DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket Number EERE–2009–BT–STD–0018]

RIN 1904–AC00

Energy Conservation Program: Energy Conservation Standards for Metal Halide Lamp Fixtures

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

ACTION: Notice of proposed rulemaking (NOPR) and public meeting.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including metal halide lamp fixtures. EPCA also requires the U.S. Department of Energy (DOE) to determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would save a significant amount of energy. In this notice, DOE proposes amended energy conservation standards for metal halide lamp fixtures. The notice also announces a public meeting to receive comments on these proposed standards and associated analyses and results.

DATES: DOE will hold a public meeting on Friday, September 27, 2013, from 9 a.m. to 4 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section VIII, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than October 21, 2013. See section, ''VIII Public Participation,'' for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E–089 1000 Independence Avenue SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Edwards to initiate the necessary procedures. Please also note that those wishing to bring laptops into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing laptops, or allow an extra 45 minutes. Persons can attend the public meeting via webinar. For more information, refer to the Public Participation section near the end of this notice.

Any comments submitted must identify the NOPR for Energy Conservation Standards for metal halide lamp fixtures, and provide docket number EE–2009–BT–STD–0018 and/or regulatory information number (RIN) 1904–AC00. Comments may be submitted using any of the following methods:

1. *Federal eRulemaking Portal: www.regulations.gov.* Follow the instructions for submitting comments.
2. *Email: MHLF-2009-STD-0018@ee.doe.gov.* Include the docket number and/or RIN in the subject line of the message.
3. *Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue SW., Washington, DC 20585–0121. If possible, please submit all items on a CD. It is not necessary to include printed copies.
4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza SW., Suite 600, Washington, DC 20024. Telephone: (202) 586–2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

Written comments regarding the burden-hour estimates or other aspects of the collection-of-information requirements contained in this proposed rule may be submitted to Office of Energy Efficiency and Renewable Energy through the methods listed above and by email to *Chad_S_Whiteman@omb.eop.gov*.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section VIII of this document (''Public Participation'').

Docket: The docket is available for review at *www.regulations.gov,* including **Federal Register** notices, framework documents, public meeting attendee lists and transcripts, comments, and other supporting documents/materials. 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: *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49*. This Web page will contain a link to the docket for this notice on the regulations.gov site. The regulations.gov Web page will contain simple instructions on how to access all documents, including public comments, in the docket. See section VIII for further information on how to submit comments through *www.regulations.gov*.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Ms. Brenda Edwards at (202) 586–2945 or by email: *brenda.edwards@ee.doe.gov*.

FOR FURTHER INFORMATION CONTACT:

Ms. Lucy deButts, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue SW., Washington, DC 20585–0121. Telephone: (202) 287–1604. Email: *metal_halide_lamp_fixtures@ee.doe.gov.*

Mr. Ari Altman, U.S. Department of Energy, Office of the General Counsel, GC–71, 1000 Independence Avenue SW., Washington, DC 20585–0121. Telephone: (202) 287–6307. Email: *ari.altman@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

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I. Summary of the Proposed Rule

Title III, Part B [1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Public Law 94–163 (42 U.S.C. 6291–6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles. Pursuant to EPCA, any new or amended energy conservation standard that the U.S. Department of Energy (DOE) prescribes for certain products, such as metal halide lamp fixtures (MHLFs or ''fixtures''), shall be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in a significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) In accordance with these and other statutory provisions discussed in this notice, DOE proposes amended energy conservation standards for metal halide lamp fixtures. The proposed standards, which are the

[1] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

minimum allowable ballast efficiencies [2] based on fixture location, ballast type, and rated lamp wattage, are shown in Table I.1.

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR METAL HALIDE LAMP FIXTURES

Equipment classes	Rated lamp wattage	Indoor/outdoor ***	Test input voltage †	Minimum standard equation %
1	≥50 W and ≤100 W	Indoor	480 V	99.4/(1 + 2.5 * P∧(−0.55)) ‡.
2	≥50 W and ≤100 W	Indoor	All others	100/(1 + 2.5 * P∧(−0.55)).
3	≥50 W and ≤100 W	Outdoor	480 V	99.4/(1 + 2.5 * P∧(−0.55)).
4	≥50 W and ≤100 W	Outdoor	All others	100/(1 + 2.5 * P∧(−0.55)).
5	>100 W and <150 W *	Indoor	480 V	99.4/(1 + 0.36 * P∧(−0.30)).
6	>100 W and <150 W *	Indoor	All others	100/(1 + 0.36 * P∧(−0.30)).
7	>100 W and <150 W *	Outdoor	480 V	99.4/(1 + 0.36 * P∧(−0.30)).
8	>100 W and <150 W *	Outdoor	All others	100/(1 + 0.36 * P∧(−0.30)).
9	≥150 W ** and ≤250 W	Indoor	480 V	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0 * 10∧(−2) * P + 76.0.
10	≥150 W ** and ≤250 W	Indoor	All others	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0 * 10∧(−2) * P + 74.0.
11	≥150 W ** and ≤250 W	Outdoor	480 V	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 6.0 * 10∧(−2) * P + 76.0.
12	≥150 W ** and ≤250 W	Outdoor	All others	For ≥150 W and ≤200 W: 88.0. For >200 W and ≤250 W: 7.0 * 10∧(−2) * P + 74.0.
13	>250 W and ≤500 W	Indoor	480 V	91.0.
14	>250 W and ≤500 W	Indoor	All others	91.5.
15	>250 W and ≤500 W	Outdoor	480 V	91.0.
16	>250 W and ≤500 W	Outdoor	All others	91.5.
17	>500 W and ≤2000 W	Indoor	480 V	For >500 W to <1000 W: 0.994 * (3.2 * 10∧(−3) * P + 89.9). For ≥1000 W to ≤2000 W: 92.5 and may not utilize a probe-start ballast.
18	>500 W and ≤2000 W	Indoor	All others	For >500 W to <1000 W: 3.2 * 10∧(−3) * P + 89.9. For ≥1000 W to ≤2000 W: 93.1 and may not utilize a probe-start ballast.
19	>500 W and ≤2000 W	Outdoor	480 V	For >500 W to <1000 W: 0.994 * (3.2 * 10∧(−3) * P + 89.9). For ≥1000 W to ≤2000 W: 92.5 and may not utilize a probe-start ballast.
20	>500 W and ≤2000 W	Outdoor	All others	For >500 W to <1000 W: 3.2 * 10∧(−3) * P + 89.9. For ≥1000 W to ≤2000 W: 93.1 and may not utilize a probe-start ballast.

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by Underwriters Laboratories (UL) 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

*** DOE's proposed definitions for "indoor" and "outdoor" metal halide lamp fixtures are described in section V.A.2.

† Input voltage for testing would be specified by the test procedures. Ballasts rated to operate lamps less than 150 W would be tested at 120 V, and ballasts rated to operate lamps ≥150 W would be tested at 277 V. Ballasts not designed to operate at either of these voltages would be tested at the highest voltage for which the ballast is designed to operate.

‡ P is defined as the rated wattage of the lamp that the fixture is designed to operate.

[2] DOE is proposing to continue using a ballast efficiency metric for regulation of metal halide lamp fixtures, rather than a system or other approach. See section III.B for further discussion.

A. Benefits and Costs to Customers

Table I.2 presents DOE's evaluation of the economic effects of the proposed standards on customers of metal halide lamp fixtures, as measured by the average life-cycle cost (LCC) savings and the median payback period (PBP). The average LCC savings are positive for a majority of users for all equipment classes. For example, the estimated average LCC savings are approximately $30 for fixtures operating a 400 W metal halide (MH) lamp in indoor and outdoor applications.

TABLE I.2—IMPACTS OF PROPOSED STANDARDS ON METAL HALIDE LAMP FIXTURE CUSTOMERS

Equipment class	Average LCC savings 2012$	Median payback period years
70 W (indoor, magnetic baseline)	38.41	4.2
70 W (outdoor, magnetic baseline)	46.44	4.4
150 W (indoor)	10.14	4.7
150 W (outdoor)	112.51	10.5
250 W (indoor)	13.12	11.8
250 W (outdoor)	13.75	14.0
400 W (indoor)	28.23	10.5
400 W (outdoor)	30.47	12.3
1000 W (indoor)	502.21	2.0
1000 W (outdoor)	409.02	3.0

B. Impact on Manufacturers

The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2013 to 2045). Using a real discount rate of 8.9 percent, DOE estimates that the INPV for manufacturers of metal halide ballasts ranges from $77 million in the low shipment-preservation of operating profit markup scenario to $127 million in the high shipment-flat markup scenario in 2012$. Under the proposed standards, DOE expects ballast manufacturers to lose up to 25.0 percent of their INPV, which is approximately $25.9 million, in the low shipment,- preservation of operating profit markup scenario. In the high shipment-flat markup scenario, DOE expects manufacturers to increase their INPV up to 3.7 percent, which is approximately $4.5 million. Using a real discount rate of 9.5 percent, DOE estimates that the INPV for manufacturers of metal halide lamp fixtures ranges from $523 million in the low shipment-preservation of operating profit markup scenario to $695 million in the high shipment-flat markup scenario in 2012$. Under the proposed standards, DOE expects fixture manufacturers to lose up to 3.2 percent of their INPV, which is approximately $17.3 million, in the low shipment-preservation of operating profit markup scenario. In the high shipment-flat markup scenario, DOE expects manufacturers to increase their INPV up to 10.3 percent, which is approximately $64.8 million. Additionally, based on DOE's interviews with the manufacturers of metal halide lamp fixtures, DOE does not expect any plant closings or significant loss of employment.

C. National Benefits

DOE's analyses indicate that the proposed standards would save a significant amount of energy. The lifetime savings for metal halide lamp fixtures purchased in a 30-year period (2016–2045) amount to 0.80–1.1 quads.

The cumulative national net present value (NPV) of total customer costs and savings of the proposed standards in 2012$ ranges from $0.95 billion (at a 7-percent discount rate) to $3.2 billion (at a 3-percent discount rate) for metal halide lamp fixtures. This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment costs for equipment purchased in 2016–2045, discounted to 2013.

In addition, the proposed standards would have significant environmental benefits. The energy savings would result in cumulative emission reductions of 49–65 million metric tons (Mt) [3] of carbon dioxide (CO_2), 214–289 thousand tons of methane (CH_4), 0.89–3.0 thousand tons of nitrous oxide (N_2O), 65–87 thousand tons of sulfur dioxide (SO_2), 66–90 thousand tons of nitrogen oxides (NO_X), and 0.11–0.15 tons of mercury (Hg).[4 5]

The value of the CO_2 emissions reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by a recent interagency process. The derivation of the SCC values is discussed in section V.M.1. DOE estimates the net present monetary value of the CO_2 emissions reduction is between $0.33 and $4.7 billion, expressed in 2012$ and discounted to 2013. DOE also estimates the net present monetary value of the NO_X emissions reduction, expressed in 2012$ and discounted to 2013, is $45 million at a 7-percent discount rate, and $91 million at a 3-percent discount rate.[6]

Table I.3 summarizes the national economic costs and benefits expected to result from today's proposed standards for metal halide lamp fixtures.

[3] A metric ton is equivalent to 1.1 short tons. Results for CH_4, SO_2, NO_X and Hg are presented in short tons.

[4] DOE calculates emissions reductions relative to the Annual Energy Outlook (AEO) 2013 Reference case, which generally represents current legislation and environmental regulations for which implementing regulations were available as of December 31, 2012.

[5] DOE also estimated CO_2 and CO_2 equivalent (CO_2eq) emissions that occur by 2030 (CO_2eq includes greenhouse gases such as CH_4 and N_2O). The estimated emissions reductions by 2030 are 15–17 million metric tons CO_2, 1,471–1,627 thousand tons CO_2eq for CH_4, and 63–70 thousand tons CO_2eq for N_2O.

[6] DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it monetizes Hg in its rulemakings.

TABLE I.3—SUMMARY OF NATIONAL ECONOMIC BENEFITS AND COSTS OF METAL HALIDE LAMP FIXTURE ENERGY CONSERVATION STANDARDS (PRIMARY (LOW SHIPMENTS) ESTIMATE)

Category	Present value million 2012$	Discount rate (percent)
Benefits		
Operating Cost Savings	1,848	7
	3,748	3
CO_2 Reduction Monetized Value ($12.9/t case)*	333	5
CO_2 Reduction Monetized Value ($40.8/t case)*	1,532	3
CO_2 Reduction Monetized Value ($62.2/t case)*	2,436	2.5
CO_2 Reduction Monetized Value (at $117/t case)*	4,689	3
NO_X Reduction Monetized Value (at $2,639/ton)**	45	7
	91	3
Total Benefits†	3,424	7
	5,371	3
Costs		
Incremental Installed Costs	897	7
	1,294	3
Net Benefits		
Including CO_2 and NO_X Reduction Monetized Value	2,528	7
	4,076	3

* The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values in parentheses represent the SCC in 2015. The SCC time series used by DOE incorporate an escalation factor.

** The value represents the average of the low and high NO_X values used in DOE's analysis.

† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to average SCC value with 3-percent discount rate.

The benefits and costs of today's proposed standards, for equipment sold between 2016 and 2045, can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value of the benefits from customer operation of equipment that meets the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing customer NPV), and (2) the annualized monetary value of the benefits of emissions reductions, including CO_2 emissions reductions.[7]

Although combining the values of operating savings and CO_2 emissions reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. customer monetary savings that occur as a result of market transactions, while the value of CO_2 emissions reductions is a global value. Second, the assessments of operating cost savings and CO_2 emissions savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of metal halide lamp fixtures shipped between 2016 and 2045. The SCC values, on the other hand, reflect the present value of some future climate-related impacts resulting from the emission of 1 ton of CO_2 in each year. These impacts will continue well beyond 2045.

Estimates of annualized benefits and costs of the proposed standards are shown in Table I.4. The results under the primary estimate are as follows. (All monetary values below are expressed in 2012$.) Using a 7-percent discount rate for benefits and costs other than CO_2 emissions reductions, for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of $40.8/ton in 2012$, the cost of the standards proposed in today's rule is $68.0 million per year in increased equipment costs, while the annualized benefits are $139 million per year in reduced equipment operating costs, $76 million in CO_2 emissions reductions, and $3.4 million in reduced NO_X emissions. In this case, the net benefit amounts to $151 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of $40.8/ton in 2012$, the cost of the standards proposed in today's rule is $64 million per year in increased equipment costs, while the benefits are $186 million per year in reduced operating costs, $76 million in CO_2 emissions reductions, and $4.5 million in reduced NO_X emissions. In this case, the net benefit amounts to $202 million per year.

