to estimate EF as a function of flow for variable-speed representative units operating at reduced speeds near the low-speed test point. DOE developed these equations using the pump affinity laws and the regressions of pump total efficiency versus pump speed described in section IV.C.4.c. Chapter 5 of the direct final rule TSD provides further details on these analytical outputs.

DOE also developed equations to estimate the power consumption as a function of flow for waterfall pumps and pressure cleaner booster pumps operating near the respective test points for those equipment classes. DOE developed these equations by aggregating pump test data that was submitted to DOE by manufacturers. The resulting equations estimate head and power consumption as a function of flow for waterfall pumps and pressure cleaner booster pumps at all efficiency levels. The distribution of field installations and their operating parameters are discussed further in the energy use analysis in section IV.E. Chapter 5 of the direct final rule TSD presents more details regarding these analytical outputs.

7. Manufacturer Selling Price

To account for manufacturers' non-production costs and profit margin, DOE applied a non-production cost multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price (MSP) is the price at which the manufacturer distributes a unit into commerce.

DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (SEC) 10-K reports filed by publicly traded manufacturers primarily engaged in pool pump manufacturing and whose combined product range includes pool pumps. DOE adjusted these estimates based on feedback received during confidential manufacturer interviews. DOE estimated a manufacturer markup of 1.46 for self-priming and waterfall pool pumps, 1.35 for non-self-priming and pressure cleaner booster pool pumps, and 1.27 for integral cartridge filter and integral sand filter pool pumps.

D. Markups Analysis

The markups analysis develops appropriate markups in the distribution chain and sales taxes to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analyses. At each step in the distribution channel, companies mark up the price of the equipment to cover business costs and profit margin.

1. Dedicated-Purpose Pool Pump Markups

For this dedicated-purpose pool pump direct final rule, DOE identified two markets in which dedicated-purpose pool pumps pass from the manufacturer to residential and commercial consumers: (1) replacement of a pool pump for an existing swimming pool; (2) installation of a pool pump in a new swimming pool.

Based on manufacturer interviews, the distribution channels for dedicated-purpose pool pumps were characterized as noted in Table IV-23.

Table IV-23 Fraction of Dedicated-Purpose Pool Pump Distribution by Channel

Distribution Channel	Fraction of Dedicated-Purpose Pool Pumps %
Replacement for an Existing Pool	
Manufacturer → Wholesaler → Pool Service Contractor → Consumer	75
Manufacturer → Pool Product Retailer → Consumer	20
New Installation for a New Pool	
Manufacturer → Pool Builder → Consumer	5

For all market participants except for manufacturers, DOE developed baseline and incremental markups. Baseline markups are applied to the price of equipment with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup, and is designed to maintain similar per-unit operating profit before and after new or amended standards.[72]

To estimate baseline and incremental markups, DOE relied on several sources, including: (1) for pool wholesalers, SEC form 10-K from Pool Corp;[73] (2) for pool

[72] Because the projected price of standards-compliant equipment is typically higher than the price of baseline equipment, using the same markup for the incremental cost and the baseline cost would tend to result in higher per-unit operating profit. While such an outcome is possible, DOE maintains that in markets that are reasonably competitive it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

[73] U.S. Securities and Exchange Commission. SEC 10-K Reports for Pool Corp (2010-2015). Available at www.sec.gov/ (Last accessed May 26, 2016.)

product retailers, SEC form 10-K from several major home improvement centers[74] and U.S. Census Bureau 2012 Annual Retail Trade Report,[75] and (3) for pool contractors and pool builders, U.S. Census Bureau 2012 Economic Census data[76] on the building construction industry.

2. Replacement Motor Markups

As discussed in section IV.F, in some cases, only the motor component in the pool pump is replaced instead of the entire pool pump. DOE treated motor replacement as a repair of the pump. In this case, the replacement motor typically goes through different distribution channels than pool pumps. Based on inputs from motor manufacturers inputs, DOE considered three distribution channels to characterize how motors are distributed in the motor replacement market. Table IV-24 shows these distribution channels.

Table IV-24 Fraction of Dedicated-Purpose Pool Pump Replacement Motor Distribution by Channel

Distribution Channel	Fraction of Pool Pumps %
Via Motor Manufacturer	
1) Motor Manufacturer → Wholesaler → Contractor → Consumer	25
2) Motor Manufacturer → Wholesaler → Retailer → Consumer via internet or direct sale at local stores	25
Via Pool Pump Manufacturer	
3) Pump Manufacturer →Pump Product Retailer → Consumer	50

[74] U.S. Securities and Exchange Commission. SEC 10-K Reports for Home Depot, Lowe's, Wal-Mart and Costco. Available at www.sec.gov/ (Last accessed May 26, 2016.)
[75] U.S. Census Bureau, 2012 Annual Retail Trade Report, available at www.census.gov/retail/index.html (last accessed Dec. 3, 2015).
[76] U.S. Census Bureau, 2012 Economic Census Data, available at www.census.gov/econ/ (last accessed Dec. 3, 2015).

Due to limited available information, DOE assumed that the motor wholesaler markup in the second motor replacement channel via internet and direct local store sales is the same as in the first motor replacement channel via contractor. To estimate baseline and incremental markups for each of the market participants (except for manufacturers) mentioned in **Error! Reference source not found.**, DOE relied on several sources, including: (1) for motor wholesalers, U.S. Census Bureau 2012 Annual Wholesale Trade Report;[77] (2) for electrical contractors, RSMeans electrical cost data;[78] and (3) for motor retailers, U.S. Census Bureau 2012 Annual Retail Trade Report.[79]

In addition to the markups, DOE obtained state and local taxes from data provided by the Sales Tax Clearinghouse.[80] These data represent weighted average taxes that include county and city rates. DOE derived shipment-weighted average tax values for each region considered in the analysis.

Chapter 6 of the direct final rule TSD provides details on DOE's development of markups for pool pumps.

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[77] U.S. Census Bureau, 2012 Annual Wholesale Trade Report, available at www.census.gov/wholesale/index.html (last accessed Dec. 3, 2015).

[78] RSMeans. Electrical Cost Data 2015. 2014. RSMeans: Norwell, MA.

[79] U.S. Census Bureau, 2012 Annual Retail Trade Report, available at www.census.gov/retail/index.html (last accessed April 28, 2016).

[80] Sales Tax Clearinghouse Inc., State Sales Tax Rates Along with Combined Average City and County Rates (2016), available at http://thestc.com/STrates.stm (last accessed April 18, 2016).

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of pool pumps at different efficiencies in representative U.S. applications, and to assess the energy savings potential of increased dedicated-purpose pool pump efficiency. The energy use analysis estimates the range of energy use of dedicated-purpose pool pumps in the field (i.e., as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of standards.

1. Dedicated-Purpose Pool Pump Consumer Samples

DOE created individual consumer samples for five dedicated-purpose pool pump markets: (1) single-family homes with a swimming pool; (2) indoor swimming pools in commercial applications; (3) single-family community swimming pools; (4) multi-family community swimming pools; and (5) outdoor swimming pools in commercial applications. DOE used the samples to determine dedicated-purpose pool pump annual energy consumption as well as for conducting the LCC and PBP analyses.

DOE used the Energy Information Administration’s (EIA) 2009 Residential Energy Consumption Survey (RECS 2009) to establish a sample of single-family homes that have a swimming pool.[81] For dedicated-purpose pool pumps used in indoor

[81] U.S. Department of Energy–Energy Information Administration. 2009 RECS Survey Data. (Last accessed July 27, 2016.) www.eia.gov/consumption/residential/data/2009/.

swimming pools in commercial applications, DOE developed a sample using the 2012 Commercial Building Energy Consumption Survey (CBECS 2012).[82] RECS and CBECS include information such as the household or building owner demographics and the location of the household or building.

Neither RECS nor CBECS provide data on community pools or outdoor swimming pools in commercial applications, so DOE created samples based on other available data. To develop samples for dedicated-purpose pool pumps in single or multi-family communities, DOE used a combination of RECS 2009, U.S. Census 2009 American Home Survey Data (2009 AHS),[83] and 2015 PK Data report.[84] To develop a sample for pool pumps in outdoor commercial swimming pools, DOE used a combination of CBECS 2012 and 2015 PK Data report.

Table IV-25 shows the estimated shares of the five dedicated-purpose pool pump markets in the existing stock based on the afore-mentioned sources. The vast majority of dedicated-purpose pool pumps are used for residential single-family swimming pools.

Table IV-25 Fraction of Dedicated-Purpose Pool Pumps by DPPP Market

Pool Type ID	Description	Fraction of Pool Pumps %
1	Residential Single Family Swimming Pools	95.1
2	Community Pools (Single Family)	0.8
3	Community Pools (Multi Family)	0.4

[82] U.S. Department of Energy–Energy Information Administration. 2012 CBECS Survey Data. (Last accessed: July 27, 2016.) www.eia.gov/consumption/commercial/data/2012/index.cfm?view=microdata.
[83] U.S. Census Bureau. 2009 AHS survey data (Last accessed: July 27, 2016.) www.census.gov/programs-surveys/ahs/data/2009/ahs-2009-public-use-file--puf-/2009-ahs-national-puf-microdata.html.
[84] PK Data. 2015 Swimming Pool and Pool Heater Customized Report for LBNL. (Last accessed: April 30, 2016.) www.pkdata.com/current-reports.html.

4	Commercial Indoor Pools	0.3
5	Commercial Outdoor Swimming Pools	3.4

Dedicated-purpose pool pumps can be installed with either above-ground or in-ground swimming pools. DOE established separate sets of consumer samples for in-ground pools and above-ground pools by adjusting the original sample weights based on the number of installed in-ground and above-ground pools in 2014 per state provided by APSP. (EERE-2015-BT-STD-0008-0010, No. 31 at pp. 14-15) The consumer samples for self-priming, auxiliary (waterfall) and pressure cleaner booster pumps are drawn from the in-ground pool samples; the consumer samples for non-self-priming and integral pumps are obtained from the above-ground pool samples.

See chapter 7 of the direct final rule TSD for more details about the creation of the consumer samples and the regional breakdowns.

2. Energy Use Estimation

DOE calculated the annual unit energy consumption (UEC) of pool pumps at the considered efficiency levels by multiplying the average daily UEC by the annual days of operation. For single-speed pool pumps, the daily UEC is simply the pool pump power multiplied by the daily operating hours. For two-speed and variable-speed pool pumps, the daily UEC is the sum of low-speed mode power multiplied by the low-speed daily operating hours and the high-speed mode power multiplied by the corresponding daily operating hours.

a. Power Inputs

Self-Priming and Non-Self-Priming Pumps

For self-priming and non-self-priming pool pumps, the power inputs are obtained by using flow (Q, in gallon/minute) divided by energy factor (in gallon/Wh). In the case of single-speed pumps, Q and EF are provided in the engineering analysis for each representative unit at each system curve (A, B or C).[85] In the case of two-speed pumps, Q and EF are provided for both low-speed and high-speed modes for each representative unit at each system curve. For variable-speed pumps, Q and EF are provided only for the high-speed mode, which, according to the DOE test procedure, corresponds to 80 percent of maximum speed; for the low-speed mode, Q is specific to each consumer and EF is provided as a function of Q. For each consumer in the sample, DOE specified the system curve used (A, B or C) by drawing from a probability distribution suggested by the DPPP Working Group. The suggested distribution was based on field testing and experience indicating that many pools are closer to curve C, but additional amenities such as a sand filter or a heater would bring a pump's performance to curve A. (EERE-2015-BT-STD-0008-0094, pp. 144-147) In the recommended distribution, 35 percent of the pool pumps follow curve A, 10 percent of the pool pumps follow curve B, and the remaining 55 percent follow curve C.

For variable-speed pumps, to define the consumer-specific low-speed flow, DOE used the pool size divided by the desired time per turnover, which was assumed by the

[85] The requirements of a pool (or any water system), can be expressed in terms of a system curve. When a pump is tested on a system curve (such as curve C), any one of the measurements hydraulic power, P (hp), volumetric flow, Q (gpm) and total dynamic head, H (feet of water) can be used to calculate the other two measurements. See section IV.A.1 for further details.

DPPP Working Group to be 12 hours for residential applications, and 6 or 10 hours for commercial applications (EERE-2015-BT-STD-0008-0094 pp. 143-144). DOE developed a distribution for pool size based on information given in several references.[86,87,88] The minimum of the pool size distribution for standard-size self-priming pool pumps and integral pool pumps was then decreased by the DPPP Working Group based on the existing small pools on the market, and the mode of the pool size distribution for standard-size non-self-priming pool pumps was increased based on the DPPP Working Group's decision. (EERE-2015-BT-STD-0008-0094 pp. 163-171) The pool size distributions for integral pumps were later adjusted by the DPPP Working Group based on the suggested pool sizes for the integral pumps on the market. (EERE-2015-BT-STD-0008-0078 pp. 75-77) A minimum threshold of flow Q is considered according to the capacity of the pumps. The variable-speed EF can therefore be calculated, as it was provided in the engineering analysis as a function of Q for each representative unit on each system curve.

Pressure Cleaner Booster Pumps and Waterfall Pumps

The test procedure final rule established a test point at 10 gpm of flow for pressure cleaner booster pumps and a test point at 17 feet of head for waterfall pumps. DOE developed a distribution for each of these equipment classes, in coordination with

86 CEE Residential Swimming Pool Initiative. (Last Accessed: July 28, 2016) http://library.cee1.org/sites/default/files/library/9986/cee_res_swimmingpoolinitiative_07dec2012_pdf_10557.pdf.

87 California Energy Commission Pool Heater CASE. (Last Accessed: July 28, 2016) www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2F_Residential_Pool_Pumps_and_Replacement_Motors/California_IOUs_Response_to_the_Invitation_for_Standards_Proposals_for_Pool_Heaters_2013-07-29_TN-71754.pdf.

88 Evaluation of potential best management practices –Pools, Spas, and Fountains 2010. (Last Accessed: July 28, 2016) http://cuwcc.org/LinkClick.aspx?fileticket=3p3DgiY6ObY%3D.

the DPPP Working Group, from which a flow or head value, respectively is drawn for each sampled consumer. (Pressure cleaner booster pumps: EERE-2015-BT-STD-0008-0092 pp. 310; waterfall pumps: EERE-2015-BT-STD-0008-0094 pp. 149-150) For waterfall pumps, DOE used the pump curve H=f(Q) provided in the engineering analysis for each representative unit to determine the flow Q associated with the selected head, from which the corresponding power can be calculated based on the power curve P=f(Q), also provided by the engineering analysis. For single-speed pressure cleaner booster pumps, DOE calculated the power directly from the power curve P=f(Q) from the engineering analysis. For variable-speed pressure cleaner booster pumps, DOE estimated power consumption at reduced speed for consumers with sampled Q above 10 gpm.

Integral Pumps

For integral pumps, the power value was provided for each representative unit. DOE did not apply a distribution to this value given that integral pumps are designed to be used for specific pools, and therefore the power is not expected to vary widely.

b. Operating Hours

The following sub-sections describe DOE's methodology for calculating daily operating hours for each pump variety. For self-priming and non-self-priming pool filter pumps in residential applications, operating hours are calculated uniquely for each consumer based on pool size, number of turnovers per day (itself based on ambient conditions), and the pump flow rate. In commercial applications, DOE assumes these pumps operate 24 hours per day. For integral pumps, those without a timer operate 12 hours a day, while those with a timer have operating hours determined the same way as for pool filter pumps. For pressure cleaner booster pumps and waterfall pumps, operating hours are drawn from a distribution. Table IV-26 summarizes the results of these calculations.

Table IV-26 Weighted Average Daily Operating Hours by Pump Variety

	Weighted Average Daily Operating Hours*	
Pump Variety	Residential	Commercial
Standard-Size Self-Priming Pool Filter Pump	10	24
Small-Size Self-Priming Pool Filter Pump	7.7	-
Standard-Size Non-Self-Priming Pool Filter Pump	6.2	-
Extra-Small Non-Self-Priming Pool Filter Pump	3.3	-
Waterfall Pump	2.0	12.0
Pressure Cleaner Booster Pump	2.5	2.5
Integral Cartridge Filter Pool Pump	5.0	-
Integral Sand Filter Pool Pump	4.8	-

* Only during the pool operating season.

<u>Self-Priming and Non-Self-Priming Pool Filter Pumps</u>

For self-priming and non-self-priming pool filter pumps in residential applications, the single-speed pump daily run time is the product of the assigned pool size and the number of turnovers per day divided by pump flow rate. For two-speed and variable-speed pumps, DOE calculated run time at both high speed and low speed. For high speed, DOE assumed a maximum of 2 hours a day based on the ENERGY STAR calculator.[89] For low speed, DOE calculated the runtime in the same manner as for single-speed pumps and then subtracted two hours (for assumed high-speed operation).[90] In the two-speed analysis, DOE followed the recommendation of the DPPP Working Group based on the observations that some of the timer controls for two-speed pumps are not wired correctly, or some of the consumers never operate at low-speed. (EERE-2015-BT-STD-0008-0079 pp. 199-203) DOE assumed that 5 percent of the consumers either would not purchase or would not correctly operate the timer control to switch from high-speed mode (the default mode) to low-speed mode. For these consumers, high-speed runtime was calculated in the same manner as for single-speed pumps, and low-speed runtime was assumed to be zero.

For each equipment class, DOE developed distributions for the number of turnovers per day (i.e., the number of times a pool's contents can be filtered through its filtration equipment in a 24-hour period). The number of turnovers per day is drawn from a probability distribution linked to the ambient condition of the sampled consumer (hot humid, warm or cold) and sanitary requirements, especially for the commercial pool samples. This distribution was adjusted and approved by the DPPP Working Group based on the observation that some consumers do not follow the Centers for Disease Control

[89] ENERGY STAR Pool Pump Calculator. (Last Accessed: July, 2016) www.energystar.gov/sites/default/files/asset/document/Pool%20Pump%20Calculator.xlsx.

[90] In cases where the calculation (product of pool volume times turns per day, divided by flow) results in less than 2 hours, the high speed run time is reduced to that value, and low speed run time is assumed to be zero.

and Prevention (CDC) recommendation[91] and operate fewer turnovers than recommended. (EERE-2015-BT-STD-0008-0094 pp. 175-186)

For commercial applications, DOE assumed that single-speed pumps operate 24 hours a day. (EERE-2015-BT-STD-0008-0094 p. 151) For the two-speed and variable-speed pumps, based on the ENERGY STAR calculator, the high speed was assumed to operate 2 hours per day, while the low speed was assumed to operate the remaining 22 hours per day. (EERE-2015-BT-STD-0008-0094 pp. 172-185)

Pressure Cleaner Booster Pumps and Waterfall Pumps

For pressure cleaner booster pumps and waterfall pumps, DOE drew the operating hours from operating hours distributions suggested and approved by the DPPP Working Group. (EERE-2015-BT-STD-0008-0094 pp. 159-162).

Integral Pumps

For integral pumps, the DPPP Working Group suggested that 80 percent of the consumers use these pumps without a timer. (EERE-2015-BT-STD-0008-0094 p. 157) DOE assumed that integral pumps without a timer operate 12 hours per day, based on the recommendation of the DPPP Working Group (EERE-2015-BT-STD-0008-0094 pp. 155-157). For those that have a timer, DOE calculated the operating hours the same way as for residential single-speed self-priming pool filter pumps.

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[91] CDC suggests 4 turnovers per day for public aquatic facilities. (Last accessed: September 21, 2016) http://www.cdc.gov/healthywater/pdf/swimming/pools/mahc/Complete-First-Edition-MAHC-Code.pdf

c. Annual Days of Operation

DOE calculated the annual unit energy consumption (UEC) by multiplying the daily operating hours by the annual days of operation, which depends on the number of months of pool operation. For each consumer sample, DOE assigned different annual days of operation depending on the region in which the dedicated-purpose pool pump is installed. Table IV-27 provides the assumptions of pool pump operating season based on geographical locations. This assignment was based on DOE's Energy Saver website assumptions[92] and PK Data[93] that include average pool season length (i.e., operating months) by state, along with discussion of the geographic distribution of pool operating days by the DPPP Working Group, which suggested that although some of the regions had warm weather, the pool pumps should still be operating all year long. (EERE-2015-BT-STD-0008-0094 pp. 191-193)

[92] DOE Energy Saver. (Last Accessed: April 26, 2016) http://energy.gov/energysaver/articles/heat-pump-swimming-pool-heaters.
[93] PK Data. 2015 Swimming Pool and Pool Heater Customized Report for LBNL. (Last accessed: April 16, 2016) www.pkdata.com/current-reports.html.