[7] DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in 2013, the year used for discounting the NPV of total customer costs and savings, for the time-series of costs and benefits using discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 emissions reductions. For the latter, DOE used a range of discount rates, as shown in Table I.4. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2016 through 2045) that yields the same present value. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of costs and benefits from which the annualized values were determined is a steady stream of payments.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF PROPOSED STANDARDS FOR METAL HALIDE LAMP FIXTURES

	Discount rate	Monetized Values [*million 2012$/year*]	
		Primary (low shipments) estimate *	High estimate *
Benefits			
Operating Cost Savings	7%	139	169
	3%	186	240
CO_2 Reduction Monetized Value ($12.9/t case) **	5%	21	26
CO_2 Reduction Monetized Value ($40.8/t case) **	3%	76	99
CO_2 Reduction Monetized Value ($62.2/t case) **	2.5%	114	149
CO_2 Reduction Monetized Value $117/t case) **	3%	232	303
NO_X Reduction Monetized Value (at $2,639/ton) **	7%	3.36	4.06
	3%	4.49	5.76
Total Benefits†	7% plus CO_2 range	163 to 375	200 to 476
	7%	218	272
	3%	266	344
	3% plus CO_2 range	211 to 422	272 to 548
Costs			
Incremental Equipment Costs	7%	68	81
	3%	64	80
Net Benefits/Costs			
Total †	7% plus CO_2 range	96 to 307	119 to 396
	7%	151	192
	3%	202	264
	3% plus CO_2 range	147 to 358	192 to 468

* This table presents the annualized costs and benefits associated with fixtures shipped in 2016 and 2045. These results include benefits to customers which accrue after 2045 from the fixtures purchased in 2016 to 2045. Costs incurred by manufacturers, some of which may be incurred prior to 2016 in preparation for the rule, are not directly included, but are indirectly included as part of incremental equipment costs. The Low (Primary) and High Estimates utilize forecasts of energy prices from the Energy Information Administration's 2012 *Annual Energy Outlook (AEO2013)* from the *AEO2013* Reference case, with the Low and High Estimates based on projected fixture shipments in the Low Shipments, Roll-up and High Shipments, Roll-up scenarios, respectively. In addition, all estimates use incremental equipment costs that reflect a declining trend for equipment prices, using *AEO* price trends (deflators). The derivation and application of price trends for equipment prices is explained in section V.F.

** The interagency group selected four sets of SCC values for use in regulatory analyses. Three sets of values are based on the average SCC from the three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth set, which represents the 95th percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. The values in parentheses represent the SCC in 2015. The SCC time series incorporate an escalation factor. The value for NO_X is the average of the low and high values used in DOE's analysis.

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

DOE has tentatively concluded that the proposed standards represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. DOE further notes that equipment achieving these standard levels are already commercially available for at least some, if not most, equipment classes covered by today's proposal. Based on the analyses described above, DOE has tentatively concluded that the benefits of the proposed standards to the nation (energy savings, positive NPV of customer benefits, customer LCC savings, and emissions reductions) would outweigh the burdens (loss of INPV for manufacturers and LCC increases for some customers).

DOE also considered more-stringent fixture energy-use levels as trial standard levels (TSLs), and is still considering them in this rulemaking. DOE has tentatively concluded, however, that the potential burdens of the more-stringent energy-use levels would outweigh the projected benefits. Based on its consideration of the public comments DOE receives in response to this notice and related information collected and analyzed during the course of this rulemaking effort, DOE may adopt energy-use levels that are either higher or lower than the proposed standards, or some combination of level(s) that incorporate the proposed standards in part.

II. Introduction

The following section discusses the statutory authority underlying today's proposal, as well as some of the historical background related to the establishment of standards for metal halide lamp fixtures.

A. Authority

Title III, Part B of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles,[8] a program covering most major household appliances (collectively referred to as "covered products"). Amendments to EPCA have given DOE the authority to regulate the energy efficiency of several additional kinds of equipment, including certain metal halide lamp fixtures, which are the subject of this rulemaking. (42 U.S.C. 6292(a)(19)) EPCA, as amended by the Energy Independence and Security Act of 2007 (EISA 2007) prescribes energy conservation

[8] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

standards for these products (42 U.S.C. 6295(hh)(1)), and directs DOE to conduct a rulemaking to determine whether to amend these standards. (42 U.S.C. 6295(hh)(2)(A)) (DOE notes that under 42 U.S.C. 6295(hh)(3)(A), the agency must review its already established energy conservation standards for metal halide lamp fixtures. Under this requirement, the next review that DOE would need to conduct must occur no later than January 1, 2019.)

Pursuant to EPCA, DOE's energy conservation program for covered products consists of four parts: (1) Testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6293) Manufacturers of covered products must use the prescribed DOE test procedures as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. The DOE test procedures for metal halide lamp fixtures currently appear at title 10 of the Code of Federal Regulations (CFR) §§ 431.323 and 431.324.

DOE must follow specific statutory criteria for prescribing amended standards for covered products. As indicated above, any amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) For certain products, including metal halide lamp fixtures, if no test procedures have been established for the product, or (2) if DOE determines by rule that the proposed standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven factors:

1. The economic impact of the standard on manufacturers and consumers of the products subject to the standard;
2. The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the imposition of the standard;
3. The total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;
4. Any lessening of the utility or the performance of the covered products likely to result from the imposition of 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 imposition of 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))

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

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

Additionally, 42 U.S.C. 6295(q)(1) specifies requirements when promulgating a standard for a type or class of covered product that has two or more subcategories. DOE must specify a different standard level than that which applies generally to such type or class of products for any group of covered products that have the same function or intended use if DOE determines that products within such group (A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. In determining whether a performance-related feature justifies a different standard for a group of products, DOE must consider such factors as the utility to the consumer of the feature and other factors DOE deems appropriate. (42 U.S.C. 6294(q)(1)) Any rule prescribing such a standard must include an explanation of the basis on which such a higher or lower level was established. (42 U.S.C. 6295(q)(2))

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

Finally, pursuant to the amendments contained in section 310(3) of EISA 2007, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) When DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into the standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedures and standards for metal halide lamp fixtures address standby mode and off mode energy use. However, in this rulemaking, DOE only addresses active mode energy consumption as standby and off mode energy use are not applicable to the proposed scope of coverage.

DOE has also reviewed this regulation pursuant to Executive Order (E.O.) 13563, issued on January 18, 2011. 76 FR 3281, (Jan. 21, 2011). E.O. 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in E.O. 12866. To the extent permitted by law, agencies are required by E.O. 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 E.O. 13563 requires agencies ''to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible.'' In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include ''identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes.'' For the reasons stated in the preamble, DOE believes that today's NOPR is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized. Consistent with EO 13563, and the range of impacts analyzed in this rulemaking, the energy efficiency standard proposed herein by DOE achieves maximum net benefits.

B. Background

1. Current Standards

EISA 2007 prescribed the current energy conservation standards for metal halide lamp fixtures manufactured on or after January 1, 2009. (42 U.S.C. 6295(hh)(1)) The current standards are set forth in Table II.1. EISA 2007 excludes from the standards: fixtures with regulated-lag ballasts, fixtures with electronic ballasts that operate at 480 volts (V); and fixtures that (1) are rated only for 150 W lamps; (2) are rated for use in wet locations; and (3) contain a ballast that is rated to operate at ambient air temperatures higher than 50 °C.

TABLE II.1—FEDERAL ENERGY EFFICIENCY STANDARDS FOR METAL HALIDE LAMP FIXTURES *

Ballast type	Operated lamp rated wattage range	Minimum ballast efficiency (percent)
Pulse-start	≥150 and ≤500 W	88
Magnetic Probe-start	≥150 and ≤500 W	94
Nonpulse-start Electronic	≥150 and ≤250 W	90
Nonpulse-start Electronic	≥250 and ≤500 W	92

* (42 U.S.C. 6295(hh)(1)).

2. History of Standards Rulemaking for Metal Halide Lamp Fixtures

DOE is conducting this rulemaking to review and consider amendments to the energy conservation standards in effect for metal halide lamp fixtures, as required under 42 U.S.C. 6295(hh)(2) and (4). On December 30, 2009, DOE published a notice announcing the availability of the framework document, ''Energy Conservation Standards Rulemaking Framework Document for Metal Halide Lamp Fixtures,'' and a public meeting to discuss the proposed analytical framework for the rulemaking. 74 FR 69036. DOE also posted the framework document on its Web site; this document is available at *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49.* The framework document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for metal halide lamp fixtures, and identified various issues to be resolved in conducting this rulemaking.

DOE held a public meeting on January 26, 2010, during which it presented the contents of the framework document, described the analyses it planned to conduct during the rulemaking, sought comments from interested parties on these subjects, and in general, sought to inform interested parties about, and facilitate their involvement in, the rulemaking. At the meeting and during the period for commenting on the framework document, DOE received comments that helped identify and resolve issues involved in this rulemaking.

DOE then gathered additional information and performed preliminary analyses to help develop potential energy conservation standards for metal halide lamp fixtures. On April 1, 2011, DOE published in the **Federal Register** an announcement (the April 2011 notice) of the availability of the preliminary technical support document (the preliminary TSD) and of another public meeting to discuss and receive comments on the following matters: (1) The equipment classes DOE planned to analyze; (2) the analytical framework, models, and tools that DOE was using to evaluate standards; (3) the results of the preliminary analyses performed by DOE; and (4) potential standard levels that DOE could consider. 76 FR 1812 (April 1, 2011). In the April 2011 notice, DOE requested comment on issues that would affect energy conservation standards for metal halide lamp fixtures or that DOE should address in this notice of proposed rulemaking (NOPR). The preliminary TSD is available at *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/49.*

The preliminary TSD summarized the activities DOE undertook in developing standards for metal halide lamp fixtures, and discussed the comments DOE received in response to the framework document. It also described the analytical framework that DOE uses in this rulemaking, including a description of the methodology, the analytical tools, and the relationships among the various analyses that are part of the rulemaking. The preliminary TSD presented and described in detail each analysis DOE performed up to that point, including descriptions of inputs, sources, methodologies, and results. These analyses were as follows:

• A *market and technology assessment* set the scope of this rulemaking, identified the potential equipment classes for metal halide lamp fixtures, characterized the markets for this equipment, and reviewed techniques and approaches for improving their efficiency;

- A *screening analysis* reviewed technology options to improve the efficiency of metal halide lamp fixtures, and weighed these options against DOE's four prescribed screening criteria;
- An *engineering analysis* estimated the manufacturer selling prices (MSPs) associated with more energy-efficient metal halide lamp fixtures;
- An *energy-use analysis* estimated the annual energy use of metal halide lamp fixtures;
- A *markups analysis* converted estimated MSPs derived from the engineering analysis to customer prices;
- A *life-cycle cost (LCC) analysis* calculated, for individual customers, the discounted savings in operating costs throughout the estimated average life of the equipment compared to any increase in installed costs likely to result directly from the imposition of a given standard;
- A *payback period (PBP) analysis* estimated the amount of time it would take individual customers to recover the higher purchase expense of more energy-efficient products through lower operating costs;
- A *shipments analysis* estimated shipments of metal halide lamp fixtures over the time period examined in the analysis. This was then used in the national impact analysis (NIA);
- A *national impact analysis* assessed the national energy savings, and the national net present value of total customer costs and savings, expected to result from specific, potential energy conservation standards for metal halide lamp fixtures; and
- A *preliminary manufacturer impact analysis (MIA)* began evaluating the effects on manufacturers of amended efficiency standards.

The public meeting announced in the April 2011 notice took place on April 18, 2011 (April 2011 public meeting). At this meeting, DOE presented the methodologies and results of the analyses set forth in the preliminary TSD. Interested parties discussed the following major issues at the public meeting: (1) Alternative approaches to performance requirements and the various related efficiency metrics; (2) the possibility of including design standards; (3) amendments to the test procedures for metal halide ballasts to account for multiple input voltages; (4) the cost and feasibility of utilizing electronic ballasts in metal halide lamp fixtures; (5) equipment class divisions; (6) overall pricing methodology; (7) lamp lifetimes; (8) cumulative regulatory burden; (9) shipments; and (10) the possibility of merging the metal halide lamp fixture and the high-intensity discharge (HID) lamp rulemakings. This NOPR responds to the issues raised in the comments received since publication of the April 2011 notice, including those received at the April 2011 public meeting.

3. Compliance Date

EPCA, as amended by EISA 2007, contains guidelines for the compliance date of the standards amended by this rulemaking. EPCA requires DOE to determine whether to amend the standards in effect for metal halide lamp fixtures and whether any amended standards should apply to additional metal halide lamp fixtures. The Secretary was directed to publish a final rule no later than January 1, 2012 to determine whether the energy conservation standards established by EISA 2007 for metal halide lamp fixtures should be amended, with any amendment applicable to products manufactured after January 1, 2015. (42 U.S.C. 6295(hh)(2)(B))

III. Issues Affecting the Scope of This Rulemaking

A. Additional Metal Halide Lamp Fixtures for Which DOE Is Proposing Standards

As noted in section II.B.1, the existing energy conservation standards for metal halide lamp fixtures are established in EPCA through amendments made by EISA 2007. (42 U.S.C. 6295(hh)(1)(A)) EISA 2007 prescribed energy conservation standards for metal halide lamp fixtures by setting minimum ballast efficiency requirements for fixtures manufactured after January 1, 2009. Currently, coverage is limited to certain rated wattages of lamps used in metal halide lamp fixtures (150 W to 500 W). Such fixtures must be equipped with a ballast that has a designated starting method (pulse-start or probe-start) and electronic configuration (magnetic or electronic). However, the statute excludes from coverage metal halide lamp fixtures with regulated-lag ballasts,[9] electronic ballasts that operate at 480 V, and fixtures that: (1) Are rated only for 150 W lamps, (2) are rated for use in wet locations,[10] and (3) contain a ballast that is rated to operate at ambient air temperatures greater than 50 °C.[11] (42 U.S.C. 6295(hh)(1)(A)).

[9] 'Regulated lag ballast' means ballasts designed to withstand significant line voltage variation with minimum wattage variation to the lamp.

[10] Specifications for ''wet locations'' are from the National Electrical Code 2002, section 410.4(A).

[11] Specifications for ballasts that operate at ambient air temperatures above 50 °C are found in UL 1029–2001.

In the preliminary TSD, DOE requested comment from interested parties on the scope of energy conservation standards rulemaking for metal halide lamp fixtures. DOE received several comments related to expanding the scope to include fixtures exempted by EISA 2007, fixtures designed to be operated with additional rated lamp wattages, and the definition of a general lighting application.

1. EISA 2007 Exempted Metal Halide Lamp Fixtures

DOE considered expanding its energy conservation standards to cover metal halide lamp fixtures exempted by EISA 2007, including fixtures with regulated-lag ballasts; electronic ballasts that operate at 480 V; and ballasts that are rated only for (1) use with 150 W lamps, (2) use in wet locations, and (3) operation in ambient air temperatures higher than 50 °C. (42 U.S.C. 6295(hh)(1)(B))

Fixtures With Regulated-Lag Ballasts

In the preliminary analysis, DOE tentatively decided to continue the exemption for regulated-lag ballasts. Through information gathered in manufacturer interviews and market research, DOE determined that regulated-lag ballasts are mainly used for specialty applications where line voltage variation is large. Regulated-lag ballasts are designed to withstand significant line voltage variation with minimum wattage variation to the lamp, which results in an efficiency penalty compared to ballasts whose output changes more significantly with line voltage variation. To be able to withstand large variations, regulated-lag ballasts are currently designed to be significantly larger than standard ballasts, and as a result exhibit poor efficiency. According to manufacturers and market research, EISA 2007's exemption did not lead to a significant market shift to regulated-lag ballasts.