Table IV-27 Pool Pump Operating Season Assumption by Geographical Location

Location (States or Census Divisions)	Avg. Months of Pool Use	Pool Use Months
CT,ME,NH,RI,VT	4	5/1–8/31
MA	4	5/1–8/31
NY	4	5/1–8/31
NJ	4	5/1–8/31
PA	4	5/1–8/31
IL	4	5/1–8/31
IN,OH	4	5/1–8/31
MI	4	5/1–8/31
WI	4	6/1–9/30
IA,MN,ND,SD	4	6/1–9/30
KS,NE	4	6/1–9/30
MO	4	6/1–9/30
VA	7	4/1–10/31
DE,DC,MD	5	5/1–9/30
GA	7	4/1–10/31
NC,SC	7	4/1–10/31
FL	12	1/1–12/31
AL,KY,MS	12	1/1–12/31
TN	12	1/1–12/31
AR,LA,OK	12	1/1–12/31
TX	12	1/1–12/31
CO	4	5/1–8/31
ID,MT,UT,WY	4	5/1–8/31
AZ	12	1/1–12/31
NV,NM	12	1/1–12/31
CA	12	1/1–12/31
OR,WA	3	6/1–8/31
AK	5	5/1–9/30
HI	12	1/1–12/31
WV	5	5/1–9/30
New England	4	5/1–8/31
Middle Atlantic	5	5/1–9/30
East North Central	5	5/1–9/30
West North Central	4	6/1–9/30
South Atlantic	12	1/1–12/31
East South Central	12	1/1–12/31
West South Central	12	1/1–12/31
Mountain	4	5/1–8/31
Pacific	12	1/1–12/31

Chapter 7 of the direct final rule TSD provides details on DOE's energy use analysis for pool pumps.

F. Life-Cycle Cost and Payback Period Analyses

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for dedicated-purpose pool pumps. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

- The LCC (life-cycle cost) is the total consumer expense of equipment over the life of that equipment, consisting of total installed cost (MSP, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the equipment.

- The PBP is the estimated amount of time it takes consumers to recover the increased purchase cost (including installation) of more-efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-standards case, which reflects the estimated efficiency distribution of pool pumps in the absence of energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline equipment.

For each considered efficiency level in each equipment class, DOE calculated the LCC and PBP for a nationally representative set of consumers. As stated previously, DOE developed consumer samples from the 2009 RECS and 2012 CBECS. For each consumer in the sample, DOE determined the energy consumption for the pool pump and the appropriate energy price. By developing a representative sample of consumers, the analysis captured the variability in energy consumption and energy prices associated with the use of pool pumps.

Inputs to the calculation of total installed cost include the cost of the equipment—which includes MPCs, manufacturer markups, retailer and distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, equipment lifetimes, and discount rates. DOE created distributions of values for equipment lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC and PBP, which incorporates Crystal Ball™ (a commercially-available software program), relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and pool pump consumer samples. The model calculated the LCC and PBP for equipment at each efficiency level for 10,000 units per simulation run.

DOE calculated the LCC and PBP for all consumers of pool pumps as if each were to purchase a new product in the expected year of required compliance with new energy efficiency standards. As discussed in section III.B, the standards would apply to pool pumps manufactured 54 months years after the date on which new standards are published. At the time of the analysis for this rule, DOE estimated publication of this direct final rule in the second half of 2016. Therefore, for purposes of its analysis, DOE used 2021 as the year of compliance with any new standards for pool pumps.

Table IV-28 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the direct final rule TSD and its appendices.

Table IV-28 Summary of Inputs and Methods for the LCC and PBP Analysis*

Inputs	Source/Method
Equipment Cost	Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate. Used historical data to derive a price scaling index to project equipment costs.
Installation Costs	Baseline installation cost determined with data from manufacturer interviews.
Annual Energy Use	The daily energy consumption multiplied by the number of operating days per year. Variability: Based on regional data and 2009 RECS and 2012 CBECS.
Energy Prices	Electricity: Based on EIA's Form 861 data for 2014. Variability: Regional energy prices determined for 30 regions for pool pumps in individual single-family homes and 9 census divisions for pool pumps in community and commercial pool pumps. Marginal prices used for electricity.
Energy Price Trends	Based on AEO2016 No-CPP case price projections.
Repair and Maintenance Costs	Consider only motor replacement as repair cost, which includes labor cost from RS Means and motor cost provided with MPC.
Equipment Lifetime	For residential applications, on average 7 years for self-priming and waterfall pumps, 5 years for non-self-priming and pressure cleaner booster pumps, and 4 years for integral pumps. For commercial applications, the residential equipment lifetime is adjusted according to the ratio of commercial to residential daily operating hours. Variability: Based on Weibull distribution.
Discount Rates	Residential: approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances. Commercial: Calculated as the weighted average cost of capital for entities purchasing pool pumps. Primary data source was Damodaran Online.
Compliance Date	2021.

* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the direct final rule TSD.

1. Equipment Cost

To calculate consumer equipment costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described above (along with sales taxes). DOE used different markups for baseline products and higher efficiency products, because DOE applies an incremental markup to the increase in MSP associated with higher efficiency products.

To project an equipment price trend for the direct final rule, DOE derived an inflation-adjusted index of the Producer Price Index (PPI) for pumps and pumping equipment over the period 1984-2015.[94] These data show a general price index increase from 1987 through 2009. Since 2009, there has been no clear trend in the price index. Given the relatively slow global economic activity in 2009 through 2015, the extent to which the future trend can be predicted based on the last two decades is uncertain and the observed data do not provide a firm basis for projecting future cost trends for pump equipment. Therefore, for single-speed and two-speed pumps, DOE used a constant price assumption as the default trend to project future pump prices in 2021. For variable-speed pool pumps, however, DOE assumed that the controls portion of the electrically commutated motor would be affected by price learning. DOE used PPI data on "Semiconductors and related device manufacturing" between 1967 and 2015 to estimate the historic price trend of electronic components in the control.[95] The regression performed as an exponential trend line fit results in an R-square of 0.98, with an annual price decline rate of 6 percent.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE estimates all the installation costs associated with fitting a dedicated-purpose pool pump in a new housing unit (new owners), or as a replacement for an existing pool pump. To simplify the calculation, DOE only accounted for the difference of installation cost by efficiency levels. For two-speed pumps, DOE included the cost of a timer control and its installation where applicable, as recommended by the DPPP Working Group (EERE-2015-BT-STD-0008-0079 pp. 199-203). DOE used

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[94] Series ID PCU333911333911; www.bls.gov/ppi/

[95] Semiconductors and related device manufacturing PPI series ID: PCU334413334413; www.bls.gov/ppi/.

information obtained in the manufacturer interviews to calculate the supplemental installation labor costs for two-speed and variable-speed pumps.

See chapter 8 of the direct final rule TSD for more details on installation costs.

3. Annual Energy Consumption

For each sampled installation, DOE determined the energy consumption for a dedicated-purpose pool pump at different efficiency levels using the approach described in section IV.E of this direct final rule.

4. Energy Prices

DOE used residential electricity prices for dedicated-purpose pool pumps in residential applications, and commercial electricity prices for dedicated-purpose pool pumps in commercial applications.

DOE derived average annual residential marginal electricity prices for 30 geographic regions and commercial marginal electricity prices for 9 census divisions using 2015 data from the EIA.[96]

To estimate electricity prices in future years, DOE multiplied the average regional prices by annual energy price factors derived from the forecasts of annual average

[96] U.S. Department of Energy-Energy Information Administration, Form EIA-826 Database Monthly Electric Utility Sales and Revenue Data (2015) available at www.eia.doe.gov/cneaf/electricity/page/eia826.html

residential and commercial electricity price changes by region that are consistent with cases described on p. E-8 in AEO 2016.[97] AEO 2016has an end year of 2040. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2030 to 2040.

5. Repair and Maintenance Costs

Repair costs are associated with repairing or replacing equipment components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the equipment. Typically, small incremental increases in equipment efficiency produce no, or only minor, changes in repair and maintenance costs compared to baseline efficiency equipment. DOE assumed that for maintenance costs, there is no change with efficiency level, and therefore DOE did not include those costs in the model.

The primary repair cost for dedicated-purpose pool pumps is motor replacement, and cost of a motor does vary by efficiency level. DOE estimated that such replacement occurs at the halfway point in a pump's lifetime, but only for those dedicated-purpose pool pumps whose lifetime exceeds the average lifetime for the relevant equipment class. The cost of the motor was determined in the engineering analysis and the markups

[97] EIA. Annual Energy Outlook 2016 with Projections to 2040. Washington, DC. Available at www.eia.gov/forecasts/aeo/. The standards finalized in this rulemaking will take effect a few years prior to the 2022 commencement of the Clean Power Plan compliance requirements. As DOE has not modeled the effect of CPP during the 30 year analysis period of this rulemaking, there is some uncertainty as to the magnitude and overall effect of the energy efficiency standards. These energy efficiency standards are expected to put downward pressure on energy prices relative to the projections in the AEO 2016 case that incorporates the CPP. Consequently, DOE used the electricity price projections found in the AEO 2016 No-CPP case as these electricity price projections are expected to be lower, yielding more conservative estimates for consumer savings due to the energy efficiency standards.

analysis. DOE used 2015 RS Means, a well-known and respected construction cost estimation source, to estimate labor costs for pump motor replacement.[98] DOE accounted for the difference in labor hours depending on the dedicated-purpose pool pump horsepower, as well as regional differences in labor hourly costs.

Further detail regarding the repair costs developed for dedicated-purpose pool pumps can be found in chapter 8 of the direct final rule TSD.

6. Equipment Lifetime

DOE used dedicated-purpose pool pump lifetime estimates from manufacturer input and the DPPP Working Group's discussion (EERE-2015-BT-STD-0008-0094 pp. 209-223). The data allowed DOE to develop a survival function, which provides a distribution of lifetime ranging from a minimum of 2 or 3 years based on warranty covered period, to a maximum of 15 years, with a mean value of 7 years for self-priming and waterfall pumps, 5 years for non-self-priming and pressure cleaner booster pumps, and 4 years for integral pumps. These values are applicable to pumps in residential applications. For commercial applications, DOE scaled the lifetime to acknowledge the higher operating hours compared to residential applications, resulting in a reduced average lifetime.

[98] RS Means Company, Inc., RS Means Electrical Cost Data 2015 (2015).

7. Discount Rates

In calculating the LCC, DOE applies discount rates appropriate to consumers to estimate the present value of future operating costs. The discount rate used in the LCC analysis represents the rate from an individual consumer's perspective. DOE estimated a distribution of residential discount rates for dedicated-purpose pool pumps based on the opportunity cost of funds related to appliance energy cost savings and maintenance costs.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's Survey of Consumer Finances[99] (SCF) for 1995, 1998, 2001, 2004, 2007, 2010 and 2013. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity and income groups, weighted by the shares of each type, is 4.6 percent.

[99] Board of Governors of the Federal Reserve System. Survey of Consumer Finances. 1995, 1998, 2001, 2004, 2007, 2010, and 2013. (Last accessed December 15, 2015.) (www.federalreserve.gov/econresdata/scf/scfindex.htm).

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[100] The LCC does not analyze the equipment purchase decision, so the implicit discount rate is not relevant in this model. The LCC estimates net present value over the lifetime of the equipment, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long time horizon modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish commercial discount rates for the small fraction of applications where businesses purchase and use dedicated-purpose pool pumps, DOE estimated the weighted-average cost of capital using data from Damodaran Online.[101] The weighted-average cost of capital is commonly used to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so their cost of capital is the weighted average of the cost to the firm of equity and debt financing. DOE estimated the cost of equity using the

[100] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: transaction costs; risk premiums and response to uncertainty; time preferences; interest rates at which a consumer is able to borrow or lend.

[101] Damodaran Online, Data Page: Costs of Capital by Industry Sector (2016). (Last accessed April, 2016) http://pages.stern.nyu.edu/~adamodar/.

capital asset pricing model, which assumes that the cost of equity for a particular company is proportional to the systematic risk faced by that company.

See chapter 8 of the direct final rule TSD for further details on the development of consumer discount rates.

8. Energy Efficiency Distribution in the No-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of equipment efficiencies under the no-standards case.

The estimated efficiency market shares for dedicated-purpose pool pumps for 2015 were based on manufacturer interviews. To project efficiencies to the compliance year, 2021, DOE shifted 1 percent per year of the market share in the single-speed efficiency levels to the variable-speed efficiency levels. (See section IV.H.1 for more detail.) For the equipment classes that don't have variable-speed efficiency levels (i.e., waterfall pumps and integral pumps), efficiency was held constant at 2015 levels based on the Working Group discussion. (EERE-2015-BT-STD-0008-0078 pp. 138-141)

Table IV-29 shows the efficiency distribution for the self-priming pool filter pump equipment class as an example. See chapter 8 of the direct final rule TSD for further information on the derivation of the efficiency distributions, as well as the distributions for the remaining equipment classes.

Table IV-29 Efficiency Distribution in the No-Standards Case for Self-Priming Pool Filter Pumps in 2021

Efficiency Level	Description	National Market Share %
0 (Baseline)	Low efficiency single-speed motor Low hydro efficiency	39
1	Medium efficiency single-speed motor Low hydro efficiency	15
2	High efficiency single-speed motor Low hydro efficiency	10
3	Low efficiency two-speed motor Low hydro efficiency	2
4	Medium efficiency two-speed motor Low hydro efficiency	2
5	High efficiency two-speed motor Low hydro efficiency	2
6	Variable-speed motor Low hydro efficiency (High speed is 80% of max)	11
7	Variable-speed motor High hydro efficiency (High speed is 80% of max)	19

9. Payback Period Analysis

The payback period is the amount of time it takes the consumer to recover the additional installed cost of more-efficient equipment, compared to baseline equipment, through energy cost savings. Payback periods are expressed in years. Payback periods that exceed the life of the equipment mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the equipment and the change in the first-year annual operating expenditures relative to the baseline. The PBP calculation uses the same inputs as the LCC analysis, except that discount rates are not needed.

As noted above, EPCA, as amended, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price forecast for the year in which compliance with the new standards would be required.

G. Shipments Analysis

DOE uses projections of annual equipment shipments to calculate the national impacts of potential or new amended energy conservation standards on energy use, emissions, NPV, and future manufacturer cash flows. The shipments model takes an accounting approach, tracking market shares of each equipment class and the vintage of units in the stock. Stock accounting uses equipment shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

For the direct final rule, because there was no readily available data on dedicated-purpose pool pump shipments, DOE estimated shipments in 2015 using data collected from manufacturer interviews. Shipments were projected from 2015 throughout the end of the analysis period (2050) initially using growth rates obtained from manufacturer interviews, the Veris Consulting report, and several macroeconomic indicators. These rates were then reviewed by the DPPP Working Group, which recommended minor modifications to the growth rates[102] (EERE-2015-BT-STD-0008-0078, pp. 106-120). The modified growth rates were also applied in reverse to determine historical shipments. DOE was then able to apply retirement functions derived from dedicated-purpose pool pump lifetime estimates to each vintage in historical shipments to calculate the existing stock. Shipments were divided into two market segments: replacements and new pool construction. The market segment associated with dedicated-purpose pool pump replacements was calculated such that the stock is maintained, using historical shipments, lifetime curves, and repair-replace decision making. The market segment for new pool construction pool pump installations is thus the difference between total shipments and replacement shipments.

Because the standards-case projections take into account the increase in purchase price and the decrease in operating costs associated with higher efficiency equipment, projected shipments for a standards case typically deviate from those for the no-standards case. Because purchase price tends to have a larger impact than operating cost on equipment purchase decisions, standards-case projections typically show a decrease in shipments relative to the no-standards case. For dedicated-purpose pool pumps, DOE modeled this impact in two ways. In the replacement segment, DOE implemented a repair-replace model in which under the standards case where the pool pump is more

[102] The initial growth rates for Non-Self-Priming Pool Filter Pumps and Integral Cartridge Filter Pumps were -2.77% and -2.0%, respectively. These were adjusted due to Working Group recommendations to 3.08% (so that Non-Self-Priming Pool Filter Pumps matched the rate of Self-Priming Pool Filter Pumps) and 2.0% (so that Integral Cartridge Filter Pumps matched the rate of Integral Sand Filter Pumps).

expensive, 60 percent of the time the pump is repaired (i.e., motor replacement) rather than replaced, compared to only around 40 percent in the base case. (EERE-2015-BT-STD-0008-0100 pp. 173-175) In the new construction segment, DOE implemented a relative price elasticity. However, DOE determined that where the cost of the pool far exceeds the incremental cost of a more-efficient pump (i.e., inground pool installations or, where timers are considered, larger inflatable/rigid steel-framed installations), shipments would not be affected by an increase in purchase price of the dedicated-purpose pool pump. Therefore, a relative price elasticity, which accounts for the total installed cost of the pool including the pump, is only applied to non-self-priming pool filter pumps, smaller integral cartridge filter pool pumps, and smaller integral sand filter pool pumps, and is based on DPPP Working Group recommendations and data obtained from manufacturer interviews. The elasticity[103] implemented was 0.2. (EERE-2015-BT-STD-0008-0079 pp. 67-72, 138-139) See chapter 9 of the direct final rule TSD for more detail on the shipments model.

H. National Impact Analysis

The NIA assesses the national energy savings (NES) and the national net present value from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[104] DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual equipment shipments, along with the annual energy consumption

[103] Elasticity of -0.2 was only applied to approximately 40% of the integral cartridge filter and integral sand filter pump shipments, thus yielding an effective elasticity of -0.08 for these two categories rather than -0.2. This percentage represents the smallest and least expensive segment of this market, where an increase in pump price due to standards is significant relevant to the pool price.

[104] The NIA accounts for impacts in the 50 States and U.S. territories.

and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, equipment costs, and NPV of consumer benefits over the lifetime of pool pumps sold from 2021 through 2050.

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

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV-30 summarizes the inputs and methods DOE used for the NIA analysis for the direct final rule. Discussion of these inputs and methods follows the table. See chapter 10 of the direct final rule TSD for further details.

Table IV-30 Summary of Inputs and Methods for the National Impact Analysis

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2021.
Efficiency Trends	No-standards case: Future trend shifts 1% per year from single-speed efficiency levels to variable-speed efficiency levels. Standards cases: Roll-up in the compliance year. 1% shift also used.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each efficiency level.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each efficiency level. Incorporates projection of future equipment prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values increase with higher efficiency levels.
Energy Prices	AEO2016 no-CPP case price forecasts (to 2040) and extrapolation through 2050.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on AEO2016.
Discount Rate	Three and seven percent.
Present Year	2016.

1. Equipment Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-standards case and each of the standards cases. Chapter 8 of the direct final rule TSD describes how DOE developed an energy efficiency distribution for the no-standards case for each of the considered equipment classes for the first year of anticipated compliance with an amended or new standard. To project the trend in efficiency absent standards for pool pumps over the entire shipments projection period, DOE shifted 1 percent per year of the market share in the single-speed efficiency levels to the variable-speed efficiency levels. For the equipment classes that do not have variable-speed efficiency levels, efficiency was held constant at 2015 levels. The DPPP Working Group agreed with DOE's assumptions.(EERE-2015-BT-STD-0008-0078 pp. 138-141).

For the standards cases, DOE used a “roll-up” scenario to establish the shipment-weighted efficiency for the first year of compliance assumed for standards (2021). In this scenario, the market shares of equipment in the no-standards case that do not meet the standard under consideration would roll up” to meet the new standard level, and the market share of equipment above the standard would remain unchanged. In the standards cases, the efficiency after the compliance year increases at a rate similar to that of the no-standards case.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case (TSL) and the case with no energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each equipment (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (i.e., the energy consumed by power plants to generate site electricity) using annual conversion factors derived from AEO2016. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

In 2011, in response to the recommendations of a committee on Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards appointed by the National Academy of Sciences, DOE announced its intention to use 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). After evaluating the approaches discussed in the August 18, 2011 document, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (NEMS) is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[105] that EIA uses to prepare its Annual Energy Outlook. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the direct final rule TSD.

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are: (1) total annual installed cost; (2) total annual operating costs (energy costs and repair and maintenance costs); and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-standards case and each standards case in terms of total savings in

[105] For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (2009) (Oct. 2009) (Available at www.eia.gov/forecasts/aeo/nems/overview/pdf/0581(2009).pdf).

operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of each unit shipped during the projection period.

As previously noted in section IV.F.1, for single-speed and two-speed pumps, DOE used a constant price assumption as the default price trend to project future pump prices for single-speed and two-speed pumps. For variable-speed pool pumps, however, DOE followed a suggestion from the Working Group and assumed that the controls portion of the electrically commutated motor would be affected by price learning,[106] and used an annual price decline rate of 6 percent. To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different product price forecasts on the consumer NPV for the considered TSLs for dedicated-purpose pool pumps. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a low price trend based on an exponential fit to the integral horsepower motors and generators PPI from 1991 to 2000 for equipment classes with integral sized motors (self-priming 1 hp and self-priming 3 hp), and an exponential fit to fractional horsepower motors PPI from 1967 to 2015 for equipment classes with fractional sized motors (small-size self-priming pool filter pumps, standard-size non-self-priming pool filter pumps, extra-small non-self-priming pool filter pumps, waterfall pumps, pressure cleaner booster pumps, integral sand filter pool pumps, and integral cartridge filter pool pumps); and (2) a high price trend based on an exponential fit to the integral horsepower motors and generators PPI from 1969 to 2015 for the equipment

[106] A member of the Working Group suggested adding price learning to the controls portion of variable-speed efficiency levels, similar to what was done in the Ceiling Fans Rulemaking (EERE-2015-BT-STD-0008-0079, pp. 95-96, and also EERE-2015-BT-STD-0008-0100, pp. 159-161).

classes with integral sized motors, and an exponential fit to the fractional horsepower motors PPI from 2001 to 2015 for the equipment classes with fractional sized motors.[107] The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the direct final rule TSD.