The Appliance Standard Awareness Project (ASAP) encouraged DOE to consider coverage for regulated-lag ballasts. While ASAP stated that they understood that regulated-lag ballasts may be inherently less efficient, they suggested a separate equipment class with a lower standard might be more appropriate than no standard. They also stated that little information about the market for regulated-lag ballasts is available. (ASAP, Public Meeting Transcript, No. 33 at p. 24)[12] DOE

[12] A notation in the form ''ASAP, Public Meeting Transcript, No. 33 at p. 24'' identifies a comment that DOE has received and included in the docket of this rulemaking. This particular notation refers to a comment: (1) Submitted by ASAP during the

conducted additional research on regulated-lag ballasts and found none of these products available in major manufacturers' catalogs. DOE assumed that absence from catalogs indicates a very small market share, and concluded that there was no potential for significant energy savings through inclusion of these products in the scope of coverage. In addition, DOE continues to agree with the preliminary analysis that the size and weight of regulated-lag ballasts prohibit their use as substitutes in traditional applications. For the NOPR, DOE proposes to continue exempting from energy conservation standards fixtures that include regulated-lag ballasts and requests comment on this proposal.

Fixtures With 480 V Electronic Ballasts

In the preliminary analysis, DOE also considered continuing the exemption of 480 V electronic ballasts based on their unavailability in the market. In its comments, Empower Electronics disagreed with the exemption, stating that 347 V and 480 V electronic ballasts for metal halide lamps are now feasible, and suggested that regulations could help the maturation of these technologies. (Empower Electronics, No. 36 at pp. 3–4)[13] Following additional research for the NOPR, DOE did identify one manufacturer of 480 V electronic ballasts, but determined that these ballasts have a very small market share based on their limited availability from distributors and only being manufactured by one company. Therefore, DOE concluded that there is no potential for significant energy savings and proposes to continue exempting fixtures that use 480 V electronic ballasts until DOE has an opportunity to analyze commercially available products. DOE requests comment on this proposal.

Exempted 150 W Fixtures

In the preliminary analysis, DOE considered eliminating the current exemption for 150 W outdoor fixtures rated for wet and hot locations because these products could be made more efficient and have the potential for significant energy savings. Shipments for these exempted 150 W fixtures increased in response to the EISA 2007 regulations (a shift from 175 W fixtures), further increasing the potential energy savings for regulations targeted at this product type. In addition, DOE found that many fixtures commonly used indoors (high- and low-bay fixtures for high-ceiling buildings) meet the high-temperature requirements and have the option of being rated for wet locations. DOE preliminarily concluded that some fixtures used indoors were using the exemption designed for outdoor fixtures, negating possible energy savings for indoor 150 W fixtures. DOE requested comment on the impact of eliminating the exemption for 150 W outdoor fixtures rated for wet and high-temperature locations.

The National Electrical Manufacturers Association (NEMA), Philips Lighting Electronics (Philips), and Georgia Power commented that the wet-location and high-temperature outdoor 150 W fixture exemption was created in part to move the market from the popular 175 W ballast to the 150 W ballast, and lead to energy savings through a wattage reduction, and therefore does not constitute a loophole. (NEMA, No. 34 at p. 4; Philips, Public Meeting Transcript, No. 33 at pp. 24–25; Georgia Power, No. 28 at p. 1) NEMA stated that this exemption is critical for outdoor lighting ballasts because 150 W magnetic ballasts cannot meet the 88 percent EISA 2007 requirement. NEMA contended that the power savings realized by shifting from 175 W lamps to 150 W lamps, and the risk that the market would migrate back to 175 W without the exemption, far outweigh any additional savings generated by requiring that 150 W ballasts meet a ballast efficiency requirement. (NEMA, No. 34 at p. 4) DOE disagrees with NEMA that the removal of the exemption will result in a shift to 175 W fixtures. DOE is not required to set the standard for 150 W fixtures at or above the 88 percent minimum set by EISA 2007. Because these fixtures were not previously covered, setting a less stringent standard than 88 percent would not constitute backsliding and has the potential to save significant energy. DOE would analyze efficiency levels for 150 W fixtures according to the same criteria it uses for all other wattages. Section V.C.9 describes the efficiency levels under consideration in the NOPR for 150 W fixtures.

Northwest Energy Efficiency Alliance (NEEA) commented that there is no reason to continue the exclusion for fixtures rated for wet locations and ambient temperatures higher than 50 °C. If electronic ballasts with their higher efficiencies cannot be utilized in these fixtures, NEEA suggested placing them in a separate class for standards purposes rather than excluding them from coverage. (NEEA, No. 31 at pp. 1, 3) ASAP and, in a joint comment, Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Gas Company, and Southern California Edison (hereafter the ''California Investor-Owned Utilities'' [CA IOUs]) also supported the coverage of 150 W fixtures because the exemption may have become a loophole. (ASAP, Public Meeting Transcript, No. 33 at p. 23; CA IOUs, No. 32 at p. 1)

DOE agrees that these 150 W ballasts should be covered by this rulemaking and notes that the criteria for the scope of coverage for this rulemaking is defined as technology which is technologically feasible, economically justified, and has the potential for significant energy savings. Because a range of ballast efficiencies exist or are achievable in commercially available ballasts, DOE believes that improving the efficiencies of ballasts in 150 W fixtures in wet locations and high ambient temperatures is technologically feasible. DOE's analysis indicates that removing the wet-location and high-ambient-temperature 150 W fixture exemption has the potential for energy savings and is economically justified. Therefore, in this NOPR, DOE proposes to remove the exemption for fixtures that are rated only for use with 150 W lamps, wet environments, and in ambient temperatures greater than 50 °C and include these fixtures in the scope of coverage. DOE requests comment on this proposal.

2. Additional Rated Lamp Wattages

During the preliminary analysis, DOE considered expanding its coverage of energy conservation standards to include metal halide lamp fixtures that operate lamps rated from 50 W to 150 W and fixtures that operate lamps rated greater than 500 W. DOE's review of ballast manufacturer catalogs (an indication of product availability) showed many types of metal halide ballasts for fixtures operating lamps rated outside the currently regulated wattage range. The catalogs showed that approximately 30 percent (by number of products, not by market share) of available metal halide ballasts are designed for lamps rated less than 150 W and approximately 13 percent of available metal halide ballasts are designed for lamps rated greater than 500 W. Due to the number of ballasts outside of the existing scope of coverage, DOE believed that there was potential for significant energy savings and considered including fixtures designed to operate lamps with rated

public meeting on April 18, 2011; (2) in the transcript of that public meeting, document number 33 in the docket of this rulemaking; and (3) appearing on page 24 of the transcript.

[13] A notation in the form ''Empower Electronics, No. 36 at pp. 3–4'' identifies a written comment that DOE has received and included in the docket of this rulemaking. This particular notation refers to a comment: (1) Submitted by Empower Electronics; (2) in document number 36 of the docket; and (3) on pages 3 to 4 of that document.

wattage ≥50 W in the analysis. DOE received comment on expanding the scope to fixtures that operate lamps rated from 50 W to 150 W and fixtures that operate lamps rated greater than 500 W.

In response to request for comment in the preliminary TSD, NEMA suggested that there is little energy savings to be realized by regulating fixtures for the 50 W to 150 W range due to their low energy usage and the movement of the market to the greater than 150 W power range. (NEMA, Public Meeting Transcript, No. 34 at p. 13) ASAP, NEEA, the CA IOUs, Empower Electronics, and Progress Energy Carolinas supported the expansion of scope to the greater than 50 W and less than 150 W range discussed in the preliminary TSD. (ASAP, Public Meeting Transcript, No. 33 at p. 23; NEEA, No. 31 at p. 1; CA IOUs, No. 32 at p. 1; Empower Electronics, No. 36 at p. 3; Progress Energy Carolinas, No. 24 at p. 2) DOE conducted testing within the 50 W to 150 W range and identified varying efficiencies within a single wattage, which suggests that standards to improve the least-efficient ballasts are technologically feasible. Furthermore, as discussed in section VI.B.3, DOE determined that standards for this wattage range have the potential for significant energy savings. Therefore, DOE proposes to include fixtures designed to operate lamps rated ≥50 W and <150 W.

DOE also received comment on the greater than 500 W equipment class. Georgia Power stated that regulating high wattages (such as 1000 W and 1500 W) would save little energy at significant cost. (Georgia Power, No. 28 at p. 2) ASAP, NEEA, the CA IOUs, Empower Electronics, and Progress Energy Carolinas, however, agreed with DOE's preliminary findings and supported the expansion of scope to the >500 W range discussed in the preliminary TSD. (ASAP, Public Meeting Transcript, No. 33 at p. 23; NEEA, No. 31 at p. 1; CA IOUs, No. 32 at p. 1; Empower Electronics, No. 36 at p. 3; Progress Energy Carolinas, No. 24 at p. 2) In terms of technological feasibility, NEMA stated that the ballasts included in high-wattage fixtures are already up to 92 percent efficient. NEMA took the position that because this efficiency is comparable to the efficiencies of lower-wattage equipment with the highest-grade components, it would be difficult, if not impossible, to define energy efficiency requirements that would result in appreciable savings. Still, NEMA supported DOE's determination that ballasts greater than 500 W were within the scope of DOE's authority for preclusion of ''state-by-state'' rulemaking through preemption (NEMA, No. 34 at p. 3) In terms of potential for significant energy savings, NEMA noted that market estimates for greater-than-500–W ballasts are on the order of 15 percent, while the total energy use for equipment in this power range is estimated to be as high as 40 percent of the total of installed metal halide lamp fixtures. Id.

DOE agrees that the greater-than-500–W ballasts have higher efficiencies than the lower-wattage equipment. However, based on test data, DOE still found a range of efficiencies present in commercially available ballasts, indicating technological feasibility. DOE also verified NEMA's comment that these high-wattage products have fewer shipments than the lower-wattage products included in this rulemaking, but they consume more energy per installation. DOE's analysis indicates that regulation of these higher wattages could be economically justified and has the potential for significant energy savings. Finally, based on review of product catalogs, DOE determined that fixtures rated for use with lamps rated for wattages greater than 2000 W served small-market-share applications like graphic arts, ultraviolet curing, and scanners. Therefore, DOE proposes not to include fixtures rated for wattages greater than 2000 W in this rulemaking. In summary, because DOE finds economic justification and potential energy savings in regulating ballasts greater than 500 W and less than or equal to 2000 W, DOE proposes that these fixtures be included in the scope of this rulemaking. DOE requests comment on this proposal.

3. General Lighting

EISA 2007 defines the scope of this rulemaking as applying to fixtures used in general lighting applications. (42 U.S.C. 6291(64)) In section 2 of 10 CFR Part 430, Subpart A, a general lighting application is defined as lighting that provides an interior or exterior area with overall illumination. DOE is proposing to add this definition to 10 CFR 431.2,[14] the section of the CFR that relates to commercial and industrial equipment. DOE applies this definition to determine which lighting applications DOE has the authority to cover.

NEMA and OSRAM SYLVANIA (OSI) recommended capping the greater-than-500 W class at 1000 W because 1000 W is the highest wattage used for general lighting applications, arguing that DOE does not have authority to consider higher wattages. (NEMA, No. 34 at pp. 13–14; OSI, No. 27 at p. 4) OSI also commented that metal halide systems are also used in specialty applications such as stage, theater, television, film, solar simulation, airfield, medical/surgical, microscope, endoscope, video projection, display, treatment of skin disorders, sports, and automotive. OSI recommended that these specialized applications be excluded from this rulemaking. (OSI, No. 27 at p. 7)

DOE's research indicated that there are a number of fixtures available for general lighting applications above 1000 W. The primary application of such fixtures is outdoor sports lighting, which commonly uses metal halide ballasts of 1000 W to 2000 W. Because sports lighting provides overall illumination to an exterior area (playing field and stadium), DOE believes sports lighting does meet the definition of a general lighting application. While DOE agrees that some special applications listed by OSI do not fit under the covered general illumination definition, others, such as sports and airfield lighting, do provide general illumination to an exterior area and are covered by this rulemaking. DOE requests comment on this proposal.

4. Summary

DOE proposes to include metal halide lamp fixtures designed to operate ballasts rated from 50 W to 2000 W and for use in general lighting applications in the scope of coverage. EISA 2007 exempted specific metal halide lamp fixtures from regulation. These included (a) fixtures that include regulated-lag ballasts, (b) fixtures that include 480 V electronic metal halide ballasts, and (c) fixtures that include lamps rated at 150 W with ballasts that (1) are rated for use in wet locations and (2) contain a ballast that is rated to operate at ambient air temperatures greater than 50 °C. In this rulemaking, DOE proposes to continue the exemption for the first two categories (regulated-lag ballasts and 480 V electronic ballasts) but not for the third, certain 150 W fixtures. DOE finds that regulating these 150 W ballasts could provide considerable potential energy savings and would be economically justifiable. As such, DOE proposes that the 150 W ballasts rated for use in wet locations and containing a ballast that is rated to operate at ambient air temperatures greater than 50 °C be covered in this rulemaking.

[14] The general lighting application definition prescribed by EISA 2007 was previously incorporated into the consumer products section (10 CFR Part 430), but has not yet been added to the commercial and industrial equipment section (10 CFR Part 431).

B. Alternative Approaches to Energy Conservation Standards: System Approaches

EISA 2007 requires DOE to set standards for metal halide lamp fixtures. (42 U.S.C. 6295(hh)(2)) As previously stated, although metal halide lamp fixtures usually comprise a metal halide lamp, a metal halide ballast, and other fixture components, EPCA established MHLF energy conservation standards by setting minimum efficiency requirements for only the ballast. For the preliminary analysis, DOE considered three system approaches as alternatives to regulating only ballast efficiency. The first was a lamp and ballast system approach in which the lamp and ballast would be rated together in terms of lumens per lamp-ballast system watts. The second was a whole fixture system approach in which the ballast, lamp, and optics/enclosure would all be rated together in terms of a fixture-level metric such as Fitted Target Efficacy (FTE) or Target Efficacy Rating (TER). The third was an approach similar to California Title 20, which allowed for multiple compliance pathways utilizing a combination of design standards, ballast efficiency standards, and lamp wattage requirements. DOE received several comments on these three system approaches.

In general, interested parties recognized the potential value for system approaches over a ballast efficiency approach, but also noted several limitations related to each possible approach. NEEA supported systems approaches to rating equipment, but did not find any of the three specific approaches discussed in the preliminary analysis to be practicable to implement. (NEEA, No. 31 at p. 2) Philips stated that, generally, NEMA considers the system approach to be the preferred approach for any rulemaking. (Philips, Public Meeting Transcript, No. 33 at p. 32) Philips noted that a system approach is an extremely complex issue and pointed out that there are other metrics beyond those that DOE listed as under consideration. (Philips, Public Meeting Transcript, No. 33 at pp. 36–37) DOE found that the three system approaches considered in the preliminary TSD have the theoretical potential of saving more energy than the current ballast-only approach, but also have many practical limitations. DOE weighed the benefits and drawbacks of each system approach, but for this rulemaking, DOE proposes a ballast-efficiency approach consistent with the current EISA 2007 regulations. DOE discusses each of the system approaches in the following sections. DOE also discusses the possibility of a coordinated metal halide lamp fixture and high-intensity discharge lamp rulemaking in section III.C as an additional approach to considering all aspects of the metal halide lighting system when considering energy conservation standards.

1. Lamp-Ballast System

In the lamp-ballast system approach, metal halide lamp fixtures would be regulated on the basis of a lumens-per-watt metric that assesses the performance of the lamp and ballast included in the fixture. Fixture manufacturers would be required to report the system lumens per watt (lm/W) of every lamp and ballast pair included in their fixtures. This approach has the potential to save more energy and allow more design flexibility for manufacturers. However, this approach is somewhat at odds with current fixture sales practices. Fixture manufacturers commonly ship fixtures with the ballast installed to ensure that the fixture is compliant with fire safety requirements and meets energy conservation standards. There are currently no requirements for fixtures to be shipped with certain lamps, and in general, fixture manufacturers noted that few fixtures are sold with lamps, giving customers flexibility to choose lamps from a variety of manufacturers. In a lamp-ballast system approach, fixture manufacturers would be required to provide fixtures with installed lamps and ballasts, and customers would be limited to predetermined lamp and ballast combinations.

During preliminary interviews, DOE found that there are several metal halide ballast manufacturers that do not manufacture metal halide lamps. In a lamp-ballast system approach, these manufacturers could have a competitive disadvantage compared with manufacturers that manufacture both lamps and ballasts. Manufacturers said that for fixture manufacturers that are not vertically integrated (*i.e.,* fixture manufacturers that do not also produce lamps and ballasts), sourcing lamp and ballast systems is problematic as only a few manufacturers have the capability to provide them. Non-vertically-integrated manufacturers also said that they would not have the same ability to optimize the fixtures as their lamp and ballast-manufacturer competitors. Based on the concern that some manufacturers would be at a disadvantage to their vertically integrated competitors and that fixtures are typically not shipped with lamps, DOE preliminarily determined that ballast efficiency was a better approach than lamp-ballast systems.

NEMA described the pros and cons of a simple lumens-per-watt standard based on a lamp-ballast system. NEMA stated that this methodology provides more technological flexibility and can yield overall higher performance by including the effect of lamp efficacy. On the other hand, NEMA stated that there are compatibility issues with operation of certain lamp and ballast pairs. While some of these compatibility issues would be resolved through use of a database, that database would require management by the industry, which represents additional cost and a reporting burden if manufacturers are required to report on various lamp and ballast combinations. It also might require manufacturers to transport mercury (if DOE mandates that a fixture be sold with a lamp). (NEMA, No. 34 at p. 5)

Georgia Power and NEEA commented on the practical limitations of a lamp-ballast system approach. Georgia Power pointed out that utilities buy lamps and fixtures separately and strive to minimize the number of lamp types that they must stock to use in new and existing fixtures. Georgia Power said that matching different lamps to different ballasts of the same wattage would be costly and very confusing. Additionally, Georgia Power noted that training the installers and relampers would be costly and impractical for the utilities. (Georgia Power, No. 28 at p. 1) NEEA commented that because there is no way to control which replacement lamps are used after the initial lamp fails, real system energy savings may be smaller than forecasts that assume an equivalent lamp is used as a replacement. (NEEA, No. 31 at p. 2)

With regards to lamp-ballast compatibility concerns with a lamp-ballast approach to setting standards, OSI commented that lamp and electronic ballast manufacturers already maintain lists of compatible products, indicating a lamp-ballast approach would not create additional burden. OSI stated that NEMA's main concern is with high-frequency electronic ballasts operating high-wattage lamps. As noted in section V.C.8, these ballasts can create acoustic resonance problems with lamps. The issue is further complicated by the fact that different lamps have different acoustic resonance points. OSI noted that NEMA has assembled a task force on lamp and electronic ballast compatibility issues, and the task force is close to finalizing compatibility test procedures. Once finalized, each manufacturer will conduct testing based on the procedure to determine compatibility with other products. OSI recommended that all electronic metal halide ballasts be designed to meet existing American National Standards Institute (ANSI) standards based on magnetic operation. This redesign will help assure lamp and ballast compatibility. (OSI, No. 27 at p. 7)

In the preliminary TSD, DOE also considered a 'table of standard lamps' for use in a lamp-ballast system standard approach. The use of a table of standard lamps would allow for fixture performance to be assigned to all fixtures, including those not shipped with lamps. This table of standard lamps would allow for conversion of tested ballast efficiency to lumens per watt for determination of compliance with a lamp-ballast system standard, mitigating the potential for lost competitive advantage for ballast-only manufacturers. NEEA commented that they did not agree that a table of standard lamps (and a lamp-ballast system approach without a table of standard lamps) would adequately control which replacement lamps are used in fixtures. (NEEA, No. 31 at p. 2)

DOE recognizes these positive and negative aspects of the lamp and ballast approach (both with and without the table of standard lamps) and has weighed them carefully and tentatively decided not to propose this approach. DOE found that a lamp and ballast system approach might be burdensome due to unresolved compatibility and compliance issues related to specifying performance of every lamp and ballast combination sold. DOE tentatively agrees with Georgia Power's concern that some users could need to stock multiple lamps for pairing with different manufacturers' ballasts of the same wattage, unless they were willing to place all of their lamp and ballast orders from a single supplier. Additionally, once the original lamp fails, customers may replace it with a lower-efficacy alternative. A lamp-ballast system approach could also complicate defining categories and classes. In regards to a lamp-ballast system approach with a table of standard lamps, DOE agrees with NEEA that such a table would not address customers using less-efficacious replacement lamps and does not provide an adequate improvement over a traditional lamp-ballast system approach or a simple ballast efficiency approach. Though inclusion of the table could be more equitable for ballast-only manufacturers, it is still hindered by compliance and compatibility issues, and would likely result in less energy savings than a pure lamp-ballast system approach.

2. Fixtures Systems—Lamp, Ballast, Optics, and Enclosure

For the preliminary TSD, DOE analyzed fixture-level metrics by conducting independent research and interviewing manufacturers. DOE found that fixture energy use depends on four variables: (1) Lamp efficacy; (2) ballast efficiency; (3) light absorption by the fixture; and (4) usefulness of light emitted by the fixture (direction or light distribution pattern). DOE considered two alternative metrics to quantify these areas of importance, namely FTE and TER. DOE drafted the FTE metric for the solid-state lighting (SSL) ENERGY STAR® program. NEMA, along with its luminaire division, developed TER. FTE and TER metrics treat each fixture-energy-use area of importance more effectively in some ways than others.

The FTE metric measures the fixture performance by fitting a rectangle to a uniform ''pool'' of light for each fixture, then multiplying the lumens delivered to this pool by the percent coverage of the rectangular target, and dividing the result by input watts to the fixture. Because FTE was developed for roadway and parking lot applications, separate algorithms for each respective application would need to be calculated and verified. As FTE is calculated using a rectangular area, a fixture that is designed to (1) light a non-rectangular area, (2) produce a large amount of unlighted area within the rectangle, or (3) produce specific light patterns that light both a horizontal plane and a vertical plane, or even above the fixture, will be at a disadvantage.

TER involves calculating fixture efficacy by multiplying the light leaving the fixture by the Coefficient of Utilization (CU), which factors in the distribution of light, room geometry, and room surface reflectances. CU represents the percentage of rated lamp lumens reaching the workplane. The calculation of efficacy for TER also takes into account lamp and ballast efficiency. TER has 22 different types of luminaire classifications, each with a different TER calculation method and value,[15] though every classification is not applicable to metal halide lamp fixtures.

For the preliminary TSD, DOE tentatively decided not to implement either FTE or TER. DOE found that FTE only accounts for light hitting the specified test area and does not take into account other surfaces that the fixture is designed to light. This methodology disadvantages fixture types not designed to light a uniform, flat, rectangular space. DOE tentatively decided not to use TER out of concern that certain fixtures could fall within multiple categories of fixture due to their designs. Because of the need for uniformity and more simplicity, DOE preliminarily found TER unsuitable this rulemaking. The following discussion describes the comments DOE received about the use of these metrics.

Georgia Power and Progress Energy Carolinas suggested that TER and FTE were better metrics than the current ballast-efficiency metric because they address the optical performance of the entire fixture, accounting for light directionality and losses. (Georgia Power, No. 28 at p. 1; Progress Energy Carolinas, No. 24 at p. 1) However, NEEA commented that it did not believe that FTE or TER is appropriate as the basis for energy efficiency standards at this time. NEEA stated that either approach could be used as a design optimization framework, but both have sufficient drawbacks and lack of field implementation experience that render them unusable as the basis for a minimum efficiency standard. (NEEA, No. 31 at p. 2) NEMA agreed with the preliminary TSD, stating that because this rulemaking covers all types of products (*e.g.,* downlights, track lighting, industrial highbay/lowbay, streetlighting, roadway lighting, floodlights, parking lots, parking garages), it is challenging to define a metric that effectively covers all applications without flawed assumptions. Specifically, NEMA pointed out that none of the metrics considered covers equipment that is designed to be aimed or tilted. (NEMA, No. 34 at p. 6) Both NEEA and Empower Electronics also supported DOE's determination from the preliminary TSD not to use either FTE or TER. (NEEA, No. 31 at p. 2; Empower Electronics, No. 36 at p. 4)

Though a fixture-level metric has the potential to save the most energy, DOE does not believe an approach currently exists that adequately assesses the types of metal halide lamp fixtures included in this rulemaking. Because FTE is focused on applications that deliver light to a horizontal space and a TER standard would require fixture classifications that have not yet been developed, DOE has determined that ballast efficiency is a better approach at this time. Therefore, DOE does not find fixture-level metrics practicable for setting standards for this equipment at this time, and proposes not to use a system-approach metric in this rulemaking.

[15] There are two main calculation methods—one for indoor and one for outdoor applications. The methods are then customized to each classification.

3. California Title 20 Approach

California's Title 20 [16] includes regulations that aim to reduce energy consumption in appliances, including metal halide lamp fixtures.[17] For metal halide lamp fixtures, Title 20 requires compliance through one of four primary paths: (1) The use of lamps from reduced-wattage bins with a minimum 88 percent efficient ballast; (2) an integrated motion sensor and high-low control with a minimum 88 percent efficient ballast; (3) an integrated daylight sensor and high-low control (for indoor only) with a minimum 88 percent efficient ballast; and (4) high-efficiency ballasts with a minimum efficiency of 90 percent for 150 W to 250 W lamps or 92 percent for 251 W to 500 W lamps. In the preliminary TSD, DOE requested comment on the implementation of a similar approach, with multiple options for compliance, including the integration of controls.

Several commenters gave direct feedback on the Title 20 approach. Energy Solutions supported DOE's consideration of a Title 20 or Title-20-like approach. (Energy Solutions, Public Meeting Transcript, No. 33 at p. 39) NEMA and Acuity Brands Lighting (Acuity) stated that although it also adds complexity to the associated enforcement and reporting, the Title 20 approach provides flexibility for manufacturers and designers. Additionally, NEMA and Acuity noted that the Title 20 requirement for 336 W to 500 W reduced-wattage lamps to produce 80 lm/W is not currently achievable. Acuity requested that DOE not consider these lamp specifications, and stated that they have been working with the California Energy Commission (CEC) to correct that efficacy level. (NEMA, No. 34 at p. 6; Acuity, Public Meeting Transcript, No. 33 at p. 41)

NEMA and Philips then addressed regulations that consider lamps and ballasts simultaneously for analysis, but assign performance metrics to each component individually. NEMA commented that they would support regulation that allows for lower ballast efficiency requirements in conjunction with higher lamp efficacy requirements. However, NEMA noted that a requirement to ship high-efficacy lamps in new fixtures would not prevent future replacement of these lamps with lower-efficacy alternatives. (NEMA, No. 34 at p. 5) Philips noted that it is possible to specify certain lamps for particular fixtures through an Underwriters Laboratories (UL) listing. Philips explained that if a ballast and a fixture are labeled for a particular lamp, then that fixture would only keep its UL listing when that lamp is used. This could mitigate the risk that the type of lamp originally packaged with the fixture would be replaced with a less-efficacious alternative. Additionally, Philips pointed out that for ENERGY STAR and fluorescent lamps, NEMA has maintained a table of corresponding lamp and ballast efficacies so that fixture manufacturers can easily select compliant products. Philips suggested that DOE could create a similar database for this rulemaking. (Philips, Public Meeting Transcript, No. 33 at pp. 33–34)

DOE also received many comments on the controls and dimming compliance pathways of the Title 20 approach. The CA IOUs noted that dimming and occupancy controls can greatly reduce the overall electricity consumption of a lighting system. The CA IOUs stated that many electronic ballasts in the 150 W to 575 W range include dimming circuitry. (CA IOUs, No. 32 at p. 5) OSI agreed that the use of dimming as an energy-saving tool is growing. OSI clarified that it is actually easier to develop an electronic metal halide dimming ballast than a magnetic one; and the electronic ballast will provide more utility for the end user. (OSI, No. 27 at p. 3) The CA IOUs specifically noted that for outdoor fixtures, from a public safety standpoint, dimming can be prohibitively slow in magnetic ballasts. However, there are commercially available electronically ballasted systems with appropriate response times that are much better suited for the transition towards fully controllable and dimmable fixtures. (CA IOUs, No. 32 at p. 5)

Several commenters provided feedback on the relative merits of electronic metal halide lamp dimming, magnetic metal halide lamp dimming, and other lighting technologies like fluorescent lighting. OSI explained that magnetic ballasts (by using a split capacitor) can only provide two light levels (bi-level dimming). An electronic ballast has a microprocessor to provide stepped dimming at programmed levels or continuous dimming using a 0 to 10 V signal. A continuously dimming ballast is compatible with daylight harvesting, scheduling, building management, demand response systems, and other processes where dimming is desirable. OSI stated that dimming can be provided in various applications, including outdoor lighting, by replacing a magnetic ballast with an electronic one with no rewiring needed. (OSI, No. 27 at p. 3) Progress Energy Carolinas stated that bi-level dimming in magnetic ballasts has been around for years and has a proven track record. Although there is an efficacy decrease associated with dimming to 50 percent, Progress Energy Carolinas concluded that bi-level dimming is cost effective. (Progress Energy Carolinas, No. 24. at pp. 1–2) NEMA stated, however, that the incremental cost associated with an integrated bi-level dimming control in a metal halide lamp fixture can almost double the overall fixture cost. By contrast, the cost of integrated controls for a fluorescent lamp fixture designed for the same application requirements are about 30 to 40 percent higher than without controls, and the controls have more functionality due to the instant on and continuous dimming capability of the fluorescent system. For these reasons, NEMA argued that bi-level dimming with metal halide lamp fixtures is more costly and has less functionality than alternative technologies. (NEMA, No. 34 at p. 9)

Next, DOE received several comments relating to the applications that commonly use dimming, and the potential for difficulty in distinguishing some of these categories based on technical features. NEMA pointed out that although dimming metal halide lamp fixtures in certain applications where there is sporadic or limited occupancy (*e.g.,* high-bay and low-bay applications for warehousing) can result in significant energy reduction, many MHLF applications are not well suited for bi-level control capabilities, such as operations and roadway lighting that operates 24 hours per day, 7 days per week. (NEMA, No. 34 at p. 9) Progress Energy Carolinas also noted that apart from dusk-to-dawn photocontrol, occupancy sensors will not work for street lighting. Progress Energy Carolinas stated that street lighting would need to be controlled with a smart-box type of control. (Progress Energy Carolinas, No. 24 at p. 2) Cooper Lighting suggested that DOE analyze dimming in roadway lighting separately from other applications. (Cooper, Public Meeting Transcript, No. 33 at p. 40) Georgia Power recognized that the specifics of which applications can and cannot be dimmed, and how to measure energy reduction in unmetered applications (*e.g.,* roadway lighting provided by a utility), will be complex. (Georgia Power, No. 28 at p. 1) NEMA noted that because DOE cannot distinguish products based on application type, it is unclear how DOE would describe regulatory requirements without specifying the use of controls based on application characteristics.