The operating cost savings are the sum of the differences in energy cost savings, maintenance, and repair costs, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional prices by annual energy price factors derived from the forecasts of annual average residential and commercial electricity price changes by region that are consistent with cases described on p. E-8 in AEO 2016,[108] which has an end year of 2040. To estimate price trends after 2040, DOE used the average annual rate of change in prices from 2030 to 2040. As part of the NIA, DOE also analyzed scenarios that used lower and higher energy price trends. NIA results based on these cases are presented in appendix 10C of the DPPP direct final rule TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this NOPR, DOE estimated the NPV

[107] U.S. Census. Producer Price Index data. Available at www.bls.gov/ppi/

[108] The standards finalized in this rulemaking will take effect a few years prior to the 2022 commencement of the Clean Power Plan compliance requirements. As DOE has not modeled the effect of CPP during the 30 year analysis period of this rulemaking, there is some uncertainty as to the magnitude and overall effect of the energy efficiency standards. These energy efficiency standards are expected to put downward pressure on energy prices relative to the projections in the AEO 2016 case that incorporates the CPP. Consequently, DOE used the electricity price projections found in the AEO 2016 No-CPP case as these electricity price projections are expected to be lower, yielding more conservative estimates for consumer savings due to the energy efficiency standards.

of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis.[109] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "social rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this direct final rule, DOE analyzed the impacts of the considered standard levels on senior-only households.[110] The analysis used a subset of the RECS 2009 sample is comprised of households that meet the criteria for the subgroup. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered

[109] United States Office of Management and Budget. Circular A-4: Regulatory Analysis (September 17, 2003), section E. (Available at www.whitehouse.gov/omb/memoranda/m03-21.html).

[110] DOE did not evaluate low-income consumer subgroup impacts because the sample size of the subgroup is too small for meaningful analysis.

efficiency levels on the subgroup. Chapter 11 in the direct final rule TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

DOE conducted an MIA for dedicated-purpose pool pumps to estimate the financial impact of standards on manufacturers of dedicated-purpose pool pumps. The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA relies on the GRIM, an industry cash-flow model customized for the dedicated-purpose pool pumps covered in this rulemaking. The key GRIM inputs are data on the industry cost structure, MPCs, shipments, assumptions about manufacturer markups, and conversion costs. The key MIA output is INPV. DOE used the GRIM to calculate cash flows using standard accounting principles and to compare changes in INPV between the no-standards case and various TSLs (the standards cases). The difference in INPV between the no-standards case and the standards cases represents the financial impact of energy conservation standards on dedicated-purpose pool pump manufacturers. Different sets of assumptions (scenarios) produce different INPV results. The qualitative part of the MIA addresses factors such as manufacturing capacity; characteristics of, and impacts on, any particular subgroup of manufacturers, including small manufacturers; and impacts on competition.

DOE conducted the MIA for this rulemaking in three phases. In the first phase, DOE prepared an industry characterization based on the market and technology assessment and publicly available information. In the second phase, DOE estimated industry cash flows in the GRIM using industry financial parameters derived in the first phase and the shipments derived in the shipment analysis. In the third phase, DOE conducted interviews with dedicated-purpose pool pumps manufacturers that account for the large majority of domestic DPPP sales covered by this rulemaking. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics specific to each company, and obtained each manufacturer's view of the dedicated-purpose pool pump industry as a whole. The interviews provided information that DOE used to evaluate the impacts of amended standards on manufacturers' cash flows, manufacturing capacities, and direct domestic manufacturing employment levels. See section V.B.2.b of this direct final rule for the discussion on the estimated changes in the number of domestic employees involved in manufacturing dedicated-purpose pool pumps covered by energy conservation standards.

During the third phase, DOE used the results of the industry characterization analysis in the first phase and feedback from manufacturer interviews to group manufacturers that exhibit similar production and cost structure characteristics. DOE identified one manufacturer subgroup for a separate impact analysis: small businesses. DOE determined that dedicated-purpose pool pump manufacturing falls under the North American Industry Classification System (NAICS) code 333911, pump and pumping equipment manufacturing. The U.S. Small Business Administration (SBA) defines a small business as having less than 750 total employees for manufacturing under this NAICS code. This threshold includes all employees in a business' parent company and any other subsidiaries. Based on this classification, DOE identified five domestic dedicated-purpose pool pump businesses that manufacture dedicated-purpose pool pumps in the United States and qualify as small businesses per the SBA threshold. DOE analyzed the impact on the small business subgroup in the complete MIA in the Regulatory Flexibility analysis, required by the Regulatory Flexibility Act, 5 U.S.C. 601, et. seq., presented in section VII.B of this final rule.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to new standards that result in a higher or lower industry value. The GRIM uses an annual discounted cash-flow analysis that incorporates MPCs, manufacturer markups, shipments, and industry financial information as inputs. The GRIM models the changes in MPCs, the distribution of shipments, manufacturing investments, and manufacturer margins that could change as a result from new energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2016 (the reference year of the analysis) and continuing to 2050 (the terminal year of the analysis). DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. DOE used a real discount rate of 11.8 percent for all dedicated-purpose pool pump equipment classes. This discount rate is derived from industry financials and modified based on feedback received during manufacturer interviews.

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

a. Manufacturer Production Costs

Manufacturing more efficient equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered equipment can affect the revenues, gross margins, and cash flow of the industry.

In the MIA, DOE used the MPCs calculated in the engineering analysis, as described in section IV.C.5 and further detailed in chapter 5 of the direct final rule TSD. DOE made several revisions to the MPCs based on feedback and data that was received during the working group meetings. The MIA used these MPCs as inputs to the MIA for the direct final rule.

b. Shipments Forecasts

The GRIM estimates manufacturer revenues based on (1) total unit shipment forecasts and the distribution of those shipments by efficiency level, (2) MPCs, and (3) manufacturer markups. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the annual shipment forecasts derived from the shipments analysis from 2016 to 2050. See section IV.G of this direct final rule for additional details.

c. Product and Capital Conversion Costs

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

In general, DOE assumes all conversion-related investments occur between the year of publication of the direct final rule and the year by which manufacturers must comply with the new standards. DOE used inputs from manufacturer interviews and feedback from the working group meetings to evaluate the level of conversion costs manufacturers would likely incur to comply with new energy conservation standards. The majority of design options analyzed represent the implementation of more efficient motors, either single-speed, two-speed, or variable-speed. For standard-size self-priming, small-size self-priming, standard-size non-self-priming, waterfall, and pressure cleaner booster pool pumps, the max-tech efficiency level represents a hydraulic wet-end redesign. For extra-small non-self-priming pool filter pumps max-tech represents the implementation of a more efficient single-speed motor, and for integral cartridge-filter pool pumps and integral sand filter pool pumps DOE analyzed the incorporation of a timer as a design option.

Product conversion costs represent the majority of conversion costs for efficiency levels that represent a motor redesign and are estimated on a per model basis. DOE estimated product conversion costs of $140,000, $160,000, and $500,000 per model to implement a single-speed, two-speed, or variable-speed motor in a dedicated-purpose pool pump, respectively. DOE estimated the incorporation of a variable-speed motor to cost an additional $100,000 for standard-size non-self-priming pool filter pumps, because there are currently no non-self-priming pool filter pumps on the market with variable-speed motors. The additional product conversion costs represent housing redesign costs to accommodate variable-speed motors.

In addition to motor redesign costs and testing and certification costs, DOE estimated the per-model cost for new tooling and machinery that would be needed as a result of new standards. DOE approximated capital conversion costs of $100,000 per wet-end when incorporating single-speed, two-speed, or variable-speed motors in dedicated-purpose pool pumps. These estimates are based on comments from manufacturers made during working group meetings that a motor change could alter the dimensions of a dedicated-purpose pool pump and require investments in packaging machines and other equipment. The working group offered no objections to this estimate. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at p. 105)

Max-tech represents a hydraulic wet-end redesign for all equipment classes except for extra-small non-self-priming pool filter pumps, integral cartridge filter pumps, and integral sand filter pumps. DOE estimated product conversion costs for a hydraulic redesign at $500,000 per wet-end, in addition to the previously discussed $500,000 per model to incorporate a variable-speed motor. The hydraulic redesign costs represent research and development costs associated with optimizing the impeller and the volute for efficiency. For capital conversion costs, at max-tech, DOE estimated $1.5 million per wet-end for self-priming and waterfall pumps, $750,000 per wet-end for non-self-priming pool filter pumps, and $375,000 per wet-end for pressure cleaner booster pumps. These estimates vary based on the type of tooling and machinery that is used to manufacture pumps in different equipment classes.

Max-tech for extra-small non-self-priming pool filter pumps represents the incorporation of a more efficient single-speed motor. DOE used the conversion cost estimates previously described to implement a single-speed motor.

After gathering per-model and per-wet-end conversion cost estimates, DOE analyzed self-priming pool filter pump equipment offerings to estimate the number of dedicated-purpose pool pumps that would be redesigned at each efficiency level. DOE used catalogs from the three largest dedicated-purpose pool pump manufacturers that have approximately 75 percent of all self-priming pool filter pump models in the market based on DOE's product database. DOE first listed all self-priming pool filter pumps of the three manufacturers and estimated their efficiency based on descriptions found in catalogs. All analyzed manufacturer catalogs list the number of speeds (i.e., single-speed, two-speed, multi-speed, or variable-speed) and the catalogs provided an estimate of their efficiency (i.e., single-speed standard efficiency compared to single-speed energy efficient).

After DOE estimated the efficiency of each dedicated-purpose pool pump, DOE grouped pumps together for each manufacturer based on their performance characteristics, including: the pump wet-ends, port size, voltage, total horsepower, and pump performance curve (i.e., head vs. flow curve). This allowed DOE to make a mapping with pump characteristics on one axis and pump efficiency level on the other axis. DOE used this mapping to estimate the number of dedicated-purpose pool pumps that would be redesigned if a standard were set at each efficiency level. DOE assumed that:

- Pumps with the same performance characteristics, but a different efficiency, can replace each other.
- There can be no gaps in equipment offerings. At least one pump has to meet the efficiency at each performance characteristic.
- A redesigned single- or two-speed pump can only replace one other pump.
- A variable-speed pump can replace multiple single and two-speed pumps with the same wet-end, port size, voltage, and similar total horsepower.

These assumptions were discussed during the working group meetings and allowed DOE to estimate the number of self-priming pool filter pumps needed to be redesigned at each efficiency level for each manufacturer. (Docket No. EERE-2015-BT-STD-0008-0100, May 18 DPPP Working Group Meeting, at p. 23-24) To estimate the total number of industry redesigns DOE divided the number of redesigns per efficiency level by the percent of models that belongs to the three largest manufacturers.

DOE did not have reliable performance data for non-self-priming, waterfall, and pressure cleaner booster pumps. Therefore, DOE used the shipments distribution to estimate the number of pumps that do not meet each efficiency level. In the absence of data, DOE assumed manufacturers would redesign 25 percent of non-compliant non-self-priming models. DOE presented this number to the working group, which included manufacturers of such equipment. However the working group offered no suggestions on how to change the number. Therefore DOE continued using the assumption that manufacturers would redesign 25 percent of non-compliant non-self-priming models. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at p. 64) Further, DOE assumed that all non-compliant pressure cleaner booster and waterfall models would be redesigned due to the limited number of models in the market.

The design option analyzed for integral cartridge filter and integral sand filter pool pumps represents the incorporation of a timer. Based on confidential interviews with manufacturers that represent the majority of the market, DOE estimates that the R&D required to design a pump with a timer requires a full month of work for three engineers, and involves testing and certification costs. DOE estimated that the per model product conversion costs associated with adding a timer are $50,000 for integral cartridge filter pumps and $60,000 for integral sand filter pumps. DOE used specification sheets to determine the number of integral cartridge filter pumps and integral sand filter pumps that do not have a timer and multiplied this by the per model product conversion cost to calculate industry product conversion costs.

In addition, manufacturers that own tooling and machinery may incur capital conversion costs to replace molding machines and tooling. DOE estimated that the capital conversion costs associated with these activities would be $220,000 per manufacturer. DOE multiplied this by the number of manufacturers that own tooling and machinery, to calculate industry capital conversion costs. DOE presented these conversion cost estimates to the DPPP working group.

In responses, Hayward stated that the product conversion costs [for integral pumps] are probably nominally low. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at p. 130) However, Hayward is not a manufacturer of integral cartridge filter and integral sand filter pool pumps and did not provide specific recommendations to alter the estimates. In addition the numbers presented during the working group reflect input from manufacturers that represent the majority of the market. Therefore, DOE used the product conversion costs estimates presented during the working group.

Testing and Certification Costs

DOE also estimated the magnitude of the aggregate industry compliance testing costs needed to conform to new energy conservation standards. Although compliance testing costs are a subset of product conversion costs, DOE estimated these costs separately. DOE pursued this approach because no energy conservation standards currently exist for dedicated-purpose pool pumps; as such, all basic models will be required to be tested and certified to comply with new energy conservation standards regardless of the level of such a standard. As a result, the industry-wide magnitude of these compliance testing costs will be constant, regardless of the selected standard level.

DOE notes that new energy conservation standards will require every model offered for sale to be tested according to the sampling plan proposed in the test procedure final rule. This sampling plan specifies that a minimum of two units must be tested to certify a basic model as compliant. DOE estimated the industry-wide magnitude of compliance testing by multiplying the estimated number of models currently in each equipment class by the cost to test each model. DOE used product specification sheets and information from manufacturer interviews to estimate the total number of models in each equipment class. DOE estimated testing and certification costs based on input from third-party test labs and manufacturers to be $11,000 per model, which applies to all self-priming, all non-self-priming, pressure cleaner booster and waterfall pumps.

d. Markup Scenarios

As discussed in section IV.C.5, the MPCs for dedicated-purpose pool pumps are the manufacturers' production costs for those units. These costs include materials, labor, depreciation, and overhead, which are collectively referred to as the cost of goods sold. The MSP is the price received by DPPP manufacturers from the first sale, typically to a wholesaler or a retailer, regardless of the downstream distribution channel through which the dedicated-purpose pool pumps are ultimately sold. The MSP is not the same as the cost the end user pays for the dedicated-purpose pool pump, because there are typically multiple sales along the distribution chain and various markups applied to each sale. The MSP equals the MPC multiplied by the manufacturer markup. The manufacturer markup covers all the dedicated-purpose pool pump manufacturer's non-production costs (i.e., selling, general, and administrative expenses; research and development; interest) as well as profit. Total industry revenue for DPPP manufacturers equals the MSPs at each efficiency level multiplied by the number of shipments at that efficiency level.

Modifying these manufacturer markups in the standards cases yields a different set of impacts on DPPP manufacturers than in the no-standards case. For the MIA, DOE modeled three standards case markup scenarios for dedicated-purpose pool pumps to represent the uncertainty regarding the potential impacts on prices and profitability for DPPP manufacturers following the implementation of standards. The three scenarios are: (1) a preservation of gross margin markup scenario, or flat markup; (2) a preservation of operating profit markup scenario; and (3) a two-tiered markup scenario. Each scenario leads to different manufacturer markup values, which, when applied to the inputted MPCs, result in varying revenue and cash-flow impacts on DPPP manufacturers.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform "gross margin percentage" markup across all efficiency levels, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within an equipment class. DOE used manufacturer interviews, and publicly available financial information for manufacturers to estimate the preservation of gross margin markup for each equipment class. DOE estimated a manufacturer markup of 1.46 for all self-priming and waterfall pumps, 1.35 for all non-self-priming and pressure cleaner booster pumps, and 1.27 for integral cartridge filter and integral sand filter pool pumps. DOE presented these manufacturer markups to the working group and did not receive any objection. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at p. 92 - 99)

The preservation of operating profit markup scenario assumes that manufacturers are not able to yield additional operating profit from higher production costs and the investments that are required to comply with new DPPP energy conservation standards. Instead this scenario assumes that manufacturers are only able to maintain the no-standards case total operating profit in absolute dollars in the standards cases, despite higher product costs and investment.

DOE implemented the two-tiered markup scenario because multiple manufacturers stated in interviews that they offer tiers of product lines that are differentiated, in part, by efficiency level. Specifically, manufacturers stated that they earn lower markups on self-priming pool filter pumps that have variable-speed functionality, compared to self-priming pool filter pumps with single or two-speed functionality. As higher standards push more consumers to purchase variable-speed motors, manufacturers lose sales of higher margin single- and two-speed motor dedicated-purpose pool pumps. Therefore, average manufacturer markups decrease.

A comparison of industry financial impacts under the three markup scenarios is presented in section V.B.2.a of this direct final rule.

K. Emissions Analysis

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

The analysis of power sector emissions uses marginal emissions factors that were derived from data in AEO2016, as described in section IV.M. The methodology is described in chapter 13 and chapter 15 of the DPPP direct final rule TSD.

Combustion emissions of CH_4 and N_2O are estimated using emissions intensity factors published by the EPA: Greenhouse Gases HG Emissions Factors Hub.[111] The

[111] Available at www.epa.gov/climateleadership/center-corporate-climate-leadership-ghg-emission-factors-hub.

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

The emissions intensity factors are expressed in terms of physical units per megawatt-hour (MWh) or million Btu (MMBtu) of site energy savings. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

For CH_4 and N_2O, DOE calculated emissions reduction in tons and also in terms of units of CO_2- equivalent (CO_2eq). Emissions of CH_4 and N_2O are often converted to CO_2eq by multiplying each ton of gas by the gas' global warming potential (GWP) over a 100-year time horizon. Based on the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,[112] DOE used GWP values of 28 for CH_4 and 265 for N_2O.

The AEO incorporates the projected impacts of existing air quality regulations on emissions. AEO2016 generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations

[112] IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Chapter 8.

were available as of the end of February 2016. DOE's estimation of impacts accounts for the presence of the emissions control programs discussed in the following paragraphs.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). (42 U.S.C. 7651 et seq.) SO_2 emissions from 28 eastern States and D.C. were also limited under the Clean Air Interstate Rule (CAIR). 70 FR 25162 (May 12, 2005). CAIR created an allowance-based trading program that operates along with the Title IV program. In 2008, CAIR was remanded to EPA by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect.[113] 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,[114] and the court ordered EPA to continue administering CAIR. On April 29, 2014, the U.S. Supreme Court reversed the judgment of the D.C. Circuit and remanded the case for further proceedings consistent with the Supreme Court's opinion.[115] On October 23, 2014, the D.C. Circuit lifted the stay of CSAPR.[116] Pursuant to this action,

[113] See North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008), modified on rehearing, 550 F.3d 1176 (D.C. Cir. 2008).
[114] See EME Homer City Generation, LP v. EPA, 696 F.3d 7.
[115] See EPA v. EME Homer City Generation, 134 S. Ct. 1584, 1610 (U.S. 2014). The Supreme Court held in part that EPA's methodology for quantifying emissions that must be eliminated in certain States due to their impacts in other downwind States was based on a permissible, workable, and equitable interpretation of the Clean Air Act provision that provides statutory authority for CSAPR.
[116] See EME Homer City Generation, L.P. v. EPA, Order (D.C. Cir. filed October 23, 2014) (No. 11-1302).

CSAPR went into effect (and CAIR ceased to be in effect) as of January 1, 2015.[117] AEO2016 incorporates implementation of CSAPR.

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. In past years, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that negligible reductions in power sector SO_2 emissions would occur as a result of standards.

Beginning in 2016, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final 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. AEO2016 assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent

[117] On July 28, 2015, the D.C. Circuit issued its opinion regarding the remaining issues raised with respect to CSAPR that were remanded by the Supreme Court. The D.C. Circuit largely upheld CSAPR, but remanded to EPA without vacatur certain States' emission budgets for reconsideration. EME Homer City Generation, LP v. EPA, 795 F.3d 118 (D.C. Cir. 2015).

injection systems installed by 2016. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, emissions will be far below the cap established by CSAPR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU.[118] Therefore, DOE believes that energy conservation standards that decrease electricity generation will generally reduce SO_2 emissions in 2016 and beyond.

CSAPR 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 CSAPR because excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other facilities. 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 this direct final rule for these States.

[118] DOE notes that on June 29, 2015, the U.S. Supreme Court ruled that the EPA erred when the agency concluded that cost did not need to be considered in the finding that regulation of hazardous air pollutants from coal- and oil-fired electric utility steam generating units (EGUs) is appropriate and necessary under section 112 of the Clean Air Act (CAA). Michigan v. EPA, 135 S. Ct. 2699 (2015). The Supreme Court did not vacate the MATS rule, and DOE has tentatively determined that the Court's decision on the MATS rule does not change the assumptions regarding the impact of energy conservation standards on SO_2 emissions. Further, the Court's decision does not change the impact of the energy conservation standards on mercury emissions. The EPA, in response to the U.S. Supreme Court's direction, has now considered cost in evaluating whether it is appropriate and necessary to regulate coal- and oil-fired EGUs under the CAA. EPA concluded in its final supplemental finding that a consideration of cost does not alter the EPA's previous determination that regulation of hazardous air pollutants, including mercury, from coal- and oil-fired EGUs, is appropriate and necessary. 79 Fed. Reg. 24420 (April 25, 2016). The MATS rule remains in effect, but litigation is pending in the D.C. Circuit Court of Appeals over EPA's final supplemental finding MATS rule.

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 reduction using emissions factors based on AEO2016, which incorporates the MATS.

The AEO2016 Reference case (and some other cases) assumes implementation of the Clean Power Plan (CPP), which is the EPA program to regulate CO_2 emissions at existing fossil-fired electric power plants.[119] DOE used the AEO2016 No-CPP case as a basis for developing emissions factors for the electric power sector to be consistent with its use of the No-CPP case in the NIA.[120]

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2, CH_4, N_2O 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 consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the projection period for each

[119] U.S. Environmental Protection Agency, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units" (Washington, DC: October 23, 2015). https://www.federalregister.gov/articles/2015/10/23/2015-22842/carbon-pollution-emission-guidelines-for-existing-stationary-sources-electric-utility-generating.

[120] As DOE has not modeled the effect of CPP during the 30 year analysis period of this rulemaking, there is some uncertainty as to the magnitude and overall effect of the energy efficiency standards. With respect to estimated CO2 and NOx emissions reductions and their associated monetized benefits, if implemented the CPP would result in an overall decrease in CO2 emissions from electric generating units (EGUs), and would thus likely reduce some of the estimated CO2 reductions associated with this rulemaking.

TSL. This section summarizes the basis for the values used for monetizing the emissions benefits and presents the values considered in this direct final rule.

1. Social Cost of Carbon

The SC-CO_2 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) climate-change-related changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SC-CO_2 are provided in dollars per metric ton of CO_2. A domestic SC-CO_2 value is meant to reflect the value of damages in the United States resulting from a unit change in CO_2 emissions, while a global SC-CO_2 value is meant to reflect the value of damages worldwide.

Under section 1(b)(6) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), 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 SC-CO_2 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 SC-CO_2 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 SC-CO_2 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 SC-CO_2 estimates used in the rulemaking process.

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of CO_2 emissions, the analyst faces a number of challenges. A report from the National Research Council[121] 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, SC-CO_2 estimates can be useful in estimating the social benefits of reducing CO_2 emissions. Although any numerical estimate of the benefits of reducing carbon dioxide emissions is subject to

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

some uncertainty, that does not relieve DOE of its obligation to attempt to factor those benefits into its cost-benefit analysis. Moreover, the interagency working group (IWG) SC-CO_2 estimates are well supported by the existing scientific and economic literature. As a result, DOE has relied on the IWG SC-CO_2 estimates in quantifying the social benefits of reducing CO_2 emissions. DOE estimates the benefits from reduced (or costs from increased) emissions in any future year by multiplying the change in emissions in that year by the SC-CO_2 values appropriate for that year. The NPV 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 current SC-CO_2 values reflect the IWG's best assessment, based on current data, of the societal effect of CO_2 emissions. The IWG 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.

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 SC-CO_2 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 that represented the first sustained interagency effort within the U.S. government to develop an SC-CO_2 estimate for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules issued by DOE and other agencies.

b. Current Approach

After the release of the interim values, the IWG reconvened on a regular basis to generate improved SC-CO_2 estimates. Specially, the IWG considered public comments and further explored the technical literature in relevant fields. It relied on three integrated assessment models commonly used to estimate the SC-CO_2: 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 SC-CO_2 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 IWG 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.

In 2010, the IWG selected four sets of SC-CO_2 values for use in regulatory analyses. Three sets of values are based on the average SC-CO_2 from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SC-CO_2 estimate across all three models at a 3-percent discount rate, was included to represent higher-than-expected impacts from climate change further out in the tails of the SC-CO_2 distribution. The values grow in real terms over time. Additionally, the IWG determined that a range of values from 7 percent to 23 percent should be used to adjust the global SC-CO_2 to calculate domestic effects,[122] although preference is given to consideration of the global benefits of reducing CO_2 emissions. Table IV-31 presents the values in the 2010 IWG report.[123]

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[122] 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.

[123] United States Government–Interagency Working Group on Social Cost of Carbon. Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. February 2010. https://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

Table IV-31 Annual SCC Values from 2010 IWG Report (2007$ per Metric Ton CO_2)

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 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

In 2013 the IWG released an update (which was revised in July 2015) that contained SC-CO_2 values that were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.[124] DOE used these values for this direct final rule. Table IV-32 shows the four sets of SC-CO_2 estimates from the 2013 interagency update (revised July 2015) in 5-year increments from 2010 through 2050. The full set of annual SC-CO_2 estimates from 2010 through 2050 is reported in appendix 14A of the direct final rule TSD. The central value that emerges is the average SC-CO_2 across models at the 3-percent discount rate. However,

[124] United States Government–Interagency Working Group on Social Cost of Carbon. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. May 2013. Revised July 2015. https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf. In 2015, the IWG asked the National Academies of Science, Engineering and Medicine (NAS) to review the latest research on modeling the economic aspects of climate change to inform future revisions of the SC-CO2. The NAS Committee on the Social Cost of Carbon issued an interim report in January 2016 that recommended against a near-term update of the SC-CO2 estimates, but included recommendations for enhancing the presentation and discussion of uncertainty around the current estimates. A new Technical Support Document, released by the IWG in August 2016, responds to these recommendations (https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf). The NAS Committee's final report, expected in early 2017, will provide longer term recommendations for a more comprehensive update.

for purposes of capturing the uncertainties involved in regulatory impact analysis, the IWG emphasizes the importance of including all four sets of SC-CO_2 values.

Table IV-32 Annual SC-CO2 Values from 2013 IWG Update (Revised July 2015) (2007$ per Metric Ton CO_2)

Year	Discount Rate and Statistic			
	5%	3%	2.5%	3%
	Average	Average	Average	95th Percentile
2010	10	31	50	86
2015	11	36	56	105
2020	12	42	62	123
2025	14	46	68	138
2030	16	50	73	152
2035	18	55	78	168
2040	21	60	84	183
2045	23	64	89	197
2050	26	69	95	212

It is important to recognize that a number of key uncertainties remain, and that current SC-CO_2 estimates should be treated as provisional and revisable because they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Research Council report mentioned previously 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 analytical 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 SC-CO_2. 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.[125]

DOE converted the values from the 2013 interagency report (revised July 2015) to 2015$ using the implicit price deflator for gross domestic product (GDP) from the Bureau of Economic Analysis. For each of the four sets of SC-CO_2 cases, the values for emissions in 2020 are $13.5, $47.4, $69.9, and $139 per metric ton avoided (values expressed in 2015$). DOE derived values after 2050 based on the trend in 2010–2050 in each of the four cases in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC-CO_2 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 SC-CO_2 values in each case.

2. Social Cost of Methane and Nitrous Oxide

While carbon dioxide is the most prevalent greenhouse gas emitted into the atmosphere, other GHGs are also important contributors. These include methane and nitrous oxide. Global warming potential values (GWPs) are often used to convert emissions of non-CO_2 GHGs to CO_2-equivalents to facilitate comparison of policies and

[125] In November 2013, OMB announced a new opportunity for public comment on the interagency technical support document underlying the revised SCC estimates. 78 FR 70586. In July 2015 OMB published a detailed summary and formal response to the many comments that were received: this is available at https://www.whitehouse.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions. It also stated its intention to seek independent expert advice on opportunities to improve the estimates, including many of the approaches suggested by commenters.

inventories involving different GHGs. While GWPs allow for some useful comparisons across gases on a physical basis, using the social cost of carbon to value the damages associated with changes in CO_2-equivalent emissions is not optimal. This is because non-CO_2 GHGs differ not just in their potential to absorb infrared radiation over a given time frame, but also in the temporal pathway of their impact on radiative forcing, which is relevant for estimating their social cost but not reflected in the GWP. Physical impacts other than temperature change also vary across gases in ways that are not captured by GWP.

In light of these limitations and the paucity of peer-reviewed estimates of the social cost of non-CO_2 gases in the literature, the 2010 SCC Technical Support Document did not include an estimate of the social cost of non-CO_2 GHGs and did not endorse the use of GWP to approximate the value of non-CO_2 emission changes in regulatory analysis. Instead, the IWG noted that more work was needed to link non-CO_2 GHG emission changes to economic impacts.

Since that time, new estimates of the social cost of non-CO_2 GHG emissions have been developed in the scientific literature, and a recent study by Marten et al. (2015) provided the first set of published estimates for the social cost of CH_4 and N_2O emissions that are consistent with the methodology and modeling assumptions underlying the IWG SC-CO_2 estimates.[126] Specifically, Marten et al. used the same set of

[126] Marten, A.L., Kopits, E.A., Griffiths, C.W., Newbold, S.C., and A. Wolverton. 2015. Incremental CH_4 and N_2O Mitigation Benefits Consistent with the U.S. Government's SC-CO2 Estimates. Climate Policy. 15(2): 272-298 (published online, 2014).

three integrated assessment models, five socioeconomic and emissions scenarios, equilibrium climate sensitivity distribution, three constant discount rates, and the aggregation approach used by the IWG to develop the SC-CO_2 estimates. An addendum to the IWG's Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 summarizes the Marten et al. methodology and presents the SC-CH_4 and SC-N_2O estimates from that study as a way for agencies to incorporate the social benefits of reducing CH_4 and N_2O emissions into benefit-cost analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions.[127]

The methodology and estimates described in the addendum have undergone multiple stages of peer review and their use in regulatory analysis has been subject to public comment. The estimates are presented with an acknowledgement of the limitations and 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, just as the IWG has committed to do for the SC-CO_2. The OMB has determined that the use of the Marten et al. estimates in regulatory analysis is consistent with the requirements of OMB's Information Quality Guidelines Bulletin for Peer Review and OMB Circular A-4.

[127] United States Government–Interagency Working Group on Social Cost of Greenhouse Gases. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016. https://www.whitehouse.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf.

The SC-CH_4 and SC-N_2O estimates are presented in Table IV-33. Following the same approach as with the SC-CO_2, values for 2010, 2020, 2030, 2040, and 2050 are calculated by combining all outputs from all scenarios and models for a given discount rate. Values for the years in between are calculated using linear interpolation. The full set of annual SC-CH_4 and SC-N_2O estimates between 2010 and 2050 is reported in appendix 14-A of the direct final rule TSD. DOE derived values after 2050 based on the trend in 2010–2050 in each of the four cases in the IWG addendum.

Table IV-33 Annual SC-CH_4 and SC-N_2O Estimates from 2016 IWG Addendum (2007$ per Metric Ton)

	SC-CH_4				**SC-N_2O**			
	Discount Rate and Statistic				**Discount Rate and Statistic**			
	5%	**3%**	**2.5%**	**3%**	**5%**	**3%**	**2.5 %**	**3%**
Year	**Average**	**Average**	**Average**	**95th percentile**	**Average**	**Average**	**Average**	**95th percentile**
2010	370	870	1,200	2,400	3,400	12,000	18,000	31,000
2015	450	1,000	1,400	2,800	4,000	13,000	20,000	35,000
2020	540	1,200	1,600	3,200	4,700	15,000	22,000	39,000
2025	650	1,400	1,800	3,700	5,500	17,000	24,000	44,000
2030	760	1,600	2,000	4,200	6,300	19,000	27,000	49,000
2035	900	1,800	2,300	4,900	7,400	21,000	29,000	55,000
2040	1,000	2,000	2,600	5,500	8,400	23,000	32,000	60,000
2045	1,200	2,300	2,800	6,100	9,500	25,000	34,000	66,000
2050	1,300	2,500	3,100	6,700	11,000	27,000	37,000	72,000

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC-CH_4 and SC-N_2O estimates for that year in each of the 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 SC-CH_4 and SC-N_2O estimates in each case.

3. Social Cost of Other Air Pollutants

As noted previously, DOE estimated how the considered energy conservation standards would decrease power sector NO_X emissions in those 22 States not affected by CSAPR. Unlike greenhouse gas emissions, the social cost of other air pollution emissions depends upon the location of those emissions (and conversely, the social benefit of emissions reductions depends on the location of those reductions), making monetization more complicated.

DOE estimated the monetized value of NO_X emissions reductions from electricity generation using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards.[128] The report includes high and low values for NO_X (as $PM_{2.5}$) for 2020, 2025, and 2030 using discount rates of 3 percent and 7 percent; these values are presented in appendix 14B of the direct final rule TSD. DOE primarily relied on the low estimates to be conservative.[129] DOE developed values specific to the sector for dedicated-purpose pool pumps using a method described in appendix 14B of the direct final rule TSD. For this analysis DOE used linear interpolation to define values for the

[128] Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis. See Tables 4A-3, 4A-4, and 4A-5 in the report. The U.S. Supreme Court has stayed the rule implementing the Clean Power Plan until the current litigation against it concludes. Chamber of Commerce, et al. v. EPA, et al., Order in Pending Case, 577 U.S. ___ (2016). However, the benefit-per-ton estimates established in the Regulatory Impact Analysis for the Clean Power Plan are based on scientific studies that remain valid irrespective of the legal status of the Clean Power Plan.

[129] For the monetized NO_X benefits associated with PM2.5, the related benefits are primarily based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009), which is the lower of the two EPA central tendencies. Using the lower value is more conservative when making the policy decision concerning whether a particular standard level is economically justified. If the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2012), the values would be nearly two-and-a-half times larger. (See chapter 14 of the direct final rule TSD for citations for the studies mentioned above.)

years between 2020 and 2025 and between 2025 and 2030; for years beyond 2030 the value is held constant.

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

DOE is evaluating appropriate monetization of reduction in other emissions in energy conservation standards rulemakings. DOE has not included monetization of those emissions in the current analysis.

M. Utility Impact Analysis

The utility impact analysis estimates several effects on the electric power generation industry that would result from the adoption of new or amended energy conservation standards. The utility impact analysis estimates the changes in installed electrical capacity and generation that would result for each TSL. The analysis is based on published output from the NEMS associated with AEO2016. NEMS produces the AEO Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions consistent with the projections described on page E-8 of AEO 2016 and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the direct final rule TSD.

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

N. Employment Impact Analysis

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

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the

Labor Department's Bureau of Labor Statistics (BLS).[130] BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[131] There are many reasons for these differences, including wage differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (i.e., the utility sector) to more labor-intensive sectors (e.g., the retail and service sectors). Thus, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this direct final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 (ImSET).[132] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" (I–O) model, which was designed to estimate the national employment and income effects of energy-saving

[130] Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202-691-5618) or by sending a request by e-mail to dipsweb@bls.gov.
[131] See Bureau of Economic Analysis, Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II), U.S. Department of Commerce (1992).
[132] J. Livingston, OV, SR Bender, MJ Scott, and RW Schultz (2015). ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide. Pacific Northwest National Laboratory. PNNL-24563.

technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2028), where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the direct final rule TSD.

V. Analytical Results and Conclusions

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

A. Trial Standard Levels

DOE analyzed the benefits and burdens of five TSLs for dedicated-purpose pool pumps. These TSLs were developed by combining specific efficiency levels for each of the equipment classes analyzed by DOE. DOE presents the results for the TSLs in this direct final rule. The results for all efficiency levels that DOE analyzed are in the direct final rule TSD.

Table V-1 presents the TSLs and the corresponding efficiency levels that DOE identified for potential amended energy conservation standards for dedicated-purpose pool pumps. TSL 5 represents the maximum technologically feasible energy efficiency for all equipment classes. TSL 4 represents the combination of highest efficiency levels without hydraulic improvements (variable speed for relevant equipment classes). TSL 3 represents the standard levels recommended by the DPPP Working Group. (EERE-2015-BT-STD-0008, No. 82 Recommendation #1 at p. 1-2) TSL 2 represents the efficiency levels with the highest NPV based on dual speed for relevant equipment classes, and in other classes the same efficiency level as in TSL 1. TSL 1 represents the efficiency levels with the highest NPV based on single-speed technology and no hydraulic improvements.

Table V-1 Trial Standard Levels for Dedicated-Purpose Pool Pumps

Equipment Class	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
	Efficiency Level				
Standard-Size Self-Priming Pool Filter Pump	2	5	6	6	7
Small-Size Self-Priming Pool Filter Pump	2	5	2	6	7
Standard-Size Non-Self-Priming Pool Filter Pump	1	4	1	6	7
Extra-Small Non-Self-Priming Pool filter Pump	1	1	1	2	2
Waterfall Pump	1	1	0	2	3
Pressure Cleaner Booster Pump	1	1	1	3	4
Integral Cartridge Filter Pool Pump	0	0	1	0	0
Integral Sand Filter Pool Pump	0	0	1	0	0

DOE only considers an efficiency level above the baseline for integral cartridge filter and integral sand filter pumps in TSL3, the recommended TSL, because DOE is only able to adopt prescriptive standards and performance standards for the same equipment through use of a direct final rule based on consensus recommendations. (42 U.S.C. 6295(p)(4)(A) and 6316(a))

<u>B.</u> <u>Economic Justification and Energy Savings</u>

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on consumers of pool pumps by looking at the effects potential standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed below.

a. Life-Cycle Cost and Payback Period

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

Table V-2 through Table V-17 show the LCC and PBP results for the TSLs considered for each equipment class. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment. In the second of each pair of tables, the impacts are measured relative to the efficiency distribution in the no-standards case in the compliance year (see Section IV.F.8 of this document). Because some consumers purchase equipment with higher efficiency in the no-standards case, the average savings are less than the difference between the average LCC of the baseline equipment and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase equipment with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

Table V-2 Average LCC and PBP Results for Standard-Size Self-Priming Pool Filter Pump

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	481	774	4,565	5,046	n/a	6.7
1	2	576	605	3,640	4,216	0.6	6.7
2	5	823	315	2,082	2,906	0.7	6.7
3,4	6	853	223	1,644	2,497	0.7	6.8
5	7	853	181	1,402	2,255	0.6	6.8

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

Table V-3 Average LCC Savings Relative to the No-Standards Case for Standard-Size Self-Priming Pool Filter Pump

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1	2	669	1
2	5	1,779	5
3,4	6	2,140	10
5	7	2,085	8

* The savings represent the average LCC for affected consumers.

Table V-4 Average LCC and PBP Results for Small-Size Self-Priming Pool Filter Pump

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	320	282	1,743	2,063	n/a	6.8
1,3	2	386	200	1,294	1,679	0.8	6.8
2	5	588	146	1,004	1,593	2.0	6.8
4	6	720	94	826	1,546	2.1	6.8
5	7	720	77	723	1,443	1.9	6.8

PBP is measured relative to the baseline equipment.

Table V-5 Average LCC Savings Relative to the No-Standards Case for Small-Size Self-Priming Pool Filter Pump

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %

1,3	2	295	4
2	5	322	27
4	6	360	29
5	7	414	26

* The savings represent the average LCC for affected consumers.

Table V-6 Average LCC and PBP Results for Standard-Size Non-Self-Priming Pool Filter Pump

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	199	225	1,055	1,254	n/a	4.7
1,3	1	208	177	858	1,066	0.2	4.7
2	4	411	131	684	1,095	2.3	4.7
4	6	576	64	541	1,117	2.3	4.8
5	7	576	45	458	1,034	2.1	4.8

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

Table V-7 Average LCC Savings Relative to the No-Standards Case for Standard-Size Non-Self-Priming Pool Filter Pump

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1,3	1	191	0
2	4	35	58
4	6	10	51
5	7	93	47

* The savings represent the average LCC for affected consumers.

Table V-8 Average LCC and PBP Results for Extra-Small Non-Self-Priming Pool Filter Pump

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	135	57	305	440	n/a	4.7
1,2,3	1	146	45	259	405	0.9	4.7
4,5	2	158	43	255	413	1.6	4.7

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

Table V-9 Average LCC Savings Relative to the No-Standards Case for Extra-Small Non-Self-Priming Pool Filter Pump

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1,2,3	1	36	4
4,5	2	10	39

* The savings represent the average LCC for affected consumers.