[16] *www.energy.ca.gov/regs/title20/index.html.*

[17] California's term 'metal halide luminaire' refers to the same item as DOE's 'metal halide lamp fixture.'

(NEMA, No. 34 at p. 9) Specifically, NEMA also observed that the Title 20 approach requires differentiation between indoor and outdoor products, which DOE would have to define based on product attributes. (NEMA, No. 34 at p. 6)

Several commenters reported on the low percentage of fixtures using the controls pathways to compliance for California Title 20. Energy Solutions and the CA IOUs reported that of the chosen compliance pathways recorded in the CEC Appliance Database, most are either the reduced lamp wattage or the ballast efficiency requirement; not many report the controls compliance pathway. (Energy Solutions, Public Meeting Transcript, No. 33 at pp. 39–40; CA IOUs, No. 32 at p. 2) Philips explained that the controls compliance pathway has not been embraced because Title 20 requires all pieces of a control system to be integral to the fixture. Philips urged DOE to consider that a simplified approach to controllable fixtures would encourage more dimming systems and, therefore, more energy savings. (Philips Lighting Electronics, Public Meeting Transcript, No. 33 at p. 40) Similarly, NEMA supported the concept of controllable fixtures and also suggested that controls be separate from the fixture for any regulations. NEMA stated that any incorporation of controls should be technology-neutral, allowing various control technologies without requiring the control to be integral to the fixture. (NEMA, No. 34 at p. 6)

NEEA expressed concern over any forecasted energy savings resulting from the implementation of dimming ballasts, commenting that the presence of controls and the capability of dimming are no guarantee of use, and therefore, no guarantee of the promised energy savings. Consequently, NEEA did not agree with a Title 20 approach as part of a federal minimum efficiency standard. Furthermore, NEEA opposed DOE's adoption of the Title 20 approach because California's regulatory approach depends heavily on the existence of its Title 24 regulations (which have no DOE analog) for compliance and enforcement, including verifying the installation of the qualifying components that would meet the system requirements. For these reasons, NEEA felt that the Title 20 approach is unworkable at the federal level. (NEEA, No. 31 at p. 3)

In response to the various approaches in California Title 20, DOE is concerned that adopting these methods would risk reducing energy savings and complicating compliance and enforcement relative to ballast-efficiency-only regulations. With regards to the controls/dimming approach, DOE tentatively agrees that a standard requiring the presence of controls or dimming does not ensure energy savings. DOE believes that the use of such technologies is much less popular for metal halide systems relative to other lighting technologies. Metal halide lamp fixtures typically take 5 to 10 minutes to re-strike and turn on again after being turned off, so controls that would turn metal halide lamp fixtures on and off more frequently have less utility relative to lighting with instant restarting capability. Additionally, a majority of metal halide lamp fixtures installed today use magnetic ballasts. Magnetic ballasts are typically only capable of bi-level dimming, giving them less functionality compared to other lighting technologies. Regarding the approach to allow less-efficient ballasts when sold in fixtures with more efficacious lamps, DOE is concerned that some energy savings could be lost if the lamp is replaced with a less efficacious lamp after the first failure, similar to its conclusions with lamp and ballast systems. Given the uncertainty of resulting energy savings, DOE has tentatively decided not to propose Title-20-like standards in this rulemaking.

C. Combined Rulemakings

In addition to system approaches, another method for maximizing energy savings and simplifying compliance would be to combine the metal halide lamp fixture and high-intensity discharge (HID) lamp rulemakings (Docket EERE–2010–BT–STD–0043). These rulemakings are related because the MH lamps used in metal halide lamp fixtures are a subset of HID lamps. During the comment period and the public meeting for the metal halide lamp fixture preliminary TSD, and also in subsequent manufacturer interviews, DOE received requests that DOE consider metal halide lamp fixtures and HID lamps in a combined manner. The stated benefits of this approach include maximizing potential energy savings, avoiding conflicting rules for related technologies, avoiding duplicative efforts, improving consistency and ease of review, saving taxpayer dollars, and simplifying compliance. Based on the outcome of this NOPR, DOE will consider how to best combine the rulemakings.

OSI, NEMA, and Philips commented that the metal halide lamp fixture rulemaking should be conducted in conjunction with metal halide lamp rulemakings. (OSI, No. 27 at p. 6; NEMA, Public Meeting Transcript, No. 33 at p. 15; NEMA, No. 34 at p. 5; Philips, Public Meeting Transcript, No. 33 at p. 32) NEMA expressed concern that potential energy savings could be missed by keeping the metal halide lamp fixtures and HID lamps rulemakings separate. (NEMA, Public Meeting Transcript, No. 33 at p. 15) OSI and NEMA recommended that the ballast efficiency and lamp efficacy regulations be completed in conjunction so that overall system efficacy can be recognized in resulting regulations. (OSI, No. 27 at p. 6; NEMA, No. 34 at p. 21) Additionally, Philips stated that keeping the lamp and ballast rulemakings separate will add complexity to maintaining lamp and ballast compatibility. (Philips, Public Meeting Transcript, No. 33 at p. 32) Philips noted that if ballast regulations eliminate certain ballast types, they may also take certain lamps out of the market, losing all energy savings that were meant to be generated by the lamps' standards. (Philips, Public Meeting Transcript, No. 33 at p. 132)

In its work to date on the HID lamp and MHLF energy conservation standards, DOE has identified and is using a number of shared data sources and analytical processes in the two rulemakings. The following is an initial inventory of rulemaking data and processes either fully or partially shared between HID lamps and metal halide lamp fixtures:

- market and technology assessments;
- distribution channels and price markups;
- annual operating hours;
- lamp, fixture, and ballast lifetimes;
- lamp lumen maintenance;
- installation times and costs;
- electricity prices;
- discount rates;
- lamp and fixture shipments;
- life-cycle cost (LCC) subgroup analysis; and
- Regulatory impact analysis.

DOE is currently evaluating the data and analytical processes that are shared between the two rulemakings.

D. Standby Mode and Off Mode Energy Consumption Standards

EPCA requires energy conservation standards adopted for covered equipment after July 1, 2010 to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) The requirement to incorporate standby mode and off mode energy use into the energy conservation standards analysis is therefore applicable in this rulemaking. 10 CFR 431.322 defines the terms ''active mode,'' ''standby mode,'' and ''off mode'' as follows:

- ''Active mode'' is the condition in which an energy-using piece of equipment is connected to a main power source, has been activated, and provides one or more main functions.

• ''Off mode'' is the condition in which an energy-using piece of equipment is connected to a main power source, and is not providing any standby or active mode function.

• ''Standby mode'' is the condition in which an energy-using piece of equipment is connected to a main power source and offers one or more of the following user-oriented or protective functions: facilitating the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer; or providing continuous functions, including information or status displays (including clocks) or sensor-based functions.

For the preliminary TSD, DOE analyzed these definitions to determine their applicability to metal halide lamp fixtures. DOE tentatively found that it is possible for metal halide fixtures to operate in active mode and standby mode. The off mode condition does not apply because metal halide lamp fixtures do not operate in off mode. 74 FR 33171, 33175 (July 10, 2009).[18] Therefore, for this energy conservation standard rulemaking, DOE only considered the active mode and standby mode energy use provisions from EISA 2007 applicable to metal halide lamp fixtures that are (or could be) covered by this rulemaking.

DOE recognizes that metal halide lamp fixtures can be designed with auxiliary control devices, which could consume energy in standby mode. One example of this fixture design involves Digitally Addressable Light Interface (DALI) enabled ballasts. These ballasts may draw power in standby mode, as the internal circuitry remains on and active even when the ballast is not driving any lamps. DOE has yet to encounter such a ballast that it could purchase. DOE has continued to search for and consider DALI-enabled fixtures, as well as other types of metal halide lamp fixtures, to evaluate the issue of standby mode energy use in metal halide lamp fixtures. In the preliminary TSD, DOE tentatively concluded that it cannot establish a separate standard that incorporates standby mode energy use and invited comments on the issue of standby mode and ballast designs that incorporate it.

Philips and NEMA both expressed NEMA's view, agreeing that a standard cannot be established for standby mode energy consumption. (Philips, Public Meeting Transcript, No. 33 at p. 29, NEMA, No. 34 at p. 3) Empower Electronics also commented that a standby mode energy standard cannot be established. (Empower Electronics, No. 36 at p. 2) NEEA agreed with DOE's findings and proposals for standby mode and off mode. (NEEA, No. 31 at p. 2)

With no new findings with regard to ballasts drawing power in standby and off modes and comments supporting DOE's preliminary proposal, DOE continues to conclude in this NOPR that it cannot establish a separate standard that incorporates standby mode or off mode energy consumption.

IV. General Discussion

A. Test Procedures

1. Current Test Procedures

The current test procedures for metal halide ballasts and fixtures are outlined in Subpart S of 10 CFR Part 431. The test conditions, setup, and methodology generally follow the guidance of ANSI C82.6–2005. Testing requires the use of a reference lamp, which is to be driven by the ballast under test conditions until the ballast reaches operational stability. Ballast efficiency for the fixture is then calculated as the measured ballast output power divided by the ballast input power. In this NOPR, DOE proposes changes to test input voltage, testing electronic ballasts, and rounding requirements.

2. Test Input Voltage

Metal halide ballasts can be operated at a variety of voltages, with different voltages chosen based on the application and use of the fixture. The most common voltages are 120 V, 208 V, 240 V, 277 V, and 480 V. Ballasts will also commonly be rated for more than one, such as dual-input-voltage ballasts that can be operated on 120 V or 277 V, or quad-input-voltage ballasts that can be operated on 120 V, 208 V, 240 V, or 277 V. DOE received manufacturer feedback that the specific design of a ballast and the voltage of the lamp operated by the ballast can affect the trend between input voltage and efficiency. DOE likewise observed that changes in efficiency (on the level of several percent) were possible in individual ballasts based on its own testing of multiple-input-voltage ballasts.

The existing test procedures do not specify the voltage at which a ballast is to be tested. Therefore, to ensure consistency among testing and reported efficiencies, the input voltage should be specified in the test procedures. To set an energy conservation standard based on test data, DOE needed to determine which input voltage to use for its data. In addition, manufacturers would need to their equipment at the same input voltage that DOE used when developing energy conservation standards for the regulations to have the intended effect. Because the majority of ballasts sold are capable of operating at multiple input voltages, DOE is considering standardizing this aspect of testing. In the preliminary TSD, DOE requested comment on this issue, specifically on the possibility of testing at all input voltages and reporting the average of the efficiencies. DOE discusses several input voltage specification options in the following paragraphs.

a. Average of Tested Efficiency at All Possible Voltages

In the preliminary TSD, DOE asked for comment on the possibility of testing ballasts at each input voltage at which they are able to operate, then having a standard for the average of these efficiencies. NEEA commented that they saw the positive aspects of this method of testing. NEEA said that even though it would increase testing burden, it would also reduce efficiency bias associated with input voltage. (NEEA, No. 31 at p. 2) Philips commented that adapting a magnetic ballast for use with multiple input voltages lowers the efficiencies on one or more of the voltages, but the market has demanded the use of multi-tap ballasts, especially because the manufacturers desire to reduce inventory in an effort to lower cost. (Philips, Public Meeting Transcript, No. 33 at p. 28) NEMA said it disagreed with measuring at multiple voltages and then averaging due to the increased testing burden and associated costs. (NEMA, No. 34 at p. 2) Although DOE found little difference in ballast efficiency at different input voltages, DOE recognizes the possibility for efficiencies associated with rarely used input voltages to skew the overall efficiency of ballasts under this averaged-efficiencies approach. For example, a ballast might have the capability to operate on 120 V and 277 V at approximately 90 percent efficiency, but at 208 V (an uncommon input voltage for metal halide lighting) it operated at only 88 percent efficiency. Averaging these three efficiencies would lead to a reported value of about 89 percent, when the ballast will in all

[18] The definition of ''off mode'' requires that ballasts be connected to a main power source and not provide any standby mode or active mode function. (42 U.S.C. 6295(gg)(1)(A)(ii)) As discussed in the metal halide ballast test procedures, DOE does not believe that there is any condition in which the ballast is connected to the main power source and is not already accounted for in either active mode or standby mode.

likelihood only operate at 120 V or 277 V (at 90 percent efficiency). In this instance, averaging the efficiencies misrepresents the performance of the ballast in its most common uses. Additionally, DOE recognizes that testing at each input voltage could increase the burden relative to a requirement of testing ballasts at only a single voltage. For these reasons, in this NOPR, DOE is not proposing to test at all available input voltages and average the resulting efficiencies.

b. Posting the Highest and Lowest Efficiencies

Another approach, suggested by Empower Electronics, would require testing at each input voltage and listing the best and worst efficiencies on the product label. (Empower Electronics, No. 36 at p. 2) DOE acknowledges that, as with voltage averaging, this method could help address the concern that a manufacturer could optimize their ballasts on a voltage that could easily increase in efficiency, while most customers would be using a non-optimized voltage. Also similar to voltage averaging, however, DOE finds that this approach would lead to a compliance burden for manufacturers and would increase the required tests compared to a requirement to test ballasts only at a single voltage.

c. Test at Single Manufacturer-Declared Voltage

In response to the preliminary TSD, NEMA suggested that the test procedures should allow testing at a single voltage determined by the manufacturer and declared in the test report. (NEMA, No. 34 at p. 2) In manufacturer interviews, DOE received feedback that manufacturers optimize ballasts at a specific voltage and prefer to test their products at that voltage. DOE is concerned, however, that manufacturers might optimize efficiency at a voltage that is most convenient or least expensive rather than the voltage most used by customers. Were manufacturers to optimize efficiency at a less commonly used voltage, the efficiency claimed at this voltage would not be representative of typical efficiency in the more common uses. Because the efficiency at the manufacturer-declared voltage and the efficiency at the more commonly used voltages may not have direct correlation, such test procedures could potentially reduce the energy savings of this rulemaking.

d. Test at Highest-Rated Voltage

Another input voltage specification could be that the ballast should be tested at the highest voltage possible. OSI commented, and NEEA agreed, that fluorescent ballast test procedures set the precedent for having to test only at the highest rated voltage. They also said that this would reduce costs associated with additional testing for metal halide ballasts. (OSI, Public Meeting Transcript, No. 33 at p. 29; NEEA, No. 31 at p. 2) DOE understands the concern regarding increased burdens and costs associated with being required to test ballasts at multiple input voltages. DOE's research, however, found that a ballast's highest-rated voltage is not always its most common input voltage. For example, DOE found a significant number of 70 W ballasts that were capable of operating on 120 V, 208 V, 240 V, and 277 V. Testing at the highest-rated voltage would mean these ballasts are tested at 277 V, but manufacturer feedback indicated that 70 W ballasts are much more likely to be actually used in 120 V applications. One possible reaction to energy conservation standards based on this test procedure specification could be for manufacturers to optimize 70 W ballasts at 277 V (the tested voltage) as opposed to 120 V (the more commonly used voltage). Because of this possibility, DOE finds that testing and enforcing standards at the highest voltage could reduce the potential energy savings of this rulemaking.

e. Test on Input Voltage Based on Wattage and Available Voltages

In this NOPR, DOE is proposing that the most common input voltages for each wattage range be used in testing. Progress Energy Carolinas commented that an amendment to the current test procedures that would specify the required input voltage for testing would not provide enough energy savings for the additional expense. (Progress Energy Carolinas, No. 24 at p. 2) DOE disagrees with Progress Energy Carolinas' assertion that an added expense is inherent in specification of the input voltage for testing. DOE's proposal only requires testing at one input voltage, the minimum number of tests possible. By proposing testing at a single voltage, DOE reduces testing burden relative to a requirement for testing at multiple input voltages. In addition, because the input voltage specification matches the most commonly used voltage, the requirement encourages optimization of efficiency around an input voltage commonly used in practice. Finally, analysis of the impact of energy savings for this rulemaking is made more accurate by assessing ballast efficiency at the most commonly used input voltages.