Table V-10 Average LCC and PBP Results for Waterfall Pumps

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installe d Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	313	73	500	813	n/a	6.6
1,2	1	335	67	481	816	4.5	6.6
3	0	313	73	500	813	n/a	6.6
4	2	375	60	459	834	5.4	6.6
5	3	375	54	429	803	3.7	6.6

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

Table V-11 Average LCC Savings Relative to the No-Standards Case for Waterfall Pumps

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1,2	1	-3	50
3	0	n/a	n/a
4	2	-20	70
5	3	13	55

* The savings represent the average LCC for affected consumers.

Table V-12 Average LCC and PBP Results for Pressure Cleaner Booster Pumps

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installe d Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	255	173	858	1,113	n/a	4.8
1,2,3	1	276	140	726	1,001	0.6	4.8
4	3	631	110	758	1,390	6.0	4.8
5	4	631	99	711	1,343	5.1	4.8

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

Table V-13 Average LCC Savings Relative to the No-Standards Case for Pressure Cleaner Booster Pumps

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1,2,3	1	111	0
4	3	-372	69
5	4	-313	68

* The savings represent the average LCC for affected consumers.

Table V-14 Average LCC and PBP Results for Integral Cartridge Filter Pool Pump

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1,2,4, 5	0	98	65	234	332	n/a	3.8
3	1	110	26	93	203	0.4	3.8

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

Table V-15 Average LCC Savings Relative to the No-Standards Case for Integral Cartridge Filter Pool Pump

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1,2,4,5	0	n/a	n/a
3	1	128	3

* The savings represent the average LCC for affected consumers.

Table V-16 Average LCC and PBP Results for Integral Sand Filter Pool Pump

TSL	Efficiency Level	Average Costs 2015$				Simple Payback years	Average Lifetime years
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1,2,4, 5	0	154	39	133	287	n/a	3.8
3	1	166	14	48	214	0.5	3.8

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

Table V-17 Average LCC Savings Relative to the No-Standards Case for Integral Sand Filter Pool Pump

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* 2015$	Percent of Consumers that Experience Net Cost %
1,2,4,5	0	n/a	n/a
3	1	73	3

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on senior-only households. Table V-18 through Table V-25 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups, along with the average LCC savings for the entire consumer sample. In most cases, the average LCC savings and PBP for senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the direct final rule TSD presents the complete LCC and PBP results for the subgroup analysis.

Table V-18 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Standard-Size Self-Priming Pool Filter Pump

TSL	Average Life-Cycle Cost Savings 2015$		Simple Payback Period years	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1	741	651	0.6	0.6
2	1,902	1,664	0.7	0.8
3,4	2,344	2,054	0.7	0.7
5	2,282	2,004	0.6	0.7

Table V-19 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Small-Size Self-Priming Pool Filter Pump

TSL	Average Life-Cycle Cost Savings 2015$		Simple Payback Period Years	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,3	336	295	0.7	0.8
2	377	322	1.8	2.0
4	446	360	1.9	2.1
5	501	414	1.8	1.9

Table V-20 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Standard-Size Non-Self-Priming Pool Filter Pump

TSL	Average Life-Cycle Cost Savings 2015$		Simple Payback Period Years	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,3	217	191	0.2	0.2
2	62	35	1.9	2.3
4	86	10	2.0	2.3
5	182	93	1.8	2.1

Table V-21 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Extra-Small Non-Self-Priming Pool Filter Pump

TSL	Average Life-Cycle Cost Savings 2015$		Simple Payback Period Years	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,2,3	42	36	0.8	0.9
4,5	15	10	1.4	1.6

Table V-22 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Waterfall Pump

TSL	Average Life-Cycle Cost Savings 2015$		Simple Payback Period Years	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,2	0	-4	4.1	4.7
3	n/a	n/a	n/a	n/a
4	-14	-22	4.9	5.6
5	21	9	3.4	3.8

Table V-23 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Pressure Cleaner Booster Pump

TSL	Average Life-Cycle Cost Savings <u>2015$</u>		Simple Payback Period <u>Years</u>	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,2,3	134	112	0.5	0.6
4	-353	-372	5.2	6.0
5	-287	-312	4.4	5.1

Table V-24 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Integral Cartridge Filter Pool Pump

TSL	Average Life-Cycle Cost Savings <u>2015$</u>		Simple Payback Period <u>years</u>	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,2,4,5	n/a	n/a	n/a	n/a
3	161	128	0.3	0.4

Table V-25 Comparison of LCC Savings and PBP for Consumer Subgroup and All Households for Integral Sand Filter Pool Pump

TSL	Average Life-Cycle Cost Savings <u>2015$</u>		Simple Payback Period <u>years</u>	
	Senior-Only Households	All Households	Senior-Only Households	All Households
1,2,4,5	n/a	n/a	n/a	n/a
3	92	73	0.4	0.5

c. Rebuttable Presumption Payback

As discussed in section III.G.3, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and as required by EPCA, based the energy use calculation from the DOE test procedures for dedicated-purpose pool pumps. In contrast, the PBPs presented in section V.B.1.a were calculated using distributions that reflect the range of energy use in the field.

Table V-26 presents the rebuttable-presumption payback periods for the considered TSLs for dedicated-purpose pool pumps. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i) and 6316(a), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Table V-26 Rebuttable-Presumption Payback Periods

Equipment Class	TSL				
	1	2	3	4	5
	Years				
Self-Priming, Standard Size	0.5	0.8	0.8	0.8	0.8
Self-Priming, Small Size	0.9	2.1	0.9	2.4	2.1
Non-Self-Priming, Standard Size	0.2	2.4	0.2	2.8	2.5
Non-Self-Priming, Extra-Small	1.0	1.0	1.0	1.8	1.8
Waterfall	3.9	3.9	n/a	4.7	3.2
Pressure Cleaner Booster	0.6	0.6	0.6	7.8	6.5
Integral Cartridge	n/a	n/a	0.3	n/a	n/a
Integral Sand	n/a	n/a	0.5	n/a	n/a

2. Economic Impacts on Manufacturers

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

a. Industry Cash-Flow Analysis Results

In this section, DOE provides results from the GRIM, which examines changes to the industry that would result from the analyzed standards. Table V-27 through Table V-29 illustrate the estimated financial impacts (represented by changes in INPV) of analyzed energy conservation standards on manufacturers of dedicated-purpose pool pumps, as well as the conversion costs that DOE estimates DPPP manufacturers would incur at each TSL.

As discussed in section IV.J.2.d, DOE modeled three different manufacturer markup scenarios to evaluate a range of cash flow impacts on the DPPP industry: (1) the preservation of gross margin markup scenario, (2) the preservation of operating profit markup scenario, and (3) a two-tiered markup scenario. To assess the upper (less severe) bound on the range of potential impacts on DPPP manufacturers, DOE modeled a preservation of gross margin markup scenario. This scenario assumes that in the standards cases, manufacturers would be able to pass along the higher production costs required for more efficient products to their consumers. Specifically, the industry would be able to maintain its no-standards case gross margin (as a percentage of revenue) for each equipment class despite the higher production costs in the standards cases.

To assess the lower (more severe) bound on the range of potential impacts on DPPP manufacturers, DOE modeled two additional manufacturer markup scenarios; a preservation of operating profit markup scenario and a two-tiered markup scenario. In the preservation of operating profit markup scenario manufacturers are not able to yield additional operating profit from higher production costs and the investments that are required to comply with new DPPP energy conservation standards, but instead are only able to maintain the same per-unit operating profit in the standards cases that was earned in the no-standards case. This scenario represents a potential lower bound on the range of impacts on manufacturers because manufacturers are only able to maintain the operating profit, in dollars, that they would have earned in the no-standards case despite higher production costs and investments. Manufacturers must, therefore, reduce margins as a result of this manufacturer markup scenario, which reduces profitability.

DOE also modeled a two-tiered markup scenario as a potential lower (more severe) bound on the range of potential impacts on DPPP manufacturers. In this manufacturer markup scenario, manufacturers have two tiers of markups that are differentiated, in part, by efficiency level. Several manufacturers suggested that new standards would lead to a reduction in overall markups and could reduce their overall profitability. During manufacturer interviews, manufacturers stated that they have lower margins on self-priming pool filter pumps that use a variable-speed motor. DOE used this information to estimate manufacturer markups for self-priming pool filter pumps under a two-tiered pricing strategy in the no-standards case. In the standards cases, DOE modeled the situation in which standards result in more variable-speed self-priming pool filter pumps being purchased by consumers. Since these products are modeled to have a lower manufacturer markup than the single- and two-speed self-priming pool filter pumps, the overall manufacturer markup declines and results in a lower overall manufacturer markup and reduction in profitability.

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 no-standards case and each standards case resulting from the sum of discounted cash-flows from 2016 (the reference year) through 2050 (the end of the analysis period). To provide perspective on the short-run cash-flow impact, DOE includes in the discussion of results a comparison of free cash flow between the no-standards case and the standards case at each TSL in the year before new standards take effect.

Table V-27 through Table V-29 show the MIA results for each TSL using the manufacturer markup scenarios previously described.

Table V-27 Manufacturer Impact Analysis for Dedicated-Purpose Pool Pumps under the Preservation of Gross Margin Markup Scenario*

	Units	**No-Standards Case**	**Trial Standard Level**				
			1	**2**	**3**	**4**	**5**
INPV	**2015$ MM**	212.8	209.0	197.8	219.8	195.9	110.5
Change in INPV	**2015$ MM**	-	(3.7)	(15.0)	7.0	(16.9)	(102.3)
Change in INPV	**%**	-	(1.8)	(7.1)	3.3	(7.9)	(48.1)
Product Conversion Costs	**2015$ MM**	-	11.7	29.8	30.8	61.7	116.3
Capital Conversion Costs	**2015$ MM**	-	3.5	6.0	4.8	6.7	83.3
Total Investment Required	**2015$ MM**	-	15.2	35.8	35.6	68.4	199.5

***INPV results do not trend monotonically due to the efficiency level composition. The efficiency levels for each TSL are depicted in Table V-1 in section V.A.

Table V-28 Manufacturer Impact Analysis for Dedicated-Purpose Pool Pumps under the Preservation of Operating Profit Markup Scenario

	Units	No-Standards Case	Trial Standard Level				
			1	2	3	4	5
INPV	**2015$ MM**	212.8	201.0	178.8	166.5	126.2	36.8
Change in INPV	**2015$ MM**	-	(11.7)	(34.0)	(46.3)	(86.6)	(176.0)
Change in INPV	**%**	-	(5.5)	(16.0)	(21.8)	(40.7)	(82.7)
Product Conversion Costs	**2015$ MM**	-	11.7	29.8	30.8	61.7	116.3
Capital Conversion Costs	**2015$ MM**	-	3.5	6.0	4.8	6.7	83.3
Total Investment Required	**2015$ MM**	-	15.2	35.8	35.6	68.4	199.5

Table V-29 Manufacturer Impact Analysis for Dedicated-Purpose Pool Pumps under the Two-Tiered Markup Scenario

	Units	No-Standards Case	Trial Standard Level				
			1	2	3	4	5
INPV	**2015$ MM**	212.8	210.9	200.2	182.6	144.9	59.3
Change in INPV	**2015$ MM**	-	(1.9)	(12.6)	(30.2)	(67.8)	(153.5)
Change in INPV	**%**	-	(0.9)	(5.9)	(14.2)	(31.9)	(72.1)
Product Conversion Costs	**2015$ MM**	-	11.7	29.8	30.8	61.7	116.3
Capital Conversion Costs	**2015$ MM**	-	3.5	6.0	4.8	6.7	83.3
Total Investment Required	**2015$ MM**	-	15.2	35.8	35.6	68.4	199.5

At TSL 1, DOE estimates impacts on INPV range from -$11.7 million to -$1.9 million, or a change in INPV of -5.5 percent to -0.9 percent. At TSL 1, industry free cash-flow is expected to decrease by $5.3 million to $13.2 million, compared to the no-standards case value of $18.5 million in 2020, the year leading up to the standards.

DOE estimates that 46 percent of all self-priming shipments, 67 percent of extra-small non-self-priming shipments, 71 percent of standard-size non-self-priming shipments, 87 percent of pressure cleaner booster shipments, 30 percent of waterfall shipments, 100 percent of integral cartridge filter shipments, and 100 percent of integral sand filter DPPP shipments would already meet or exceed the efficiency levels required at TSL 1 in the standards year. To bring non-compliant equipment into compliance, DOE expects DPPP manufacturers to incur $11.7 million in product conversion costs for redesign and testing. In addition, DOE estimates manufacturers will incur $3.5 million in capital conversion costs at TSL 1.

At TSL 1, the shipment-weighted average MPC for all dedicated-purpose pool pumps increases by 6.1 percent relative to the no-standards case shipment-weighted average MPC for all dedicated-purpose pool pumps in 2021, the year of compliance for new DPPP energy conservation standards. In the preservation of gross margin markup scenario, manufacturers are able to fully pass on this cost increase to consumers. The increase in shipment-weighted average MPC for all dedicated-purpose pool pumps is outweighed by the $15.2 million in conversion costs, causing a slightly negative change in INPV at TSL 1 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, manufacturers earn the same operating profit as would be earned in the no-standards case, but manufacturers do not earn additional profit from their investments. The average manufacturer markup for both the preservation of operating profit and two-tiered markup scenarios is calculated by averaging the DPPP industry manufacturer markup, for all DPPP equipment classes in aggregate, from the year of compliance (2021) until the terminal year (2050). In this preservation of operating profit markup scenario, the 6.1 percent increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps results in a slight reduction in average manufacturer markup, from 1.413 in the no-standards case to 1.409

at TSL 1. The slight reduction in average manufacturer markup and $15.2 million in conversion costs causes a negative change in INPV at TSL 1 under the preservation of operating profit markup scenario.

Under the two-tiered markup scenario, where manufacturers earn lower markups for more efficient products, the average manufacturer markup increases from 1.409 in the no-standards case to 1.412 at TSL 1. The increase in the average manufacturer markup and the increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps are outweighed by the $15.2 million in conversion costs, causing a slightly negative change in INPV at TSL 1 under the two-tiered markup scenario.

At TSL 2, DOE estimates impacts on INPV range from -$34.0 million to -$12.6 million, or a change in INPV of -16.0 percent to -5.9 percent. At TSL 2, industry free cash-flow is expected to decrease by $11.9 million to $6.6 million, compared to the no-standards case value of $18.5 million in 2020, the year leading up to the standards.

DOE estimates that 32 percent of all self-priming shipments, 67 percent of extra-small non-self-priming shipments, 7 percent of standard-size non-self-priming shipments, 87 percent of pressure cleaner booster shipments, 30 percent of waterfall shipments, 100 percent of integral cartridge filter shipments, and 100 percent of integral sand filter pool pump shipments would already meet or exceed the efficiency levels required at TSL 2 in the standards year. To bring non-compliant equipment into compliance, DOE expects dedicated-purpose pool pump manufacturers to incur $29.8 million in product conversion costs for redesign and testing. In addition, DOE estimates manufacturers will incur $6.0

million in capital conversion costs associated with TSL 2, to make investments in tooling and machinery required to incorporate the design options analyzed at TSL 2.

At TSL 2, the shipment-weighted average MPC for all dedicated-purpose pool pumps decreases by 3.4 percent relative to the no-standards case shipment-weighted average MPC for all dedicated-purpose pool pumps in 2021. At TSL 2, consumers will repair existing self-priming and non-self-priming pool pumps instead of replacing the entire pump, which reduces shipments in the standards year by 0.5 million compared to the no-standards case shipments. In the preservation of gross margin markup scenario, the decrease in the shipment-weighted average MPC for all dedicated-purpose pool pumps, the reduction in shipments, and the $35.8 million in conversion costs, causes a negative change in INPV at TSL 2 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, the 3.4 percent decrease in the shipment-weighted average MPC for all dedicated-purpose pool pumps results in a reduction in average manufacturer markup, from 1.413 in the no-standards case to 1.399 at TSL 2. The reduction in average manufacturer markup, the reduction in shipments, and the $35.8 million in conversion costs causes a negative change in INPV at TSL 2 under the preservation of operating profit markup scenario.

Under the two-tiered markup scenario, where manufacturers earn lower markups for more efficient products, the average manufacturer markup slightly increases from 1.409 in the no-standards case to 1.412 at TSL 2. The increase in the average manufacturer markup is outweighed by the reduction in shipments, and the $35.8 million in conversion costs, causing a negative change in INPV at TSL 2 under the two-tiered markup scenario.

At TSL 3, DOE estimates impacts on INPV range from -$46.3 million to $7.0 million, or a change in INPV of -21.8 percent to 3.3 percent. At TSL 3, industry free cash flow is expected to decrease by $11.9 million to $6.6 million, compared to the no-standards case value of $18.5 million in 2020, the year leading up to the standards.

DOE estimates that 46 percent of small-size self-priming shipments, 30 percent of standard-size self-priming shipments, 67 percent of extra-small non-self-priming shipments, 71 percent of standard-size non-self-priming shipments, 87 percent of pressure cleaner booster shipments, 100 percent of waterfall shipments, 20 percent of integral cartridge filter shipments, and 20 percent of integral sand filter pool pump shipments would already meet or exceed the efficiency levels required at TSL 3 in the standards year. To bring non-compliant equipment into compliance, DOE expects DPPP manufacturers to incur $30.8 million in product conversion costs for redesign and testing. In addition, DOE estimates manufacturers will incur $4.8 million in capital conversion costs to make changes to machinery and tooling.

At TSL 3, the shipment-weighted average MPC for all dedicated-purpose pool pumps increases by 10.5 percent relative to the no-standards case shipment-weighted average MPC for all dedicated-purpose pool pumps in 2021. At TSL 3 consumers repair existing self-priming pool filter pumps instead of replacing the entire pump, which reduces shipments in the standards year by 0.3 million compared to the no-standards case shipments. In the preservation of gross margin markup scenario, the increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps outweighs the reduction in shipments in the standards year, and the $35.6 million in conversion costs, which causes a slightly positive change in INPV at TSL 3 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, the 10.5 percent increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps results in a reduction in average manufacturer markup, from 1.413 in the no-standards case to 1.380 at TSL 3. The reduction in average manufacturer markup, the reduction in shipments, and $35.6 million in conversion costs causes a negative change in INPV at TSL 3 under the preservation of operating profit markup scenario.

Under the two-tiered markup scenario, where manufacturers earn lower markups for more efficient products, the average manufacturer markup decreases from 1.409 in the no-standards case to 1.389 at TSL 3. The decrease in the average manufacturer markup, the reduction in shipments, and the $35.6 million in conversion costs cause a negative change in INPV at TSL 3 under the two-tiered markup scenario.

At TSL 4, DOE estimates impacts on INPV range from -$86.6 million to -$16.9 million, or a change in INPV of -40.7 percent to -7.9 percent. At TSL 4, industry free cash-flow is expected to decrease by $23.1 million to -$4.6 million, compared to the no-standards case value of $18.5 million in 2020, the year leading up to the standards.

DOE estimates that 30 percent of all self-priming shipments, 33 percent of extra-small non-self-priming shipments, 6 percent of standard-size non-self-priming shipments, 6 percent of pressure cleaner booster shipments, 10 percent of waterfall shipments, 100 percent of integral cartridge filter shipments and 100 percent of integral sand filter pool pump shipments would already meet or exceed the efficiency levels required at TSL 4 in the standards year. To bring non-compliant equipment into compliance, DOE expects DPPP manufacturers to incur $61.7 million in product conversion costs for redesign and testing. In addition, DOE estimates manufacturers will incur $6.7 million in capital conversion costs associated with TSL 4 to make changes to machinery and tooling.

At TSL 4, the shipment-weighted average MPC for all dedicated-purpose pool pumps increases by 39.4 percent relative to the no-standards case shipment-weighted average MPC for all dedicated-purpose pool pumps in 2021. At TSL 4, consumers repair existing self-priming, non-self-priming, and pressure cleaner booster pumps instead of replacing the entire pump, which reduces total shipments in the standards year by 0.6 million units compared to the no-standards case shipments. In the preservation of gross margin markup scenario, the increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps is outweighed by the reduction in shipments and the $68.4 million in conversion costs, which causes a negative change in INPV at TSL 4 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, the 39.4 percent increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps results in a reduction in average manufacturer markup, from 1.413 in the no-standards case to 1.367 at TSL 4. The reduction in average manufacturer markup, the reduction in shipments, and $68.4 million in conversion costs causes a significantly negative change in INPV at TSL 4 under the preservation of operating profit markup scenario.

Under the two-tiered markup scenario, where manufacturers earn lower markups for more efficient products, the average manufacturer markup decreases from 1.409 in the no-standards case to 1.376 at TSL 4. The decrease in the average manufacturer markup, the reduction in shipments, and the $68.4 million in conversion costs cause a significantly negative change in INPV at TSL 4 under the two-tiered markup scenario.

At TSL 5, DOE estimates impacts on INPV range from -$176.0 million to -$102.3 million, or a change in INPV of -82.7 percent to -48.1 percent. At TSL 5, industry free cash flow is expected to decrease by $79.3 million to -$60.9 million, compared to the no-standards case value of $18.5 million in 2020, the year leading up to the standards.