In manufacturer interviews, DOE received feedback on usage of different input voltages. DOE learned that 208 V is the least used and least optimized voltage. DOE also received feedback that efficiencies at 277 V and 240 V are similar to each other. In general, DOE determined that fixtures with wattages less than 150 W were most often used at 120 V. Wattages of 150 W and above were most commonly used at 277 V. Thus, this NOPR proposes that testing of metal halide ballasts use the following input voltages:

- For ballasts less than 150 W that have 120 V as an available input voltage, ballasts are to be tested at 120 V.
- For ballasts less than 150 W that lack 120 V as an available voltage, ballasts should be tested at the highest available input voltage.
- For ballasts operated at greater than or equal to 150 W and less than or equal to 2000 W that also have 277 V as an available input voltage, ballasts are to be tested at 277 V.
- For ballasts greater than or equal to 150 W and less than or equal to 2000 W that lack 277 V as an available input voltage, ballasts should be tested at the highest available input voltage.

3. Testing Electronic Ballasts

With regards to testing electronic metal halide ballasts, DOE received feedback on several issues in response to the preliminary TSD. Some interested parties commented that the test procedures do not apply to any electronic ballasts and others commented that high-frequency electronic ballast testing is not specified and is more prone to measurement variation than low-frequency electronic ballast testing is. DOE discusses these comments below.

In the preliminary TSD, DOE noted that it would continue to use the 2005 version of ANSI C82.6 for testing both electronic and magnetic ballasts. Philips and Venture both commented that there are currently no test procedures for electronic ballasts. (Philips, Public Meeting Transcript, No. 33 at p. 130; Venture, Public Meeting Transcript, No. 33 at p. 130) Both Cooper and NEMA noted that an update to ANSI C82.6 that was to be released by the end of 2011 would include test procedures for low-frequency electronic (LFE) ballasts, but not high-frequency electronic (HFE) ballasts.[19] (Cooper, Public Meeting Transcript, No. 33 at pp. 27–28; NEMA, No. 34 at p. 2) NEEA commented that

[19] At the time of development of this NOPR in mid-2012, an update to ANSI C82.6–2005 was not yet available.

this delay should preclude DOE from altering the test procedures for electronic metal halide ballasts at this time. (NEEA, No. 31 at p. 2) In DOE's reading of ANSI C82.6, the scope dictates testing HID lamp ballasts without specifying applicability only to magnetic ballasts. In interviews with manufacturers, DOE received feedback confirming that ANSI C82.6–2005 does provide a method for testing low-frequency ballasts. Additionally, section 4.4.3 of ANSI C82.6–2005 discusses low-frequency electronic ballasts in the context of alternative stabilization methods.

DOE also received comments that HFE ballasts should be excluded from the rulemaking because there are no test procedures for them. Philips, OSI, and NEMA noted that the available equipment cannot test HFE ballast frequencies above 125 kHz as accurately as other ballasts, and Philips noted that HFE ballast testing accuracy can range from plus or minus two to five percent. (Philips, Public Meeting Transcript, No. 33 at p. 130; NEMA, No. 34 at p. 14; OSI, No. 27 at p. 4) NEEA commented that manufacturers stated that there are no ANSI or NEMA HFE standards, and that no test procedures could accurately assess the efficiency of these ballasts to within plus or minus one percent. Based on this information, NEEA recommended that DOE should not consider these products in this rulemaking. (NEEA, No. 31 at p. 9) Empower Electronics commented that the test procedures should be amended to include HFE ballast testing. (Empower Electronics, No. 36 at p. 2) DOE agrees that the instrumentation in ANSI C82.6–2005 is specified only up to 800 Hz for ammeters and voltmeters and to 1 kHz for wattmeters, and also that these would be insufficient for measurements of HFE ballasts.

DOE is proposing to amend the metal halide ballast and fixtures test procedures to specify the instrumentation required to test HFE ballasts. DOE found that the instrumentation commonly used for high-frequency electronic metal halide ballast testing is the same instrumentation used for fluorescent lamp ballast testing. DOE proposes that instrumentation at least as accurate as required by ANSI C82.6–2005 be used to assess the output frequency of the ballast. Once the output frequency is determined to be greater than or equal to 1000 Hz, (the frequency at which DOE proposes to define high-frequency electronic ballasts), the test procedure instrumentation would be required to include a power analyzer that conforms to ANSI C82.6–2005 with a maximum of 100 picofarads (pF) capacitance to ground and frequency response between 40 Hz and 1 MHz. The test procedures would also require a current probe compliant with ANSI C82.6–2005 that is galvanically isolated and has a frequency response between 40 Hz and 20 MHz, and lamp current measurement where the full transducer ratio is set in the power analyzer to match the current to the analyzer. The full transducer ratio would be required to satisfy:

$$\frac{I_{in}}{V_{out}} \times \frac{R_{in}}{R_{in} + R_s}$$

Where:

I_{in} is current through the current transducer;
V_{out} is the voltage out of the transducer;
R_{in} is the power analyzer impedance; and
R_s is the current probe output impedance.

4. Rounding Requirements

DOE also proposes to amend the metal halide ballast test procedure requirements for measuring and recording input wattage and output wattage to require rounding to the nearest tenth of a watt, and the resulting calculation of efficiency to the nearest tenth of a percent. Through testing, DOE found that testing multiple samples of the same ballast yielded a range of ballast efficiencies typically differing by less than one percent. Because this data introduces both test measurement and sample to sample variation, the test measurement itself should be at least this accurate. Therefore, DOE believes its test procedures can resolve differences of less than one percent and rounding to the tenths decimal place would be reasonable.

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis based on information it has gathered on 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 this analysis, DOE develops a list of design options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of these options for improving efficiency is 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)

Once DOE has determined that particular design options are technologically feasible, it evaluates each of these design options according to the following three screening criteria: (1) Practicability to manufacture, install, or service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. Section V.B of this notice discusses the results of the screening analysis for metal halide lamp fixtures. In particular, it lists the designs DOE considered, those it screened out, and those that are the basis for the TSLs in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the NOPR TSD.

2. Maximum Technologically Feasible Levels

Section 325(o) of EPCA requires that when DOE amends standards 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 that product. (42 U.S.C. 6295(o)) Accordingly, DOE determined the maximum technologically feasible (''max tech'') ballast efficiency in this NOPR's engineering analysis, using the design options identified in the screening analysis (see chapter 4 of the NOPR TSD).

To determine the max tech level, DOE conducted a survey of the MHLF market and the research fields that support the market. DOE's view based on test data is that within a given equipment class, no working prototypes exist that have a distinguishably higher ballast efficiency than currently available equipment. Therefore, the highest efficiency level presented, which represents the most efficient tier of commercially available equipment, is the max tech level for this rulemaking. This highest efficiency level requires electronic ballasts using the best components and circuit topologies commercially available for fixtures rated ≥50 W to ≤500 W. The max tech efficiency level requires the highest grades of core steel and copper windings for the fixtures rated >500 W and ≤2000 W.

DOE did not screen out any technology options in the preliminary analysis. DOE received several comments regarding its determination of max tech ballast efficiency in the preliminary TSD. These comments are discussed in section V.C.8. For this NOPR, DOE conducted additional analysis to determine the appropriate max tech levels for metal halide ballasts. As discussed in section V.C.3, DOE added 150 W as a representative wattage, and tested ballasts to establish an appropriate max tech level for this wattage. DOE also conducted additional testing of the 70 W, 250 W, 400 W, and 1000 W ballasts on the market, and determined the highest efficiency levels that are technologically feasible within each equipment class. As discussed in section V.C.9, data for each equipment class has been fit with a wattage-efficiency equation to determine the minimum efficiency levels. Table IV.1 presents the max tech efficiencies for each wattage range analyzed in the NOPR.

TABLE IV.1—MAX TECH LEVELS

Equipment class wattage range	Efficiency level*	Efficiency level equation %
≥50 and ≤100	EL4	100/(1+0.36*P∧(−0.3))†.
>100 and <150*	EL4	100/(1+0.36*P∧(−0.3)).
≥150** and ≤250	EL4	100/(1+0.36*P∧(−0.3)).
>250 and ≤500	EL4	100/(1+0.36*P∧(−0.3)).
>500 and ≤2000	EL2	For >500 W to <1000 W: 3.2*10∧(−3)*P + 89.9 For ≥1000 W to ≤2000 W: 93.1.

* Includes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

** Excludes 150 W fixtures exempted by EISA 2007, which are fixtures rated only for 150 watt lamps; rated for use in wet locations, as specified by the National Electrical Code 2002, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029–2001.

† P is defined as the rated wattage of the lamp that the fixture is designed to operate.

DOE requests comment on its selection of the max tech levels and whether it is technologically feasible to attain these high efficiencies. Specifically, DOE seeks data on the potential change in efficiency, the design options employed, and the associated change in cost. Any design option that DOE considers to improve efficiency must meet the four criteria outlined in the screening analysis: technological feasibility; practicability to manufacture, install, and service; adverse impacts on product or equipment utility to customers or availability; and adverse impacts on health or safety. DOE also requests comment on any technological barriers to an improvement in efficiency above the max tech efficiency levels for all or certain types of ballasts.

C. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the equipment that are the subject of this rulemaking purchased in the 30-year period that begins in the year of compliance with new or amended standards (2016–2045). The savings are measured over the entire lifetime of products purchased in the 30-year period.[20] DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. The base case represents a projection of energy consumption in the absence of amended mandatory efficiency standards, and considers market forces and policies that affect demand for more efficient equipment. For example, in the base case, DOE models a migration from covered metal halide lamp fixtures to higher-efficiency technologies such as high-intensity fluorescent (HIF), induction lights, and light-emitting diodes (LEDs). DOE also models a move to other HID fixtures such as high-pressure sodium, based on data given by manufacturers during the 2010 framework public meeting. (Philips, Public Meeting Transcript, No.8 at p. 91)

DOE used its NIA spreadsheet to estimate energy savings from new or amended-standards for the metal halide lamp fixtures that are the subject of this rulemaking. The NIA spreadsheet model (described in section V.G of this notice and in chapter 11 of the NOPR TSD) calculates energy savings in site energy, which is the energy directly consumed by products at the locations where they are used. DOE reports national energy savings on an annual basis in terms of the source (primary) energy savings, which is the savings in the energy that is used to generate and transmit the site energy. To convert site energy to source energy, DOE derived annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) *Annual Energy Outlook 2013* (*AEO2013*).

DOE has begun to also estimate energy savings using full-fuel-cycle metrics. The full-fuel-cycle (FFC) metric includes the energy consumed in extracting, processing, and transporting primary fuels, and, thus, presents a more complete picture of the impacts of efficiency standards. DOE's approach is based on application of FFC multipliers for each fuel type used by covered products and equipment, as discussed in DOE's statement of policy published in the **Federal Register** on August 18, 2011 (76 FR 51281), and in the notice of policy amendment. 77 FR 49701 (August 17, 2012).

2. Significance of Savings

As noted above, 42 U.S.C. 6295(o)(3)(B) prevents DOE from adopting a standard for a covered product unless such standard would result in ''significant'' energy savings. Although the term ''significant'' is not defined in the Act, the U.S. Court of Appeals, in *Natural Resources Defense Council* v. *Herrington,* 768 F.2d 1355, 1373 (D.C. Cir. 1985), indicated that Congress intended ''significant'' energy savings in this context to be savings that were not ''genuinely trivial.'' The energy savings for all of the TSLs considered in this rulemaking (presented in section VI.B.3) are nontrivial, and, therefore, DOE considers them ''significant'' within the meaning of section 325 of EPCA.

D. Economic Justification

1. Specific Criteria

As noted in section II.A, 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)) The following sections discuss how DOE addresses each of those seven factors in this rulemaking.

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

a. Economic Impact on Manufacturers and Customers

In determining the impacts of a new or amended standard on manufacturers, DOE first determines quantitative impacts using an annual-cash-flow approach. This approach includes both a short-term assessment—based on the cost and capital requirements during the period between the announcement of a regulation and when the regulation comes into effect—and a long-term (30-year) assessment. The quantitative impacts analyzed include INPV (which values the industry based on expected future cash flows), annual cash flows, and changes in revenue and income. Second, DOE analyzes and reports the impacts on different types of manufacturers, including an analysis of impacts on small manufacturers. Third, DOE considers the impact of standards on overall and technology-specific domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment for technology-specific manufacturers. DOE also takes into account cumulative impacts of different DOE regulations and other regulatory requirements on manufacturers.

For individual customers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. LCC is separately specified as one of the seven factors to consider when determining the economic justification for a new or amended standard (42 U.S.C. 6295(o)(2)(B)(i)(II)), and is discussed in the following section. For customers viewed from a national perspective, DOE calculates the net present value of the economic impacts on them over the 30-year equipment shipments period used in this rulemaking.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a fixture (including its installation) and its operating expenses (including energy, maintenance, and repair expenditures) discounted over the lifetime of the fixture. The LCC savings for the considered efficiency levels are calculated relative to a base case that reflects likely trends in the absence of new or amended standards. The LCC analysis required a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetimes, and customer discount rates. DOE assumed in its analysis that customers purchase the equipment in 2016.

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. DOE identifies the percentage of customers estimated to receive LCC savings or experience an LCC increase, in addition to the average LCC savings associated with a particular standard level. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of customers that may be affected disproportionately by a national standard.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for imposing 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)) As discussed in section V.G, DOE uses the NIA spreadsheet to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing classes of equipment and evaluating design options and the impact of potential standard levels, DOE seeks to develop standards that would not lessen the utility or performance of the equipment under consideration. The efficiency levels considered in today's NOPR will not affect features valued by customers, such as input voltage and light output. Therefore, DOE believes that none of the TSLs presented in section VI.A would reduce the utility or performance of the ballasts considered in the rulemaking. (42 U.S.C. 6295(o)(2)(B)(i)(IV))

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition likely to result from standards. It directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit this determination to the Secretary, not later than 60 days after the publication of a proposed rule, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) DOE has transmitted a copy of today's proposed rule to the Attorney General and has requested that the Department of Justice (DOJ) provide its determination on this issue. DOE will address the Attorney General's determination in any final rule.

f. Need for National Energy Conservation

The energy savings from the proposed 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.