DOE estimates that 19 percent of all self-priming shipments, 33 percent of extra-small non-self-priming shipments, 3 percent of standard-size non-self-priming shipments, 3 percent of pressure cleaner booster shipments, 0 percent of waterfall shipments, 100 percent of integral cartridge filter shipments and 100 percent of integral sand filter pool pump shipments would already meet the efficiency levels required at TSL 5 in the standards year. To bring non-compliant equipment into compliance, DOE expects dedicated-purpose pool pump manufacturers to incur $116.3 million in product conversion costs for redesign and testing. In addition, DOE estimates manufacturers will incur $83.3 million in capital conversion costs associated with TSL 5 to make changes to machinery and tooling.

At TSL 5, the shipment-weighted average MPC for all dedicated-purpose pool pumps increases by 39.4 percent relative to the no-standards case shipment-weighted average MPC for all dedicated-purpose pool pumps in 2021. At TSL 5, consumers repair existing self-priming, non-self-priming, and pressure cleaner booster pumps instead of replacing the entire pump, which reduces total shipments in the standards year by 0.6 million units compared to the no-standards case shipments. In the preservation of gross margin markup scenario, the increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps is outweighed by the reduction in shipments and the $199.5 million in conversion costs, which causes a significantly negative change in INPV at TSL 5 under the preservation of gross margin markup scenario.

Under the preservation of operating profit markup scenario, the 39.4 percent increase in the shipment-weighted average MPC for all dedicated-purpose pool pumps results in a reduction in average manufacturer markup, from 1.413 in the no-standards case to 1.363 at TSL 5. The reduction in average manufacturer markup, the reduction in shipments, and $199.5 million in conversion costs causes a significantly negative change in INPV at TSL 5 under the preservation of operating profit markup scenario.

Under the two-tiered markup scenario, where manufacturers earn lower markups for more efficient products, the average manufacturer markup decreases from 1.409 in the no-standards case to 1.375 at TSL 5. The decrease in the average manufacturer markup, the reduction in shipments, and the $199.5 million in conversion costs cause a negative change in INPV at TSL 5 under the two-tiered markup scenario.

b. Impacts on Direct Employment

To quantitatively assess the impacts of new energy conservation standards on direct employment, DOE used the GRIM to estimate the domestic labor expenditures and number of employees in the no-standards case and at each TSL from 2016 through 2050. DOE used statistical data from the U.S. Census Bureau’s 2014 Annual Survey of Manufacturers (ASM) and the results of the engineering analysis to calculate industry-wide labor expenditures and domestic employment levels. Labor expenditures related to equipment manufacturing depend on the labor intensity of the equipment, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the 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 multiplied by the labor rate found in the ASM). The estimates of production workers in this section cover workers, including line supervisors, who are directly involved in fabricating and assembling equipment within the original equipment manufacturer 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 production worker estimates only account for workers who manufacture the specific equipment covered by this rulemaking.

DOE calculated the total direct employment associated with the covered equipment by multiplying the number of production workers by the ratio of "number of employees" to "production workers average per year" calculated using the employment data in the 2014 ASM. Using the GRIM, DOE estimates there would be 101 domestic production workers for original equipment manufacturers in 2021 in the absence of new energy conservation standards. Using ASM data, DOE estimated 175 full-time employees work directly on the covered equipment. Table V-30 shows the range of the impacts of energy conservation standards on U.S. production on dedicated-purpose pool pumps. Additional detail on the analysis of direct employment can be found in chapter 12 of the direct final rule TSD.

Table V-30 Total Number of Domestic Dedicated-Purpose Pool Pump Workers in 2021

	No-Standards Case	Trial Standard Level				
		1	2	3	4	5
Domestic Production Workers in 2021 (without changes in production locations)	101	101	80	94	78	78
Total Number of Domestic Employees in 2021	175	175	139	163	135	135
Potential Changes in Domestic Production Workers in 2021	-	(10) - 0	(25) – (21)	(51) – (7)	(51) – (23)	(51) – (23)

The employment impacts shown in Table V-30 represent the potential employment changes that could result following the compliance date for dedicated-purpose pool pumps. The upper end of the results in the table (less severe) estimates the decline in employment due to the decrease in the number of DPPPs sold in 2021, as more customers repair their dedicated-purpose pool pumps instead of replacing them as they would in the no-standards case. This case assumes that manufacturers would continue to produce the same scope of covered equipment within the United States. The lower end of the range (more severe) represents the maximum potential decrease to employment due to production moving to lower labor-cost countries, in addition to the decrease in the number of DPPPs sold in 2021.

DOE estimated the lower end of the range based on manufacturer interviews. Manufacturers could move production abroad depending on the requirements of a standard for self-priming pool filter pumps. Based on the complexity of the motor technology used in dedicated-purpose pool pumps, either single-speed, two-speed, or variable-speed, DOE estimated that the number of domestic production workers could be reduced by 10 percent if standards were set at TSL 1 (represented by a single-speed motor for self-priming pool filter pumps), 25 percent if standards were set at TSL 2 (represented by a two-speed motor for self-priming pool filter pumps), and 50 percent if standards were set at TSL 3, TSL 4, or TSL 5 (represented by a variable-speed motor for self-priming pool filter pumps).

The direct employment impacts shown are independent of the employment impacts from the broader U.S. economy, which are documented in the employment impact analysis found in chapter 16 of the direct final rule TSD.

c. Impacts on Manufacturing Capacity

DOE did not identify any significant capacity constraints for the design options being evaluated for this rulemaking. 46 percent of small-size self-priming, 30 percent of standard-size self-priming, 67 percent of extra-small non-self-priming, 71 percent of standard-size non-self-priming, 87 percent of pressure cleaner booster, 100 percent of waterfall, 20 percent of integral cartridge filter, and 20 percent of integral sand filter pool pump shipments already meet or exceed the adopted standard levels. In addition, the design options being evaluated are widely available as products that are on the market today.

DOE believes there is a sufficient supply of variable-speed motors to be used in all standard-size self-priming pool filter pumps in 2021. Variable speed motors are used a wide variety of equipment, and dedicated-purpose pool pumps only represent a small fraction all the equipment that use variable speed motors. As such existing production lines can cope with the change in equipment offerings, and DOE does not expect the industry to experience capacity constraints due to the increase in demand of variable speed motors or for any other reason directly resulting from new energy conservation standards.

d. Impacts on Subgroups of Manufacturers

As discussed in section IV.J.1, using average cost assumptions to develop an industry cash-flow estimate may not be adequate for assessing differential impacts among manufacturer subgroups. Small manufacturers, niche manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. Consequently, DOE identified small business manufacturers as a subgroup for a separate impact analysis.

For the small business subgroup analysis, DOE applied the small business size standards published by the SBA to determine whether a company is considered a small business. The size standards are codified at 13 CFR part 121. To be categorized as a small business under NAICS code 333911, “Pump and Pumping Equipment Manufacturing,” a DPPP manufacturer and its affiliates may employ a maximum of 750 employees. The 750-employee threshold includes all employees in a business’ parent company and any other subsidiaries. Based on this classification, DOE identified five manufacturers that qualify as domestic small businesses. The small business subgroup analysis is discussed in section VII.B of this document and in chapter 12 of the direct final rule TSD.

e. Cumulative Regulatory Burden

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

Some DPPP manufacturers also make other products or equipment that could be subject to energy conservation standards set by DOE. DOE looks at these regulations that could affect DPPP manufacturers that will take effect approximately 3 years before or after the estimated 2021 compliance date or during the compliance period of the new energy conservation standards for DPPPs.

The compliance dates and expected industry conversion costs of relevant energy conservation standards are indicated in Table V-31. Also, included in the table are Federal regulations that have compliance dates beyond the three years before or after the DPPP compliance date.

Table V-31 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Dedicated-Purpose Pool Pump Manufacturers

Federal Energy Conservation Standard	Number of Manufacturers*	Number of Manufacturers from Today's Rule**	Approx. Standards Year	Industry Conversion Costs Millions $	Industry Conversion Costs / Revenue***
Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment 81 FR 2420	13	1	2018	520.8 (2014$)	4.9%

(January 15, 2016)					
Commercial Packaged Boilers 81 FR 15836 (March 24, 2016)†	45	1	2019	27.5 (2014$)	2.3%
Commercial Water Heaters 81 FR 34440 (May 31, 2016)†	25	1	2019	29.8 (2014$)	3.0%
Commercial Warm Air Furnaces 81 FR 2420 (January 15, 2016)	13	1	2019	7.5 to 22.2 (2014$)	1.7% to 5.2%
Furnace Fans 79 FR 3813 (July 3, 2014)	38	1	2019	40.6 (2013$)	1.6%
Commercial Compressors 81 FR 40197 (June 21, 2016)†	40	1	2019	99.0 – 125.1 (2014$)	3.1% to 3.9%
Commercial and Industrial Pumps 80 FR 17826 (January 26, 2016)	86	5	2020	81.2 (2014$)	5.6%
Residential Boilers 81 FR 2320 (January 15, 2016)	36	2	2021	2.5 (2014$)	<1%
Residential Furnace 80 FR 13120 (March 12, 2015)†	14	1	2021	55.0 (2013$)	<1%
Direct Heating Equipment and Residential Water Heaters 75 FR 20112 (April 16, 2010)††	39	1	2015	17.5 (2009$)	4.9%
Residential Central Air Conditioners and Heat Pumps 76 FR 37408 (June 27, 2011)††	39	4	2015	44.0 (2009$)	0.1%
External Power Supplies 79 FR 7846 (February 10, 2014) ††	243	1	2016	43.4 (2012$)	2.3%
Walk-in Cooler and Walk-in Freezer Components 79 FR 32049 (June 3, 2014) ††	63	1	2017	33.6 (2012$)	2.7%

* This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.
** This column presents the number of manufacturers producing dedicated-purpose pool pumps that are also

listed as manufacturers in the energy conservation standard contributing to cumulative regulatory burden.
*** This column presents conversion costs as a percentage of cumulative revenue for the industry during the conversion period. The conversion period is the timeframe over which manufacturers must make conversion cost investments and lasts from the announcement year of the final rule to the standards year of the final rule. This period typically ranges from 3 to 5 years, depending on the energy conservation standard.
† The final rule for this energy conservation standard has not been published. The compliance date and analysis of conversion costs have not been finalized at this time. If a value is provided for total industry conversion expense, this value represents an estimate from the NOPR or SNOPR.
†† Consistent with Chapter 12 of the TSD, DOE has assessed whether this rule will have significant impacts on manufacturers that are also subject to significant impacts from other EPCA rules with compliance dates within three years of this rule's compliance date. However, DOE recognizes that a manufacturer incurs costs during some period before a compliance date as it prepares to comply, such as by revising product designs and manufacturing processes, testing products, and preparing certifications. As such, to illustrate a broader set of rules that may also create additional burden on manufacturers, DOE has included another rule with compliance dates that fall within six years of the compliance date of this rule by expanding the timeframe of potential cumulative regulatory burden. Note that the inclusion of any given rule in this Table does not indicate that DOE considers the rule to contribute significantly to cumulative impact. DOE has chosen to broaden its list of rules in order to provide additional information about its rulemaking activities. DOE will continue to evaluate its approach to assessing cumulative regulatory burden for use in future rulemakings to ensure that it is effectively capturing the overlapping impacts of its regulations. DOE plans to seek public comment on the approaches it has used here (i.e., both the 3 and 6 year timeframes from the compliance date) in order to better understand at what point in the compliance cycle manufacturers most experience the effects of cumulative and overlapping burden from the regulation of multiple products.

In addition to the Federal energy conservation standards listed in Table V-31, there are appliance standards in progress that do not yet have a proposed rule or final rule. The compliance date, manufacturer lists, and analysis of conversion costs are not available at this time. These appliance standards include pool heaters 80 FR 15922 (March 17, 2015), circulator pumps 80 FR 51483, (August 25, 2015), central air conditioners, and commercial and industrial fans and blowers.

During the working group negotiations manufacturers did not indicate that cumulative regulatory burden was a concern. In the DPPP Working Group meeting on April 19, 2016, DOE presented initial cumulative regulatory burden findings and provided interested parties the opportunity to comment. Interested parties did not identify any additional federal regulations. (Docket No. EERE-2015-BT-STD-0008-0079, April

19 DPPP Working Group Meeting, at p. 136) DOE identified one manufacturer that was affected by more federal regulations than other DPPP manufacturers.

DOE discusses these and other requirements and includes the full details of the cumulative regulatory burden analysis in chapter 12 of the direct final rule TSD. DOE will continue to evaluate its approach to assessing cumulative regulatory burden for use in future rulemakings to ensure that it is effectively capturing the overlapping impacts of its regulations. DOE plans to seek public comment on the approaches it has used here (i.e., both the 3 and 6 year timeframes from the compliance date) in order to better understand at what point in the compliance cycle manufacturers most experience the effects of cumulative and overlapping burden from the regulation of multiple product classes.

3. National Impact Analysis

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

a. Significance of Energy Savings

To estimate the energy savings attributable to potential standards for dedicated-purpose pool pumps, DOE compared their energy consumption under the no-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of equipment purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2021-2050). Table V-32Table presents DOE's projections of the national energy savings for each TSL considered for pool pumps. The savings were calculated using the approach described in section IV.H.2 of this document.

Table V-32 Cumulative National Energy Savings for Pool Pumps; 30 Years of Shipments (2021-2050)

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
	Quads				
Primary energy	0.75	2.9	3.6	3.9	4.4
FFC energy	0.79	3.0	3.8	4.1	4.6

OMB Circular A-4[133] 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.[134] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors

[133] U.S. Office of Management and Budget. Circular A-4: Regulatory Analysis. September 17, 2003. www.whitehouse.gov/omb/circulars_a004_a-4/.

[134] Section 325(m) of EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain equipment, 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. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6 year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some equipment, the compliance period is 5 years rather than 3 years.

specific to dedicated-purpose pool pumps. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V-33. The impacts are counted over the lifetime of pool pumps purchased in 2021-2029.

Table V-33 Cumulative National Energy Savings for Pool Pumps; 9 Years of Shipments (2021-2029)

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
	Quads				
Primary energy	0.24	0.76	0.95	1.0	1.1
FFC energy	0.25	0.80	1.0	1.0	1.2

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for pool pumps. In accordance with OMB's guidelines on regulatory analysis,[135] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V-34 shows the consumer NPV results with impacts counted over the lifetime of equipment purchased in 2021-2050.

[135] U.S. Office of Management and Budget. Circular A-4: Regulatory Analysis. September 17, 2003. www.whitehouse.gov/omb/circulars_a004_a-4/.

Table V-34 Cumulative Net Present Value of Consumer Benefits for Pool Pumps; 30 Years of Shipments (2021-2050)

Discount Rate	Trial Standard Level billion 2015$				
	1	**2**	**3**	**4**	**5**
3 percent	5.1	17	24	21	25
7 percent	2.5	8.1	11	10	12

The NPV results based on the aforementioned 9-year analytical period are presented in Table V-35. The impacts are counted over the lifetime of equipment purchased in 2021-2029. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE’s analytical methodology or decision criteria.

Table V-35 Cumulative Net Present Value of Consumer Benefits for Pool Pumps; 9 Years of Shipments (2021-2029)

Discount Rate	Trial Standard Level billion 2015$				
	1	**2**	**3**	**4**	**5**
3 percent	2.1	6.4	8.5	7.7	8.8
7 percent	1.3	4.2	5.6	5.0	5.7

The above results reflect the use of a default price trend to estimate the change in price for dedicated-purpose pool pumps over the analysis period (see section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a low price trend and one scenario with a high price trend. The results of these alternative cases are presented in appendix 10C of the direct final rule TSD. In the high price case, the NPV of consumer benefits is lower than in the default case. In the low price case, the NPV of consumer benefits is higher than in the default case.

c. Indirect Impacts on Employment

DOE expects that energy conservation standards for dedicated-purpose pool pumps would reduce energy expenditures for consumers of those equipment, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2021–2026), where these uncertainties are reduced.

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

4. Impact on Utility or Performance of Equipment

As discussed in section IV.B.2 of this direct final rule, DOE has concluded that the standards adopted in this direct final rule would not lessen the utility or performance of the pool pumps under consideration in this rulemaking. Manufacturers of these equipment currently offer units that meet or exceed the adopted standards.

5. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a proposed standard. (42 U.S.C. 6313(a)(6)(B)(ii)(V)) Specifically, it instructs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard. DOE is simultaneously publishing a NOPR containing proposed energy conservation standards identical to those set forth in this direct final rule and has transmitted a copy of the rule and the accompanying TSD to the Attorney General, requesting that the DOJ provide its determination on this issue. DOE will consider DOJ's comments on the direct final rule in determining whether to proceed with finalizing its standards. DOE will also publish and respond to the DOJ's comments in the Federal Register in a separate document.

6. Need of the Nation to Conserve Energy

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

Energy conservation resulting from potential energy conservation standards for dedicated-purpose pool pumps is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V-36 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.K. DOE reports annual emissions reductions for each TSL in chapter 13 of the direct final rule TSD.

Table V-36 Cumulative Emissions Reduction for Pool Pumps Shipped in 2021-2050

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
Power Sector Emissions					
CO_2 million metric tons	40	152	192	205	233
SO_2 thousand tons	30	115	145	155	176
NO_X thousand tons	22	82	103	110	125
Hg tons	0.10	0.39	0.50	0.53	0.60
CH_4 thousand tons	4.2	16	20	22	25
N_2O thousand tons	0.61	2.3	2.9	3.1	3.5
Upstream Emissions					
CO_2 million metric tons	2.2	8.3	11	11	13
SO_2 thousand tons	0.26	0.99	1.2	1.3	1.5
NO_X thousand tons	32	122	154	165	188
Hg tons	0.00	0.00	0.00	0.00	0.00
CH_4 thousand tons	196	749	948	1,013	1,155
N_2O thousand tons	0.01	0.06	0.07	0.07	0.08
Total FFC Emissions					
CO_2 million metric tons	42	160	202	216	246
SO_2 thousand tons	31	116	147	156	178
NO_X thousand tons	53	203	257	275	313
Hg tons	0.10	0.39	0.50	0.53	0.60
CH_4 thousand tons	200	765	968	1,035	1,179
N_2O thousand tons	0.62	2.3	3.0	3.2	3.6

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for dedicated-purpose pool pumps. As discussed in section IV.L of this document, DOE used the most recent values for the SC-CO_2 developed by the interagency working group. The four sets of SC-CO_2 values correspond to the average values from distributions that use a 5-percent discount rate, a 3-percent discount rate, and a 2.5-percent discount rate, and the 95th-percentile values from a distribution that uses a 3-percent discount rate. The actual SC-CO_2 values used for emissions in each year are presented in appendix 14A of the direct final rule TSD.

Table V-37 presents the global value of the CO_2 emissions reduction at each TSL. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values; these results are presented in chapter 14 of the direct final rule TSD. Table V-38 presents the annualized values for CO_2 emissions reduction at each TSL.

Table V-37 Estimates of Present Value of CO_2 Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	SCC Case			
	5% Discount Rate, Average	**3% Discount Rate, Average**	**2.5% Discount Rate, Average**	**3% Discount Rate, 95th Percentile**
	billion 2015$			
Total FFC Emissions				
1	327	1,442	2,269	4,388
2	1,207	5,385	8,496	16,402
3	1,524	6,804	10,734	20,724
4	1,624	7,256	11,450	22,104
5	1,841	8,242	13,011	25,113

Table V-38 Annualized Value of CO_2 Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	SCC Case			
	5% Discount Rate, Average	3% Discount Rate, Average	2.5% Discount Rate, Average	3% Discount Rate, 95th Percentile
	million 2015$			
Total FFC Emissions				
1	26	83	120	252
2	95	309	448	942
3	121	391	566	1,190
4	128	417	604	1,269
5	146	473	686	1,442

As discussed in section IV.L.2, DOE estimated monetary benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for dedicated-purpose pool pumps. DOE used the recent values for the SC-CH_4 and SC-N_2O developed by the interagency working group. Table V-39 presents the value of the CH_4 emissions reduction at each TSL, and Table V-40 presents the value of the N_2O emissions reduction at each TSL. The annualized values for CH_4 and N_2O emissions reductions at each TSL are presented in Table V-40 and Table V-42, respectively.

Table V-39 Present Value of Methane Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	SC-CH_4 Case			
	5% Discount Rate, Average	3% Discount Rate, Average	2.5% Discount Rate, Average	3% Discount Rate, 95th Percentile
	billion 2015$			
1	69	206	289	549
2	256	782	1,100	2,082
3	324	989	1,392	2,632
4	346	1,057	1,487	2,812
5	393	1,203	1,694	3,202

Table V-40 Annualized Value of Methane Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	SC-CH_4 Case			
	5% Discount Rate, Average	3% Discount Rate, Average	2.5% Discount Rate, Average	3% Discount Rate, 95th Percentile
	million 2015$			
1	5.4	12	15	32
2	20	45	58	120
3	26	57	73	151
4	27	61	78	161
5	31	69	89	184

Table V-41 Present Value of Nitrous Oxide Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	SC-N_2O Case			
	5% Discount Rate, Average	3% Discount Rate, Average	2.5% Discount Rate, Average	3% Discount Rate, 95th Percentile
	billion 2015$			
1	1.8	7.2	11	19
2	6.5	27	42	72
3	8.3	34	54	91
4	8.8	36	57	97
5	10	41	65	110

Table V-42 Annualized Value of Nitrous Oxide Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	SC-N_2O Case			
	5% Discount Rate, Average	3% Discount Rate, Average	2.5% Discount Rate, Average	3% Discount Rate, 95th Percentile
	million 2015$			
1	0.14	0.41	0.60	1.1
2	0.52	1.6	2.2	4.1
3	0.65	2.0	2.8	5.2
4	0.70	2.1	3.0	5.6
5	0.79	2.4	3.4	6.3

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 on reduced GHG emissions in this rulemaking 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 and other rulemakings, as well as other methodological assumptions and issues. Consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this rule the most recent values resulting from the interagency review process. DOE notes, however, that the adopted standards would be economically justified, as defined under EPCA, even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from the considered TSLs for dedicated-purpose pool pumps. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V-43 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates. This table presents results that use the low benefit-per-ton values, which reflect DOE's primary estimate. Results that reflect the range of NO_X benefit-per-ton values are presented in Table V-45.

Table V-43 Estimates of Present Value of NO_X Emissions Reduction for Pool Pumps Shipped in 2021-2050

TSL	3% Discount Rate	7% Discount Rate
	billion 2015$	
1	103	47
2	378	167
3	477	210
4	508	222
5	575	250

Note: Results are based on the low benefit-per-ton values.

7. Other Factors

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

8. Summary of National Economic Impacts

Table V-44 presents the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced GHG and NO_X emissions to the NPV of consumer savings calculated for each TSL considered in this rulemaking

Table V-44 Consumer NPV Combined with Present Value of Benefits from Emissions Reductions

TSL	Consumer NPV and Low NO_X Values at 3% Discount Rate Added with:			
	GHG 5% Discount Rate, Average Case	GHG 3% Discount Rate, Average Case	GHG 2.5% Discount Rate, Average Case	GHG 3% Discount Rate, 95th Percentile Case
	billion 2015$			
1	5.6	6.8	7.7	10
2	19	23	27	36
3	26	32	36	48
4	24	30	35	47
5	28	35	41	54
TSL	**Consumer NPV and Low NO_X Values at 7% Discount Rate Added with:**			
	GHG 5% Discount Rate, Average Case	**GHG 3% Discount Rate, Average Case**	**GHG 2.5% Discount Rate, Average Case**	**GHG 3% Discount Rate, 95th Percentile Case**
	billion 2015$			
1	2.9	4.2	5.1	7.5
2	9.7	14	18	27
3	13	19	24	35
4	12	19	23	35
5	14	22	27	41

Note: The GHG benefits include the estimated benefits for reductions in CO_2, CH_4, and N_2O emissions using the four sets of SC-CO_2, SC-CH_4, and SC-N_2O values developed by the interagency working group. See section IV.L.

The national operating cost savings are domestic U.S. monetary savings that occur as a result of purchasing the covered equipment, and are measured for the lifetime of equipment shipped in 2021-2050. The benefits associated with reduced GHG emissions achieved as a result of the adopted standards are also calculated based on the lifetime of dedicated-purpose pool pumps shipped in 2021-2050. However, the CO_2 reduction is a benefit that accrues globally because CO_2 emissions have a very long residence time in the atmosphere, the SC-CO_2 values for future emissions reflect climate-related impacts that continue through 2300.

C. Conclusion

When considering new energy conservation standards, the standards that DOE adopts for any type (or class) of covered equipment must be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 6316(a)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i) and 6316(a)) The new standard must also result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B) and 6316(a))

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

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

1. Benefits and Burdens of TSLs Considered for Dedicated-Purpose Pool Pumps

Table V-45 and Table V-46 summarize the quantitative impacts estimated for each TSL for pool pumps. The national impacts are measured over the lifetime of dedicated-purpose pool pumps purchased in the 30-year period that begins in the anticipated year of compliance with new standards (2021-2050). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The efficiency levels contained in each TSL are described in section V.A of this direct final rule.

Table V-45 Summary of Analytical Results for Pool Pumps TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings quads					
	0.79	3.0	3.8	4.1	4.6
NPV of Consumer Costs and Benefits billion 2015$					
3% discount rate	5.1	17	24	21	25
7% discount rate	2.5	8.1	11	10	12
Cumulative FFC Emissions Reduction					
CO_2 million metric tons	42	160	202	216	246
SO_2 thousand tons	31	116	147	156	178
NO_X thousand tons	53	203	257	275	313
Hg tons	0.10	0.39	0.50	0.53	0.60
CH_4 thousand tons	200	765	968	1,035	1,179
N_2O thousand tons	0.62	2.3	3.0	3.2	3.6
Value of Emissions Reduction					
CO_2 billion 2015$*	0.327 to 4.388	1.207 to 16.402	1.524 to 20.724	1.624 to 22.104	1.841 to 25.113
CH_4 billion 2015$	0.069 to 0.549	0.256 to 2.082	0.324 to 2.632	0.346 to 2.812	0.393 to 3.202
N_2O billion 2015$	0.002 to 0.019	0.007 to 0.072	0.008 to 0.091	0.009 to 0.097	0.010 to 0.110
NO_X – 3% discount rate billion 2015$	0.103 to 0.231	0.378 to 0.851	0.477 to 1.075	0.508 to 1.144	0.575 to 1.297
NO_X – 7% discount rate billion 2015$	0.047 to 0.106	0.167 to 0.377	0.210 to 0.475	0.222 to 0.503	0.25 to 0.566

Parentheses indicate negative (-) values.

* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

Table V-46 Summary of Analytical Results for Pool Pumps TSLs: Manufacturer and Consumer Impacts

Category	TSL 1*	TSL 2*	TSL 3*	TSL 4*	TSL 5*
Manufacturer Impacts					
Industry NPV million 2015$ (No-standards case INPV = $212.8)	201.0 – 210.9	178.8 – 200.2	166.5 – 219.8	126.2 – 195.9	36.8 – 110.5
Industry NPV % change	(5.5) – (0.9)	(16.0) – (5.9)	(21.8) – 3.3	(40.7) – (7.9)	(82.7) – (48.1)
Consumer Average LCC Savings 2015$					
Standard-Size Self-Priming Pool Filter Pump	669	1,779	2,140	2,140	2,085
Small-Size Self-Priming Pool Filter Pump	295	322	295	360	414
Standard-Size Non-Self-Priming Pool Filter Pump	191	35	191	10	93
Extra-Small Non-Self-Priming Pool Filter Pump	36	36	36	10	10
Waterfall Pump	(3)	(3)	n/a	(20)	13
Pressure Cleaner Booster Pump	111	111	111	(372)	(313)
Integral Cartridge Filter Pump	n/a	n/a	128	n/a	n/a
Integral Sand Filter Pump	n/a	n/a	73	n/a	n/a
Consumer Simple PBP years					
Standard-Size Self-Priming Pool Filter Pump	0.6	0.7	0.7	0.7	0.6
Small-Size Self-Priming Pool Filter Pump	0.8	2.0	0.8	2.1	1.9
Standard-Size Non-Self-Priming Pool Filter Pump	0.2	2.3	0.2	2.3	2.1
Extra-Small Non-Self-Priming Pool Filter Pump	0.9	0.9	0.9	1.6	1.6
Waterfall Pumps	4.5	4.5	n/a	5.4	3.7
Pressure Cleaner Booster Pumps	0.6	0.6	0.6	6.0	5.1
Integral Cartridge Filter Pump	n/a	n/a	0.4	n/a	n/a
Integral Sand Filter Pump	n/a	n/a	0.5	n/a	n/a
Percent of Consumers that Experience a Net Cost %					
Standard-Size Self-Priming Pool Filter Pump	1	5	10	10	8
Small-Size Self-Priming Pool Filter Pump	4	27	4	29	26
Standard-Size Non-Self-Priming Pool Filter Pump	0	58	0	51	47
Extra-Small Non-Self-Priming Pool Filter Pump	4	4	4	39	39
Waterfall Pumps	50	50	n/a	70	55
Pressure Cleaner Booster Pumps	0	0	0	69	68

Category	TSL 1*	TSL 2*	TSL 3*	TSL 4*	TSL 5*
Integral Cartridge Filter Pump	n/a	n/a	3	n/a	n/a
Integral Sand Filter Pump	n/a	n/a	3	n/a	n/a

* Parentheses indicate negative (-) values.

DOE first considered TSL 5, which represents the max-tech efficiency levels. TSL 5 would save an estimated 4.6 quads of energy, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit would be $12 billion using a discount rate of 7 percent, and $25 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 246 Mt of CO_2; 178 thousand tons of SO_2; 313 thousand tons of NO_X; 0.60 tons of Hg; 1,179 thousand tons of CH_4; and 3.6 thousand tons of N_2O. The estimated monetary value of the GHG emissions reduction at TSL 5 ranges from $1.8billion to $25 billion for CO_2, from $393 million to 3,202 million for CH_4, and from $10 million to $110 million for N_2O. The estimated monetary value of the NO_X emissions reduction at TSL 5 is $250 million using a 7-percent discount rate and $575 million using a 3-percent discount rate.

At TSL 5, the average LCC impact is a savings that ranges from $10 for extra-small non-self-priming pumps, to $2,085 for standard-size self-priming pump, except for pressure cleaner booster pumps, which have a savings of negative $313. The simple payback period ranges from 0.6 years for standard-size self-priming pumps to 5.1 years for pressure cleaner booster pumps. The fraction of consumers experiencing a net LCC cost ranges from eight percent for standard-size self-priming pumps to 68 percent for pressure cleaner booster pumps.

At TSL 5, the projected change in INPV ranges from a decrease of $176.0 million to a decrease of $102.3 million, which correspond to decreases of 82.7 percent and 48.1 percent, respectively. DOE estimates that industry must invest $199.5 million to comply with standards set at TSL 5. Manufacturers would need to redesign a significant portion of the equipment they offer, including hydraulic redesigns to convert the vast majority of their standard-size self-priming pool filter pumps.

The Secretary concludes that at TSL 5 for dedicated-purpose pool pumps, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on some consumers, and the significant impacts on manufacturers, including the large conversion costs and profit margin impacts that could result in a large reduction in INPV. Consequently, the Secretary has concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, which represents efficiency levels based on variable speed technology for most equipment classes. TSL 4 would save an estimated 4.1 quads of energy, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $10 billion using a discount rate of 7 percent, and $21 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 216 Mt of CO_2, 156 thousand tons of SO_2, 275 thousand tons of NO_X, 0.53 tons of Hg, 1,035 thousand tons of CH_4, and 3.2 thousand tons of N_2O. The estimated monetary value of the GHG emissions reduction at TSL 4 ranges from $1.6 billion to $22 billion for CO_2, from $346 million to $2,812 million for CH_4, and from $8.8 million to $97 million for N_2O. The estimated monetary value of the NO_X emissions reduction at TSL 4 is $222 million using a 7-percent discount rate and $508 million using a 3-percent discount rate.

At TSL 4, the average LCC impact is a savings that ranges from $10 for extra-small non-self-priming pumps, to $2,140 for standard-size self-priming pumps, except for pressure cleaner booster pumps, which have a savings of negative $372, and waterfall pumps, which have a savings of negative $20. The simple payback period ranges from 0.7 years for standard-size self-priming pumps to 6.0 years for pressure cleaner booster pumps. The fraction of consumers experiencing a net LCC cost ranges from 10 percent for standard-size self-priming pumps to 70 percent for waterfall pumps.

At TSL 4, the projected change in INPV ranges from a decrease of $86.6 million to a decrease of $16.9 million, which correspond to decreases of 40.7 percent and 7.9 percent, respectively. DOE estimates that industry must invest $68.4 million to comply with standards set at TSL 4.

The Secretary concludes that at TSL 4 for dedicated-purpose pool pumps, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions, would be outweighed by the economic burden on some consumers, and the significant impacts on manufacturers, including the large conversion costs and profit margin impacts that could result in a large reduction in INPV. Consequently, the Secretary has concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, the recommended TSL, which would save an estimated 3.8 quads of energy, an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $11 billion using a discount rate of 7 percent, and $24 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 202 Mt of $CO_{2;}$ 147 thousand tons of SO_2; 257 thousand tons of NO_X, 0.50 tons of Hg, 968 thousand tons of CH_4; and 3.0 thousand tons of N_2O. The estimated monetary value of the GHG emissions reduction at TSL 3 ranges from $1.5 billion to $21 billion for $CO_{2,}$ from $324 million to $2,632 million for $CH_{4,}$ and from $8.3 million to $91 million for N_2O. The estimated monetary value of the NO_X emissions reduction at TSL 3 is $210 million using a 7-percent discount rate and $477 million using a 3-percent discount rate.

At TSL 3, the average LCC impact is a savings that ranges from $36 for extra-small non-self-priming pool filter pumps to $2,140 for standard-size self-priming pumps. The simple payback period ranges from 0.2 years for standard-size non-self-priming pool filter pumps to 0.8 years for extra-small non-self-priming pool filter pumps. The fraction of consumers experiencing a net LCC cost ranges from zero percent for standard-size non-self-priming pumps and pressure cleaner booster pumps to 10 percent for standard-size self-priming pumps.

At TSL 3, the projected change in INPV ranges from a decrease of $46.3 million to an increase of $7.0 million, which represents a decrease of 21.8 percent to an increase of 3.3 percent, respectively. DOE estimates that industry must invest $35.6 million to comply with standards set at TSL 3.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that, at TSL 3 for dedicated-purpose pool pumps, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, the estimated monetary value of the emissions reductions, and positive average LCC savings, would outweigh the potential negative impacts on manufacturers. Accordingly, the Secretary has concluded that TSL 3 would offer the maximum improvement in efficiency that is technologically feasible and economically justified, as defined under EPCA, and would result in the significant conservation of energy.

Therefore, based on the above considerations, as well as those discussed in section III.A, DOE adopts the energy conservation standards for pool pumps at TSL 3. The new performance-based energy conservation standards for pool pumps, which are expressed as kgal/kWh, are shown in Table V-47. The new prescriptive energy conservation standards for pool pumps are shown in Table V-48.

Table V-47 Adopted Performance-Based Energy Conservation Standards for Dedicated-Purpose Pool Pumps

Equipment Class			Minimum Allowable WEF Score [kgal/kwh]
Dedicated-Purpose Pool Pump Variety	hhp Applicability *	Motor Phase	

Self-priming pool filter pumps	0.711 hp ≤ hhp < 2.5 hp	Single	- 2.30 * ln (hhp) + 6.59
Self-priming pool filter pumps	hhp < 0.711 hp	Single	5.55, for hhp ≤ 0.13 hp -1.30 * ln (hhp) + 2.90, for hhp > 0.13 hp
Non-self-priming pool filter pumps**	hhp < 2.5 hp	Any	4.60, for hhp ≤ 0.13 hp -0.85 * ln (hhp) + 2.87, for hhp > 0.13 hp
Pressure cleaner booster pumps	Any	Any	0.42

*All instances of hhp refer to rated hydraulic horsepower as determined in accordance with the DOE test procedure at 10 CFR 431.464 and applicable sampling plans.
**Because DOE selected the same efficiency level for both extra-small and standard-size non-self-priming pool filter pumps, the two equipment classes were ultimately merged into one.

Table V-48 Adopted Prescriptive Energy Conservation Standards for Dedicated-Purpose Pool Pumps

Equipment Class			Prescriptive Standard
Dedicated-Purpose Pool Pump Variety	**hhp Applicability**	**Motor Phase**	
Integral sand filter pool pump	Any	Any	Must be distributed in commerce with a pool pump timer that is either integral to the pump or a separate component that is shipped with the pump.
Integral cartridge filter pool pump	Any	Any	Must be distributed in commerce with a pool pump timer that is either integral to the pump or a separate component that is shipped with the pump.

2. Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2015$) of the benefits from operating equipment that meet the adopted standards (consisting primarily of operating cost savings from using less energy), minus increases in product purchase costs, and (2) the annualized monetary value of the benefits of GHG and NO_X emission reductions.

Table V-49 shows the annualized values for dedicated-purpose pool pumps under TSL 3, expressed in 2015$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for benefits and costs other than GHG reduction (for which DOE used average social costs with a 3-percent discount rate),[136] the estimated cost of the standards in this rule is $138 million per year in increased equipment costs, while the estimated annual benefits are $1.3 billion in reduced equipment operating costs, $449 million in GHG reductions, and $22 million in reduced NO_X emissions. In this case, the net benefit amounts to $1.7 billion per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the adopted standards for dedicated-purpose pool pumps is $149 million per year in increased equipment costs, while the estimated annual benefits are $1.5 billion in reduced operating costs, $449 million in CO_2 reductions, and $27 million in reduced NO_X emissions. In this case, the net benefit amounts to $1.8 billion per year.

[136] DOE used average social costs with a 3-percent discount rate these values are considered as the "central" estimates by the interagency group.

Table V-49 Annualized Benefits and Costs of Adopted Standards (TSL 3) for Dedicated-Purpose Pool Pumps

	Discount Rate %	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
		million 2015$/year		
Benefits				
Consumer Operating Cost Savings	7	1,340	1,221	1,467
	3	1,516	1,367	1,678
GHG Reduction (using avg. social costs at 5% discount rate)**	5	147	129	164
GHG Reduction (using avg. social costs at 3% discount rate)**	3	449	392	504
GHG Reduction (using avg. social costs at 2.5% discount rate)**	2.5	642	560	721
GHG Reduction (using 95th percentile social costs at 3% discount rate)**	3	1,346	1,175	1,510
NO_X Reduction†	7%	22	20	55
	3%	27	24	70
Total Benefits‡	7% plus GHG range	1,509 to 2,708	1,369 to 2,416	1,686 to 3,032
	7%	1,811	1,633	2,026
	3% plus GHG range	1,690 to 2,890	1,520 to 2,566	1,912 to 3,258
	3%	1,993	1,783	2,252
Costs*				
Consumer Incremental Equipment Costs	7%	138	124	151
	3%	149	133	164
Manufacturer Conversion Costs††	7%	3	3	3
	3%	2	2	2
Net Benefits				
Total‡	7% plus GHG range	1,371 to 2,570	1,245 to 2,292	1,535 to 2,881
	7%	1,673	1,509	1,875
	3% plus GHG range	1,542 to 2,741	1,387 to 2,433	1,748 to 3,094
	3%	1,844	1,651	2,088

*This table presents the annualized costs and benefits associated with pool pumps shipped in 2021–2050. These results include benefits to consumers which accrue after 2050 from the pool pumps purchased from 2021–2050. The incremental equipment costs include incremental equipment cost as well as installation costs. The costs account for the incremental variable and fixed costs incurred by manufacturers due to the adopted standards, some of which may be

incurred in preparation for the rule. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices and real GDP from the AEO2016 No-CPP case, a Low Economic Growth case, and a High Economic Growth case, respectively. In addition, incremental product costs reflect the default price trend in the Primary Estimate, a high price trend in the Low Benefits Estimate, and a low price trend in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.F.1. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.
** The interagency group selected four sets of SC-CO_2 SC-CH_4, and SC-N_2O values for use in regulatory analyses. Three sets of values are based on the average social costs from the integrated assessment models, at discount rates of 5 percent, 3 percent, and 2.5 percent. The fourth set, which represents the 95th percentile of the social cost distributions calculated using a 3-percent discount rate, is included to represent higher-than-expected impacts from climate change further out in the tails of the social cost distributions. The social cost values are emission year specific. The GHG reduction benefits are global benefits due to actions that occur nationally. See section IV.L for more details.
† DOE estimated the monetized value of NO_X emissions reductions associated with electricity savings using benefit per ton estimates from the Regulatory Impact Analysis for the Clean Power Plan Final Rule, published in August 2015 by EPA's Office of Air Quality Planning and Standards. (Available at www.epa.gov/cleanpowerplan/clean-power-plan-final-rule-regulatory-impact-analysis.) See section IV.L.3 for further discussion. For the Primary Estimate and Low Net Benefits Estimate, DOE used national benefit-per-ton estimates for NO_X emitted from the Electric Generating Unit sector based on an estimate of premature mortality derived from the ACS study (Krewski et al. 2009). For the High Net Benefits Estimate, the benefit-per-ton estimates were based on the Six Cities study (Lepuele et al. 2011); these are nearly two-and-a-half times larger than those from the ACS study.
‡ Total Benefits for both the 3-percent and 7-percent cases are presented using the average social costs with 3-percent discount rate. In the rows labeled "7% plus GHG range" and "3% plus GHG 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 social cost values.
†† Manufacturers are estimated to incur $35.6 million in conversion costs between 2017 and 2020.