The proposed standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production. DOE reports the emissions impacts from today's proposed standards, and from each TSL it considered, in section VI.B.6 of this notice. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs.

g. Other Factors

EPCA allows the Secretary to consider any other relevant factors in determining whether a standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) Under this provision, DOE considered subgroups of customers that may experience disproportionately adverse effects under the standards proposed in this rule. DOE specifically assessed the effect of standards on utilities, transportation facility owners, and warehouse owners. In considering these subgroups, DOE analyzed differences in electricity prices, operating hours, discount rates, and baseline ballasts. See section V.H for further detail.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the customer of equipment that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effects that proposed energy conservation standards would have on the payback period for customers. 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 customers, manufacturers, the nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section VI.B.1 of this NOPR.

V. Methodology and Discussion

DOE used two spreadsheet tools to estimate the impact of today's proposed standards. The first spreadsheet tool calculates LCCs and PBPs of potential new energy conservation standards. The second spreadsheet tool provides shipment projections and then calculates national energy savings and net present value impacts of potential new energy conservation standards. The Department also assessed manufacturer impacts, largely through use of the Government Regulatory Impact Model (GRIM).

Additionally, DOE estimated the impacts of energy efficiency standards on utilities and the environment. DOE used a version of EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The NEMS model simulates the energy sector of the U.S. economy. EIA uses NEMS to prepare its *Annual Energy Outlook,* a widely known reference energy forecast for the United States. The NEMS-based model used for appliance standards analysis is called NEMS–BT (BT stands for DOE's Building Technologies Program), and is based on the current AEO (*AEO2013)* NEMS with minor modifications.[21] The NEMS–BT accounts for the interactions between the various energy supply and demand sectors and the economy as a whole. For more information on NEMS, refer to *The National Energy Modeling System: An Overview,* DOE/EIA–0581 (98) (Feb. 1998), available at: *tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf.*

A. Market and Technology Assessment

1. General

When beginning an energy conservation standards rulemaking, DOE develops information that provides an overall picture of the market for the equipment concerned, including the purpose of the products, the industry structure, and the market characteristics. This activity includes both quantitative and qualitative assessments based on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include: Equipment classes and manufacturers; historical shipments; market trends; regulatory and non-regulatory programs; and technologies or design options that could improve the energy efficiency of the product(s) under examination. See chapter 3 of the NOPR TSD for further discussion of the market and technology assessment.

2. Equipment Classes

In establishing energy conservation standards, DOE divides covered equipment into classes by: (a) The type of energy used, (b) the capacity of the equipment, or (c) any other performance-related feature that justifies different standard levels, such as features affecting consumer utility. (42 U.S.C. 6295(q)) DOE then considers establishing separate standard levels for each equipment class based on the criteria set forth in 42 U.S.C. 6295(o).

In the preliminary analysis, DOE considered several potential class-setting factors for fixtures, including rated lamp wattage, input voltage, number of lamps operated, starting method, electronic configuration, circuit type, and fixture application. DOE preliminarily determined that rated lamp wattage was the only factor affecting both consumer utility and efficiency. DOE, therefore, analyzed four equipment classes for fixtures with rated lamp wattages: (1) Greater than or equal to 50 W and less than 150 W; (2) greater than or equal to 150 W and less than or equal to 250 W; (3) greater than 250 W and less than or equal to 500 W; and (4) greater than 500 W. As discussed in the following sections, several interested parties commented on the preliminary equipment classes and the other class-setting factors that DOE considered.

a. Input Voltage

Metal halide lamp fixtures are available in a variety of input voltages (such as 120 V, 208 V, 240 V, 277 V, and 480 V), and the majority of fixtures are equipped with ballasts that are capable of operating at multiple input voltages (for example quad-input-voltage ballasts are able to operate at 120 V, 208 V, 240 V, and 277 V). DOE determined that input voltage represents a feature affecting consumer utility as certain applications demand specific input voltages. Although input voltage can affect ballast resistive losses and thus, efficiency, for the preliminary analysis, DOE's ballast testing did not indicate a prevailing relationship (*e.g.,* higher voltages are not always more efficient) between discrete input voltages and ballast efficiencies. Therefore, in the preliminary analysis, DOE did not establish separate equipment classes for metal halide lamp fixtures based on input voltage. In the preliminary analysis, DOE suggested that efficiency be represented by the average of tested efficiencies at each of the input voltages at which the ballast is rated for operation.

In response to the preliminary analysis, DOE received several comments supporting and opposing input voltage as a class-setting criterion. NEMA noted that multiple-input-voltage ballasts are often optimized for the most popular voltage application. For example, a quint-input-voltage ballast (able to operate at five different input voltages) will often have a lower efficiency at 480 V than at 277 V because the ballast is optimized for 277 V operation. NEMA suggested that 480 V-capable ballasts be given an efficiency allowance, or that all ballasts be allowed to be tested at the optimal operating voltage as specified by the manufacturer. (NEMA, No. 34 at p. 10) Georgia Power also commented that due to their increased costs relative to non-480 V ballasts, dedicated 480 V and quint-input-voltage ballasts should be in a separate equipment class. (Georgia Power, No. 28 at p. 1) Progress Energy Carolinas agreed that separate equipment classes should be established for ballasts above 300 V. (Progress Energy Carolinas, No. 24 at p. 2) NEEA found that voltage does not appear to be a significant factor in energy efficiency performance or system utility. However, NEEA had no objection to treating 480 V systems as a separate class, should DOE choose to do so. (NEEA, No. 31 at p. 3) Empower Electronics commented that a separate classification based on input voltage is not needed. (Empower Electronics, No. 36 at p. 5)

As discussed in section IV.A of this NOPR, DOE is proposing that metal halide ballasts be tested at a single input voltage, based on the lamp wattage operated by the ballast. Ballasts that operate lamps 150 W or less would be tested at 120 V, and all others would be tested at 277 V, unless the ballast is incapable of operating at the specified input voltage; in that case, the ballast would be tested at the highest input voltage possible. DOE's view is that this proposal would reduce the testing burden and better characterize the

[21] The EIA does not approve use of the name ''NEMS'' unless it describes an *AEO* version of the model without any modification to code or data. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from *AEO* assumptions, the name ''NEMS–BT'' refers to the model as used here.

energy consumption of metal halide lamp fixtures for the majority of applications in which they are installed. Based on the proposed test procedures, DOE evaluated efficiency differences between dedicated 480 V, quint-input-voltage, and quad-input-voltage ballasts (which represent the vast majority of ballasts on the market). DOE found that the quint-input-voltage ballasts had similar efficiencies as the quad-input-voltage ballasts when both were tested at 120 V or 277 V. In contrast, DOE found that the dedicated 480 V ballasts (tested at 480 V) were, on average, 1.4 percent less efficient than quad-input-voltage ballasts (tested at 120 V or 277 V).

Because dedicated 480 V ballasts have a distinct utility and a difference in efficiency relative to ballasts tested at 120 V and 277 V, DOE proposes separate equipment classes for ballasts tested at 480 V (in accordance with the test procedures). These would include dedicated 480 V ballasts and any ballasts that are capable of being operated at 480 V, but incapable of being operated at the input voltage specified by the test procedures (either 120 V or 277 V, depending on lamp wattage). DOE requests comment on this proposal.

Fixture Application

Metal halide lamp fixtures are used in a variety of applications such as parking lots, roadways, warehouses, big-box retail, and flood lighting. Although the fixture size, shape, and optics are often tailored to the application, generally the same types of ballasts are currently utilized for most of the applications. DOE did not expect fixture-application-related attributes to affect ballast efficiency for a given lamp wattage, and in the preliminary analysis DOE did not analyze separate equipment classes based on such attributes.

In response to the preliminary analysis, DOE received several comments regarding the problems of utilizing electronic ballasts in outdoor applications and recommending that DOE establish separate equipment classes for outdoor fixtures and indoor fixtures. Energy Solutions noted that there are significant fixture design considerations necessitated by outdoor use. (Energy Solutions, Public Meeting Transcript, No. 33 at pp. 46–47) Progress Energy Carolinas clarified that ballasts used in outdoor fixtures need to be able to withstand high temperatures, voltage variations, and lightning and other voltage surges. Progress Energy Carolinas also indicated that the same concerns existed with LED fixtures (utilizing electronic drivers) and that they were successfully addressed by adding heat sinks to dissipate excess heat; building regulation into the drivers to deal with voltage variations; and adding metal oxide varistor (MOV) protection (typically 10 kilo volt [kV] ANSI C62.41.1–2002 [22] Class C protection) to protect against lightning and other voltage surges. LED fixtures also underwent field testing through all four seasons to prove overall reliability. Progress Energy Carolinas explained that until some of these issues are similarly addressed and their solutions proven, end users will be reluctant to use electronic metal halide ballasts in outdoor fixtures. (Progress Energy Carolinas, No. 24 at p. 1) Georgia Power and Progress Energy Carolinas stated that outdoor electronic metal halide ballasts have not been widely adopted by utilities, largely due to these reliability concerns. NEMA urged DOE to establish MHLF standards for outdoor applications (which have higher transient requirements and wider operating temperature ranges) such that magnetic ballasts would be compliant. (NEMA, No. 34 at p. 9) If electronic ballasts are mandated for outdoor fixtures, Progress Energy Carolinas recommended that utilities be exempt until reliability concerns decrease. (Georgia Power, No. 28 at p. 2; Progress Energy Carolinas, No. 24 at p. 2)

The CA IOUs, however, stated that electronic ballasts have been successfully applied in outdoor applications and are readily available on the market today, citing examples of commercially available electronic metal halide products rated for outdoor use and municipalities that have adopted electronically ballasted metal halide streetlights. The CA IOUs expressed their belief that the application environment does not affect the utility or the achievable efficiency of a ballast. The CA IOUs also stated that should DOE decide that the use of electronic ballasts in outdoor environments requires additional fixture modifications, DOE would need to conduct separate cost and savings analyses for indoor versus outdoor applications. If DOE decides to set different equipment classes for indoor and outdoor metal halide lamp fixtures, the CA IOUs suggested that DOE adopt California's approach for differentiation of these types by specifying fixtures that are ''UL 1598 Wet Location Listed and labeled 'Suitable for Wet Locations' as specified by the National Electrical Code [NEC] 2005, Section 410.4(A).'' (CA IOUs, No. 32 at pp. 2–3)

Although electronic ballasts are being successfully used in certain outdoor applications, DOE acknowledges that there is currently a market reluctance to use electronic metal halide ballasts in outdoor applications, particularly due to concerns with the electronic ballast's ability to withstand voltage transients. However, DOE disagrees with NEMA that an efficiency level that requires electronic ballasts should not be analyzed or proposed on the basis of the features of transient suppression and operating temperature ranges. DOE's view is that addressing these concerns with either (1) an external surge protection device or (2) internal transient protection of the ballast using MOVs in conjunction with other inductors and capacitors is technologically feasible, as shown by the CA IOUs' list of examples. DOE understands that this added protection also adds an incremental cost to the ballast or fixture (further discussed in section V.C.12). As these incremental costs could affect the cost effectiveness of fixtures for outdoor applications, DOE proposes separate equipment classes for indoor and outdoor fixtures. DOE proposes that outdoor fixtures be defined as those that (1) are rated for use in wet locations and (2) have 10 kV of voltage transient protection. Conversely, fixtures that do not meet these requirements will be defined as indoor fixtures.

DOE proposes to define the wet location rating as specified by the National Electrical Code 2011,[23] section 410.10(A) or Underwriters Laboratories (UL) 1598 Wet Location Listed.[24] DOE believes that providing two possible definitions will reduce the compliance burden as many manufacturers are already familiar with one or both of these ratings (the NEC definition was included in EISA 2007 and both are used in California energy efficiency regulations). For 10 kV voltage transient protection, DOE proposes to use the 10

[22] ''Institute of Electrical and Electronics Engineers Guide on the Surge Environment in Low-Voltage (V and Less) AC Power Circuits,'' Approved April 4, 2003.

[23] The NEC 2011 states that fixtures installed in wet or damp locations shall be installed such that water cannot enter or accumulate in wiring components, lampholders, or other electrical parts. All fixtures installed in wet locations shall be marked, ''Suitable for Wet Locations.'' All fixtures installed in damp locations shall be marked ''Suitable for Wet locations'' or ''Suitable for Damp Locations.''

[24] UL Standard Publication 1598 defines a wet location is one in which water or other liquid can drip, splash, or flow on or against electrical equipment. A wet location fixture shall be constructed to prevent the accumulation of water on live parts, electrical components, or conductors not identified for use in contact with water. A fixture that permits water to enter the fixture shall be provided with a drain hole.

kV voltage pulse withstand requirement from ANSI C136.2–2004 as a characteristic unique to outdoor fixtures. As discussed in section VI.C, based on weighing the benefits and drawbacks of different requirements, DOE is proposing efficiency standards that are the same for indoor and outdoor equipment classes. If a different requirement is ultimately adopted by DOE in the final rule, the definitions of indoor and outdoor will be added to the Code of Federal Regulations for metal halide lamp fixtures.

c. Electronic Configuration and Circuit Type

Of the two metal halide ballast types (electronic and magnetic), magnetic ballasts are currently more common. Magnetic ballasts typically use transformer-like copper or aluminum windings on a steel or iron core. The newer electronic ballasts, which are more efficient but less common, rely on integrated circuits, switches, and capacitors/inductors to control current and voltage to the lamp. Both electronic and magnetic ballasts are capable of producing the same light output and, with certain modifications (*e.g.,* thermal management, transient protection, 120 V auxiliary power functionality), can be used interchangeably in all applications.

Magnetic metal halide ballasts are available in the market in several types of circuit configurations including high-reactance autotransformer, constant-wattage isolated transformer, constant-wattage autotransformer (CWA), linear reactor (reactor), and magnetically regulated-lag (reg-lag or mag-reg) ballasts. Each magnetic circuit type listed has different characteristics that may be preferred in certain applications. These characteristics (discussed further in chapter 3 of the NOPR TSD) include size, efficiency, and power regulation. For example, magnetically regulated-lag ballasts are typically the largest and heaviest circuit type, but provide the greatest degree of resistance to input voltage variation (which sustains light output). In the preliminary analysis, DOE determined that although magnetic ballasts are usually less efficient and have a lower initial cost than electronic ballasts, neither configuration provides a distinct consumer utility over the other. Because electronic ballasts can provide the same utility as any magnetic circuit type, can be used as substitutes in all applications, and are generally more efficient than magnetic ballasts, DOE determined in the preliminary analysis that setting separate equipment classes based on electronic configuration (magnetic vs. electronic) or on circuit type was unnecessary.