VI. Other Prescriptive Requirements

As part of the DPPP Working Group's extended charter, the DPPP Working Group considered requirements for pumps distributed in commerce with freeze protections controls. (Docket No. EERE-2013-BT-NOC-0005, No. 71 at pp. 20–52) Freeze protection controls, as defined in the test procedure final rule, are controls that, at certain ambient temperature, turn on the dedicated-purpose pool pump to circulate water for a period of time to prevent the pool and water in plumbing from freezing. As the control schemes for freeze protection vary widely between manufacturers, the resultant energy consumption associated with such control can also vary depending on control settings and climate. To ensure freeze protection controls on dedicated-purpose pool pumps only operate when necessary and do not result in unnecessary energy use, the DPPP Working Group discussed two different approaches for regulating freeze protection controls: (1) regulation by incorporating freeze protection into the WEF metric, and (2) regulation with a prescriptive standard. Several DPPP Working Group members commented that regulation by prescriptive standard would be the simplest approach, since it would not involve revision of the WEF metric that the DPPP Working Group previously recommended. The DPPP Working Group reached consensus that freeze protection should be regulated by prescriptive standard. (Docket No. EERE-2015-BT-STD-0008-0079, April 19 DPPP Working Group Meeting, at pp. 148)

The CA IOUs suggested that the prescriptive standard prescribe the default settings for trigger temperature, run time, and operation speed that would be pre-programmed into freeze-protection-enabled dedicated-purpose pool pumps at the time of shipment. The CA IOUs commented that models with default settings of 42 degrees Fahrenheit, 12 hours of run time, and high-speed operation result in unnecessary energy use. The CA IOUs proposed that freeze-protection-enabled pumps either ship with freeze protection disabled or ship with default settings with maximums of 39 degrees Fahrenheit, 30 minutes of run time, and a half-speed operation. Hayward and Pentair commented that the suggested default settings were too restrictive and may cause end users to experience frozen piping. Pentair proposed default freeze protection settings with a trigger temperature of 40 degrees Fahrenheit and a run time of one hour. The DPPP Working Group agreed to these amended settings. (Docket No. EERE-2015-BT-STD-0008-0101, May 19 DPPP Working Group Meeting, at pp. 93-104)

Ultimately, the DPPP Working Group recommended establishing prescriptive requirements for dedicated-purpose pool pumps that are distributed in commerce with freeze protection controls. Specifically, the DPPP Working Group made the following recommendation, which it purports to maintain end-user utility while also reducing energy consumption:

All dedicated-purpose pool pumps distributed in commerce with freeze protection controls must be shipped either with freeze protection disabled, or with the following default, user-adjustable settings: (1) The default dry-bulb air temperature setting is no greater than 40 °F; and (2) the default run time setting shall be no greater than 1 hour (before the temperature is rechecked); and (3) the default motor speed shall not be more than half of the maximum available speed. Id. (Docket No. EERE-2015-BT-STD-0008, No. 82, Recommendation #6A at p. 4). DOE agrees with the DPPP Working Group's reasoning, and given the considerations discussed in section III.A, DOE adopts the recommended prescriptive standard for dedicated-purpose pool pumps distributed in commerce with freeze protection controls.

VII. 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 (Oct. 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 the adopted standards for dedicated-purpose pool pumps are intended to address are as follows:

1) Insufficient information and the high costs of gathering and analyzing relevant information leads some consumers to miss opportunities to make cost-effective investments in energy efficiency.

In some cases the benefits of more efficient equipment are not realized due to misaligned incentives between purchasers and users. An example of such a case is when the equipment purchase decision is made by a building contractor or building owner who does not pay the energy costs.

There are external benefits resulting from improved energy efficiency of products and equipment that are not captured by the users of such equipment. These benefits include externalities related to public health, environmental protection and national energy security that are not reflected in energy prices, such as reduced emissions of air pollutants and greenhouse gases that impact human health and global warming. DOE attempts to qualify some of the external benefits through use of social cost of carbon values.

The Administrator of the Office of Information and Regulatory Affairs (OIRA) in the OMB has determined that the regulatory action in this direct final rule is a significant regulatory action under section (3)(f) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(B) of the Order, DOE has provided to OIRA: (i) The text of the draft regulatory action, together with a reasonably detailed description of the need for the regulatory action and an explanation of how the regulatory action will meet that need; and (ii) an assessment of the potential costs and benefits of the regulatory action, including an explanation of the manner in which the regulatory action is consistent with a statutory mandate. DOE has included these documents in the rulemaking record.

In addition, the Administrator of OIRA has determined that the regulatory action is an "economically" significant regulatory action under section (3)(f)(1) of Executive Order 12866. Accordingly, pursuant to section 6(a)(3)(C) of the Order, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments can be found in the direct final rule TSD.

DOE also has reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011. 76 FR 3281, Jan. 21, 2011. EO 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in EO 12866. To the extent permitted by law, agencies are required by EO 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 EO 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, OIRA has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. In response to this guidance, DOE will conduct a retrospective review of the seven EPCA statutory factors that DOE evaluated to determine that the energy conservation standards in this direct final rule were economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(I)(VII)) and 6316(a)). For example, DOE's review will seek to verify the projected manufacturer impacts following compliance with the rule by comparing the estimated product conversion costs and industry net present value to the actual costs. Other parts of the review will cover the estimated impacts on consumers by assessing the accuracy of the assumed pool pump operating hours in order to update, as necessary, the estimated consumer energy savings, lifecycle savings, and payback period estimates associated with this direct final rule. DOE's review will investigate any potential utility or consumer welfare impacts that may not have been quantified in the engineering cost analysis. DOE's research will cover publicly available information, but will also consist of a survey of manufacturers and pool owners to assess the agency's assumptions. DOE will conduct this retrospective review of this direct final rulemaking prior to issuing any future revised energy efficiency standards for this product category.

For the reasons stated in the preamble, this direct final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs.

B. Review Under the Regulatory Flexibility Act

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

1. Description of Reasons Why Action is Being Considered

Currently, no Federal energy conservation standards exist for dedicated-purpose pool pumps. DOE excluded this category of pumps from its recent consensus-based energy conservation standard final rule for general pumps. 81 FR 4368 (January 26, 2016). That final rule, which was the product of a pumps working group that had been created through the ASRAC, examined a variety of pump categories. While dedicated-purpose pool pumps were one of the pump categories that were considered during the working group's discussions, the working group ultimately recommended that DOE initiate a separate rulemaking for dedicated-purpose pool pumps. (Docket No. EERE-2013-BT-NOC-0039, No. 0092 at p. 2)

2. Objectives of, and Legal Basis for, the Rule

Title III, Part C[137] of the Energy Policy and Conservation Act of 1975 (EPCA), (42 U.S.C. 6311–6317, as codified) established the Energy Conservation Program for Certain Industrial Equipment, a program covering certain industrial equipment.[138] "Pumps" are listed as a type of covered industrial equipment. (42 U.S.C. 6311(1)(A))

While pumps are listed as a type of covered equipment, EPCA does not define the term "pump." To address this, in January 2016, DOE published a test procedure final rule (January 2016 general pumps test procedure final rule) that established a definition for the term "pump." 81 FR 4086, 4147 (January 25, 2016). Dedicated-purpose pool pumps meet the definition of "pump" and are therefore a category of pump.

3. Description and Estimate of the Number of Small Entities Affected

a. Methodology for Estimating the Number of Small Entities

For manufacturers of dedicated-purpose pool pumps, 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

[137] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.
[138] All references to EPCA refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Public Law 114-11 (April 30, 2015).

requirements of this rule. The size standards are codified at 13 CFR part 121. The standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at: www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.

DPPP manufacturing is classified under NAICS 333911, pump and pumping equipment manufacturing. The SBA sets a threshold of 750 employees or fewer for an entity to be considered a small business for this category.

DOE reviewed the potential standard levels considered in this direct final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. During its market survey, DOE used publicly available information, such as databases from the CEC, APSP, and ENERY STAR; individual company websites; and market research tools (e.g., Hoover's reports) to create a list of companies that manufacture dedicated-purpose pool pumps covered by this direct final rule. During manufacturer interviews, DOE also asked stakeholders and industry representatives if they were aware of any additional small manufacturers. DOE then reviewed the list of companies manufacturing equipment covered by this direct final rule, used publicly available data sources (e.g., Hoovers,[139] Cortera,[140] LinkedIn,[141] etc.), and direct contact with various companies to determine if they met the SBA's definition of a small business manufacturer. DOE screened out companies that do not offer equipment

[139] www.hoovers.com
[140] www.cortera.com
[141] www.linkedin.com

affected by this direct final rule, do not meet the definition of a “small business,” are foreign owned and operated, or do not manufacture dedicated-purpose pool pumps in the United States.

DOE identified 21 manufacturers of dedicated-purpose pool pumps products affected by this rulemaking. Of these, DOE identified five as domestic small businesses.

b. Manufacturer Participation

DOE contacted the five identified small businesses and invited them to take part in a manufacturer impact analysis interview. Of the small businesses contacted, DOE was able to discuss potential standards with one. DOE also obtained information about small businesses and potential impacts on small businesses while interviewing large manufacturers.

c. Dedicated-Purpose Pool Pump Industry Structure and Nature of Competition

Self-priming pool filter pumps account for approximately 65 percent of manufacturer revenues in the dedicated-purpose pool pump industry. Three manufacturers have approximately 75 percent of all self-priming pool filter pump models in the market, which accounts for approximately 90 percent of shipments. None of these three major manufacturers are small businesses. Besides the three major manufacturers, DOE identified twelve other manufacturers that make self-priming pool filter pumps, including all five small businesses.

The same three manufacturers that control the majority of the self-priming pool filter pump market also control the majority of the standard-size non-self-priming pool filter pump, pressure cleaner booster pump, and waterfall pump market. Manufacturer revenues for these equipment classes are substantially smaller than revenues for the self-priming pool filter pump equipment classes. One small business only makes standard-size self-priming pool filter pumps; three small businesses make small-size self-priming, standard-size self-priming pool filter pumps, and standard-size non-self-priming pool filter pumps; and one small business makes small-size self-priming, standard-size self-priming, standard-size non-self-priming, and pressure cleaner booster pumps.

The large majority of integral cartridge filter pool pumps, integral sand filter pool pumps, and extra-small non-self-priming pool filter pumps market is controlled by manufacturers that focus on seasonal pools, such inflatable or collapsible frame pools. These manufacturers typically design dedicated-purpose pool pumps and have them manufactured overseas. DOE did not identify any small businesses that manufacture integral cartridge-filter pool pumps and integral sand filter pool pumps, since this equipment is imported from China.

4. Description of Compliance Requirements

As previously stated, DOE identified five small DPPP manufacturers. The small manufacturers make small-size self-priming, standard-size self-priming, standard-size non-self-priming, and pressure cleaner booster pumps. Accordingly, this analysis of small business impacts focuses exclusively on these equipment classes.

To evaluate impacts facing manufacturers of dedicated-purpose pool pumps, DOE estimated both the capital conversion costs (i.e., investments in property, plant, and equipment) and product conversion costs (i.e., expenditures on R&D, testing, marketing, and other non-depreciable expense) manufacturers would incur to bring their manufacturing facilities and product designs into compliance with adopted standards. As outlined in section IV.C and in chapter 5 of the direct final rule TSD, the design options analyzed to comply with the adopted energy conservation standards include changing the motor to either variable-speed for standard-size self-priming pool filter pumps, or a more efficient single-speed motor for small-size self-priming, non-self-priming, and pressure cleaner booster pumps. DOE estimated per-model and per-wet-end redesign costs to determine product and capital conversion costs.

DOE used manufacturer specification sheets and product catalogs to estimate the number of models that each small business needs to redesign to comply with the adopted standards. DOE then multiplied this number by the per model redesign costs. This methodology is outlined in more detail in section IV.J.2.c.

The largest burden small businesses face is to bring standard-size self-priming pool filter pumps into compliance with the adopted standard. All five small businesses manufacture standard-size self-priming pool filter pumps and all of them make at least one compliant variable-speed pool filter pump. These small manufacturers could decide to ramp up the production of their already-compliant models and discontinue their non-compliant equipment. However, this could cause gaps in equipment offerings for manufacturers. Therefore, it is likely that manufacturers will redesign some non-compliant pumps to fill potential gaps in their equipment offerings. As described in section IV.J.2.c, DOE assumed that one variable-speed pool filter pump can replace multiple single- and two-speed pool filter pumps. Using this assumption DOE estimated that small businesses will incur $5.3 million in conversion costs to bring non-compliant standard-size self-priming pool filter pumps into compliance.

Four small businesses make small-size self-priming pool filter pumps. The adopted efficiency level for this equipment class analyzes the incorporation of a more efficient single-speed motor. All four manufacturers make multiple single-speed models and some might need to be redesigned to maintain a complete product offering. DOE expected that two small businesses will not incur any conversion costs, and the other two small businesses will incur a combined total of $0.6 million in conversion costs to bring non-compliant small-size self-priming pool filter pumps into compliance.

DOE identified four small businesses that make standard-size non-self-priming pool filter pumps. The adopted efficiency level for this equipment class can be achieved through the incorporation of a more efficient single-speed motor. Two manufacturers offer all non-self-priming pool filter pumps in both single- and two-speed configurations. DOE estimated that these manufacturers will not incur any conversion costs, because they could discontinue non-compliant single-speed dedicated-purpose pool pumps and still continue to have the same product offering with their two-speed dedicated-purpose pool pumps. The two other manufacturers have a greater number of single-speed than two-speed non-self-priming pool filter pumps and DOE expected these manufacturers will redesign some dedicated-purpose pool pumps to maintain a complete product offering. In total, small manufacturers of non-self-priming pool filter pumps are estimated to redesign two standard-size non-self-priming pool filter pumps and incur $0.7 million in conversion costs to bring non-compliant equipment into compliance.

Only one pressure cleaner booster pump model is offered in the market by small businesses. DOE did not have performance data for this pump; however, based on the no-standards case shipments distribution, 87 percent of pressure cleaner booster shipments already meet or exceed the adopted standard. Therefore, DOE expected that this model does not have to be redesigned under the adopted standard.

DOE estimates that the five small business will incur a total of $6.6 million in conversion costs to bring non-complaint standard-size self-priming, small-size self-priming, standard-size non-self-priming, and pressure cleaner booster pool pumps into compliance. Using publicly available data, DOE estimates the average annual revenue of the five small manufacturers to be $53.6 million.[142] DOE expects small manufacturers will be able to spread their conversion costs over the four-and-a-half year and a half year compliance period between the expected publication of a final rule (2016) and the expected compliance year (2021). Given these assumptions, DOE estimates that conversion costs are 0.55 percent of total small business four-and-a-half year revenue. While the standards creates additional business risk for these small businesses, DOE's

[142] This estimate is based on estimates from Hoovers (www.hoovers.com), Last accessed July 27, 2016.

calculations show that the conversion costs associated with this increase in efficiency are moderate.

5. 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 considered today.

6. Significant Alternatives Considered and Steps Taken to Minimize Significant Economic Impacts on Small Entities

The discussion in the previous section analyzes impacts on small businesses that would result from adoption of this direct final rule, represented by TSL 3. In reviewing alternatives to the adopted rule, DOE examined energy conservation standards set at lower efficiency levels. While TSL 1 and TSL 2 would reduce the impacts on small business manufacturers, it would come at the expense of a reduction in energy savings and NPV benefits to consumers. TSL 1 achieves 79 percent lower energy savings and 77 percent less NPV benefits discounted at 7 percent to consumers compared to the energy savings and NPV benefits at TSL 3. TSL 2 achieves 21 percent lower energy savings and 26 percent less NPV benefits discounted at 7 percent to consumers compared to the energy savings and NPV benefits at TSL 3.

Establishing standards at TSL 3 balances the benefits of the energy savings and benefits to consumers at TSL 3 with the potential more significant burdens placed on DPPP manufacturers, including small business manufacturers. Accordingly, DOE is choosing not to adopt one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis, included in chapter 17 of the direct final rule TSD.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of the energy conservation standards for a period not longer than 24 months after the effective date of a final rule establishing the standards. Additionally, Section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent "special hardship, inequity, or unfair distribution of burdens" that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of dedicated-purpose pool pumps 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 dedicated-purpose pool pumps, 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 pumps. 76 FR 12422 (March 7, 2011); 80 FR 5099 (Jan. 30, 2015). 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 30 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 this direct final 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 App. B, B(1)–(5).) The rule fits within this 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://energy.gov/nepa/categorical-exclusion-cx-determinations-cx.

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.

DOE understands that publication of this direct final rule will preempt certain California Energy Commission regulations governing energy efficiency requirements for pool pumps. In accordance with Executive Order 13132, DOE has examined this rule and has determined that it would not have a substantial direct effect on any States, including California, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products, including DPPP, that are the subject of this direct final rule. Additionally, DOE solicited and received comments from the California Energy Commission, which are reflected in this rulemaking. Finally, States, including California, can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of 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, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of 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 direct 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. (2 U.S.C. 1531) For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) 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 them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at http://energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.

DOE has concluded that this direct final rule may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include (1) investment in research and development and in capital expenditures by pool pump manufacturers in the years between the direct final rule and the compliance date for the new standards and (2) incremental additional expenditures by consumers to purchase higher-efficiency pool pumps, 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 direct final rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this document and the TSD for this direct 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(m) and 6316(a), this direct final rule establishes energy conservation standards for pumps that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified, as required by 6295(o)(2)(A), 6295(o)(3)(B) and 6316(a)). A full discussion of the alternatives considered by DOE is presented in chapter [17] of the TSD for this direct 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

Pursuant to Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), DOE has determined that this rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed this direct 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 direct 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 this regulatory action, which sets forth energy conservation standards for pool pumps, is not a significant energy action because the standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on this direct final rule.

L. Information Quality

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions." Id at FR 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a report describing that peer review.[143] . 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. DOE has determined that the peer-reviewed analytical process continues to reflect current practice, and the Department followed that process for developing energy conservation standards in the case of the present rulemaking.

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 a "major rule" as defined by 5 U.S.C. 804(2).

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[143] The 2007 "Energy Conservation Standards Rulemaking Peer Review Report" is available at the following website: http://energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0.

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this direct final rule.

List of Subjects

10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Imports, Intergovernmental relations, Small businesses.

Issued in Washington, DC, on December 23, 2016.

David J. Friedman
Acting Assistant Secretary
Energy Efficiency and Renewable Energy

For the reasons set forth in the preamble, DOE amends part 431 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 431 - ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291-6317; 28 U.S.C 2461 note.

2. Section 431.462 is amended by adding the definition for “pool pump timer” in alphabetical order to read as follows:

§ 431.462 Definitions.

* * * * *

<u>Pool pump timer</u> means a pool pump control that automatically turns off a dedicated-purpose pool pump after a run-time of no longer than 10 hours.

* * * * *

3. Section 431.465 is amended by adding paragraphs (e), (f), (g) and (h) to read as follows:

§431.465 Pumps energy conservation standards and their compliance dates.

* * * * *

(e) For the purposes of paragraph (f) of this section, “WEF” means the weighted energy factor and “hhp” means the rated hydraulic horsepower, as determined in accordance with the test procedure in §431.464(b) and applicable sampling plans in §429.59 of this chapter.

(f) Each dedicated-purpose pool pump that is not a submersible pump and is manufactured starting on [**INSERT DATE 54 MONTHS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**] must have a WEF rating that is not less than the value calculated from the following table:

Equipment Class		**Minimum Allowable WEF Score [kgal/kWh]**	**Minimum Allowable WEF Score [kgal/kWh]**
Dedicated-Purpose Pool Pump Variety	**hhp Applicability**	**Motor Phase**	
Self-priming pool filter pumps	0.711 hp ≤ hhp < 2.5 hp	Single	WEF = - 2.30 * ln (hhp) + 6.59
Self-priming pool filter pumps	hhp < 0.711 hp	Single	WEF = 5.55, for hhp ≤ 0.13 hp -1.30 * ln (hhp) + 2.90, for hhp > 0.13 hp
Non-self-priming pool filter pumps	hhp < 2.5 hp	Any	WEF = 4.60, for hhp ≤ 0.13 hp -0.85 * ln (hhp) + 2.87, for hhp > 0.13 hp
Pressure cleaner booster pumps	Any	Any	WEF = 0.42

(g) Each integral cartridge filter pool pump and integral sand filter pool pump that is manufactured starting on [**INSERT DATE 54 MONTHS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**] must be distributed in commerce with a pool pump timer that is either integral to the pump or a separate component that is shipped with the pump.

(h) For all dedicated-purpose pool pumps distributed in commerce with freeze protection controls, the pump must be shipped with freeze protection disabled or with the following default, user-adjustable settings:

(1) The default dry-bulb air temperature setting is no greater than 40 °F;

(2) The default run time setting shall be no greater than 1 hour (before the temperature is rechecked); and

(3) The default motor speed shall not be more than ½ of the maximum available speed.