At wattages greater than 500 W, few electronic ballasts are available due to their higher cost and lower expected efficiency improvement over magnetic ballasts. Electronic ballasts have two primary circuit types that operate the lamp at either ''high'' or ''low'' frequency. DOE proposes to define a high-frequency ballast to be a ballast with output frequency greater than or equal to 1000 Hz. For low-frequency electronic ballasts, a square current waveform is used to diminish acoustic resonance and maintain lamp life. All lamps operate well on low-frequency square waves, so these low-frequency ballasts have few compatibility issues with lamps. At higher frequencies, however, acoustic resonance issues and electromagnetic interference (EMI) effects cause compatibility issues with lamps. At these high frequencies, ballasts have to be designed to have the right frequency for a desired lamp, but the selected frequency may be incompatible with other lamps designed for different frequencies. Therefore, high-frequency electronic ballasts are less widely compatible with lamps relative to low-frequency electronic ballasts. High-frequency ballasts may also have difficulty complying with Federal Communications Commission (FCC) standards.[25]

In response to DOE's preliminary determination not to use electronic configuration or circuit type as a class-setting factor, DOE received several comments relating to replacement of magnetic ballasts with electronic ballasts, possible reliability issues with electronic ballasts, and non-efficiency-related benefits to using electronic ballasts. Cooper Lighting stated that electronic ballasts are not direct replacements for magnetic ballasts in fixtures. (Cooper Lighting, Public Meeting Transcript, No. 33 at p. 64) With regard to reliability, Georgia Power said that (1) electronic ballasts are unproven in outdoor applications and (2) electronic ballasts are vulnerable to failures due to high temperature, moisture, and voltage variations and surges caused by lightning and other outdoor events. Progress Energy Carolinas did not disagree with including electronic and magnetically ballasted fixtures in the same equipment class, but commented that the expected energy savings are small. They stated that other operating characteristics drive the use of electronic ballasts in indoor applications (*i.e.,* correlated color temperature variation, lamp lumen depreciation, and dimming). (Progress Energy Carolinas, No. 24 at p. 2) The CA IOUs agreed with Georgia Power that electronic ballasts, especially in conjunction with pulse-start ceramic metal halide lamps that offer higher efficacy and improved color rendering index (CRI), have other advantages that can offset their added cost. The CA IOUs also stated that electronic ballasts do save energy relative to magnetically ballasted systems. (CA IOUs, No. 32 at p. 4) Finally, Empower Electronics supported DOE's preliminary determination, stating that equipment classes need not be set according to electronic configuration and circuit type. (Empower Electronics, No. 36 at p. 6)

As discussed in section V.C.12, DOE recognizes the technological differences between magnetic and electronic ballasts and has incorporated the cost of additional devices or modifications necessary for certain applications into its analysis. In section V.I.2, DOE addresses impacts on manufacturers of a transition to electronic ballasts, but does not consider these impacts in development of equipment classes. While acknowledging that customers make purchasing decisions on electronic versus magnetic ballasts after consideration of other parameters in addition to efficiency, DOE has determined that significant energy savings can be realized through a transition from magnetic to electronic ballasts (see section VI.B.3). For this NOPR, DOE maintains that electronic configuration does not affect consumer utility because with the necessary design adders, electronic ballasts can provide the same utility as magnetic ballasts. Because of this, DOE is not proposing to define equipment classes based on electronic configuration and requests comment on this matter.

d. Lamp Wattage

As lamp wattage increases, lamp and ballast systems generally (but not always) produce increasing amounts of light (lumens). The goal of efficiency standards is to decrease the wattage needed for the same lumens—resulting in an increase in energy efficiency. Because certain applications require more light than others, wattage often varies by application. For example, low-wattage (less than 150 W) lamps are

[25] FCC regulations at 47 CFR part 18, subpart C set forth technical standards for industrial, scientific, and medical equipment that specify frequency bands and tolerance ranges as well as electromagnetic field strength limits. Some metal halide ballasts may be covered under these ''industrial, scientific, and medical (ISM) equipment'' standards, which list the general operating conditions for ISM equipment. Ballasts designed to exceed 9 kHz ballast frequency have to be designed so that interference with transmitted radio frequencies is eliminated. 47 CFR 18.111, 18.301–11

used today in commercial applications for general lighting. Medium-wattage (150–500 W) lamps are the most widely used today and include warehouse, street, and general commercial lighting. High-wattage (greater than 500 W) lamps are used today in searchlights, stadiums, and other applications that require powerful white light. In the preliminary analysis, based on its impact on light output, DOE determined that lamp wattage affects consumer utility. DOE also determined that the wattage of a lamp operated by a ballast is correlated with the ballast efficiency, which generally increases for higher-wattage loads. For electronic ballasts, this efficiency gain can be attributed to the decreasing proportion of fixed losses (*e.g.,* switches) to total losses. For low-wattage electronic ballasts, certain fixed losses contribute a larger proportion of total losses than they do for high-wattage ballasts. Magnetic ballasts—essentially transformers (sometimes with capacitors for power correction and igniters for pulse-starting)—have proportionally lower overall losses with increased wattage. Transformer losses (resistive losses in windings, eddy currents, and hysteresis) do not scale linearly with wattage, meaning that overall efficiency increases with wattage. Because wattage affects consumer utility (lumen output) and has a strong correlation to efficiency, DOE determined that separate equipment classes based on wattage were warranted. As a result in the preliminary analysis, DOE analyzed four lamp wattage class bins: ≥50 W and <150 W, ≥150 W and ≤250 W, >250 W and ≤500 W, and >500 W.

NEEA, Empower Electronics, and Progress Energy Carolinas supported DOE's determination in the preliminary analysis that wattage should be a class-setting factor. (NEEA, No. 31 at p. 3; Empower Electronics, No. 36 at p. 7; Progress Energy Carolinas, No. 24 at p. 3) Because no adverse comments were received on DOE's determination, DOE proposes to continue using lamp wattage as a class-setting factor for this NOPR.

For the NOPR, DOE found that even within a designated wattage range (such as between 100 W and 150 W), the potential efficiencies manufacturers can reach is not constant, but rather varies with wattage. Instead of setting a constant efficiency standard within a wattage bin, DOE is proposing the use of an equation-based energy conservation standard for certain equipment classes (see section V.C). DOE is also continuing to use wattage bins (instead of a single equation spanning the entire covered wattage range) to define equipment classes, for two reasons. First, the range of ballast efficiencies considered can differ significantly by lamp wattage, thus making it difficult to construct a single continuous equation for ballast efficiency from 50 W to 2000 W. This efficiency difference can be attributed to the varying cost of increasing ballast efficiency for different wattages and the impact of legislated (EISA 2007) standards that affect only some wattage ranges. Second, different wattages often serve different applications and have unique cost-efficiency relationships. Analyzing each wattage range as a separate equipment class allows DOE to establish the energy conservation standards that are cost-effective for each wattage bin.

DOE also received comment that certain wattage ranges used in the preliminary analysis should be further divided. Progress Energy Carolinas commented that further division of the 50 W to 250 W equipment class was warranted on the basis of different levels of efficiency being possible for different wattages. (Progress Energy Carolinas, No. 24 at p. 1) For this NOPR, DOE determined that the ≥50 W and <150 W range should be further subdivided. DOE's test data indicates that efficiency varies more significantly for ballasts that operate 50 W to 150 W lamps than for any other wattage range considered in the preliminary TSD. Based on catalog information and manufacturer interviews, DOE determined that 50 W and 100 W fixtures typically serve the same applications, while 150 W products begin to serve applications with increased light demand such as area lighting or parking lots. DOE used this natural division in wattage based on application to further divide the lowest-wattage range from the preliminary analysis.

With regards to the specification of the boundary between fixtures rated to operate at wattages above and below 150 W, Georgia Power commented that 150 W fixtures should be included with fixtures less than 150 W, not those greater than 150 W. (Georgia Power, No. 2 at p. 2) DOE agrees that some 150 W fixtures (those exempted by EISA 2007) should be included in the >100 to <150 W equipment classes. As discussed previously in section III.A.1, there is an existing EISA 2007 exemption for ballasts rated for only 150 W lamps, used in wet locations, and that operate in ambient air temperatures higher than 50 °C. This exemption has led to a difference in the commercially available efficiencies for ballasts that are exempted or not exempted from EISA 2007. The exempted ballasts have a range of efficiencies similar to wattages less than 150 W. Ballasts not exempted by EISA 2007 have efficiencies similar to ballasts greater than 150 W. As a result, DOE is proposing that 150 W fixtures previously exempted from EISA 2007 be included in a >100 W and <150 W range, while 150 W fixtures subject to EISA 2007 standards would be included in a ≥150 W to ≤250 W range.

In the preliminary analysis, DOE included all fixtures rated to operate at wattages greater than 500 W in the same equipment class. OSI suggested that DOE include 500 W ballasts in the highest-wattage range. OSI stated that electronic ballasts that operate lamps greater than or equal to 500 W have not been developed yet. (OSI, No. 27 at p. 4) In response to the lack of electronic ballasts operating lamps greater than or equal to 500 W, DOE agrees that there are not commercially available electronic ballasts at these wattages today, but also notes that magnetic ballasts are also unavailable at this wattage. Because leaving the boundary between these two wattage ranges at 500 W does not affect any commercially available products, DOE proposes to maintain the >250 W and ≤500 W range for consistency with the EISA 2007 covered wattage range.

In summary, DOE is proposing to define metal halide lamp fixture equipment classes by rated lamp wattage ranges ≥50 W to ≤100 W, >100 W to <150 W, ≥150 W to ≤250 W, >250 W to ≤500 W, and >500 W to ≤2000 W. DOE proposes that 150 W fixtures previously exempted by EISA 2007 be included in the >100 W to <150 W range, while 150 W fixtures subject to EISA 2007 standards continue to be included in the ≥150 W to ≤250 W range. DOE requests comment on these wattage ranges.

e. Number of Lamps

Metal halide lamp fixtures are commonly designed to operate with a single lamp because of lamp characteristics related to re-striking (turning the lamp on again after being turned off, because metal halide lamps require time to cool down before being lighted again) and voltage regulation. DOE's review of manufacturer catalogs revealed that while a majority of available ballasts operate only one lamp, a small fraction are designed for two lamps. Based on this review, DOE determined that there is little to no change in efficiency between one-lamp and two-lamp metal halide ballast fixtures. In the preliminary analysis, DOE determined it unnecessary to consider multiple-lamp ballasts in equipment classes separate from single-lamp ballasts.

NEMA agreed with DOE on the limited number of two-lamp metal halide lamp fixtures. Because two-lamp ballasts represent such a small part of the market, NEMA suggested they be excluded from the rulemaking. Given the optical size of a metal halide lamp, NEMA found it unlikely that a manufacturer would use this exemption as a loophole. Fixtures using multiple-lamp ballasts would have to be larger, more expensive, and less optically efficient than those with single-lamp ballasts. (NEMA, No. 34 at p. 10) Because catalog data shows no difference in efficiency, in this NOPR, DOE continues to propose including ballasts with differing numbers of lamps in the same equipment class. DOE is not proposing to exclude 2-lamp ballasts from the scope of coverage.

f. Starting Method

Metal halide lamp fixtures currently available in the market are designed to operate with either probe-start or pulse-start lamps, but not a mixture of both types at the same time.[26] The main differences between these starting methods are: (1) The inclusion of a third probe in probe-start lamps, (2) the need for an igniter circuit for pulse-start lamps, and (3) the different wiring specification for ballasts of each starting method. Most new applications in the market are pulse-start due to its higher efficacy (pulse-start lamps provide more lumens per watt than probe-start lamps). In the preliminary analysis, DOE did not consider probe versus pulse-starting to be a class-setting factor. While pulse-start lamps are more efficacious than probe-start lamps, probe and pulse-start ballasts can achieve the same levels of ballast efficiency and are used in similar applications. DOE did not receive any adverse comment relating to this preliminary determination, so in this NOPR, DOE proposes that both probe and pulse-start ballasts be included in the same equipment class.

EISA 2007 distinguishes nonpulse-start electronic equipment classes by separating them into two rated lamp wattage ranges (≥150 W and ≤250 W, and >250 W and ≤500 W) and applying a more stringent standard to them than to other ballast types. According to DOE's review of manufacturer catalogs and information provided by manufacturers during interviews, nonpulse-start electronic metal halide lamp fixtures are not available in the market. While EISA 2007 contemplated the creation of additional classes for alternative technologies that could become available in the future, DOE has no information that indicates differences in efficiency or consumer utility based on pulse-start versus nonpulse-start ballast fixtures. Based on this information, in the preliminary analysis, DOE determined that a separate equipment class for nonpulse-start ballasts was unnecessary. DOE did not receive adverse comments relating to this preliminary determination, so in this NOPR, DOE is proposing that nonpulse-start electronic ballasts be included in the same equipment class as all other starting methods. The term nonpulse-start electronic ballast is currently undefined in the CFR. To avoid confusion, DOE is proposing to define 'nonpulse-start electronic ballast' in 10 CFR 431.322 as an electronic ballast with a starting method other than pulse-start.

Due to their apparent interchangeability and lack of unique or separate utility that would affect efficiency, DOE proposes not to use ballast-starting method as a class-setting feature.

g. Conclusions

Based on interested party input and additional research, in this NOPR, DOE has decided to propose the equipment classes in the following table. DOE has revised the wattage bins considered in the preliminary analysis to account for a varying number of efficiency levels, different cost-efficiency relationships in the lower wattages, and the lack of general lighting applications for wattages higher than 2000 W. Additionally, each of these wattage bins is further divided into indoor and outdoor applications to account for the difference in consumer utility and the cost-efficiency relationships for these application types (see section V.C.12 for further details about the cost adders that effect these relationships). Finally, each of these classes is subdivided by input voltage, with one class for ballasts tested at 480 V (in accordance with the 2009 test procedures, supplemented with the testing guidance included in this document), and the non-480 V ballasts in a separate class. Ballasts tested at 480 V include dedicated 480 V ballasts and any ballast capable of being operated at 480 V, but incapable of being operated at the input voltage specified by the amendments to the test procedures proposed in this NOPR (either 120 V or 277 V, depending on lamp wattage). DOE invites comments on these proposed equipment classes.

TABLE V.1—METAL HALIDE LAMP FIXTURE NOPR EQUIPMENT CLASSES

Equipment classes	Rated lamp wattage	Indoor/outdoor †	Input voltage type ‡
1	≥50 W and ≤100 W	Indoor	Tested at 480 V.
2	≥50 W and ≤100 W	Indoor	All others.
3	≥50 W and ≤100 W	Outdoor	Tested at 480 V.
4	≥50 W and ≤100 W	Outdoor	All others.
5	>100 W and <150 W *	Indoor	Tested at 480 V.
6	>100 W and <150 W *	Indoor	All others.
7	>100 W and <150 W *	Outdoor	Tested at 480 V.
8	>100 W and <150 W *	Outdoor	All others.
9	≥150 W ** and ≤250 W	Indoor	Tested at 480 V.
10	≥150 W ** and ≤250 W	Indoor	All others.
11	≥150 W ** and ≤250 W	Outdoor	Tested at 480 V.
12	≥150 W ** and ≤250 W	Outdoor	All others.
13	>250 W and ≤500 W	Indoor	Tested at 480 V.
14	>250 W and ≤500 W	Indoor	All others.
15	>250 W and ≤500 W	Outdoor	Tested at 480 V.
16	>250 W and ≤500 W	Outdoor	All others.
17	>500 W and ≤2000 W	Indoor	Tested at 480 V.
18	>500 W and ≤2000 W	Indoor	All others.

[26] DOE is aware of some metal halide lamps that can be operated by a pulse-start or a probe-start ballast. These lamps are much less common than lamps designed to be operated by ballasts of only one starting method.