DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

10 CFR Part 430

[Docket No. EE–RM/STD–01–350]

RIN 1904–AA78

Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnaces and Boilers

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

ACTION: Advance notice of proposed rulemaking, public meeting and webcast.

SUMMARY: The Energy Policy and Conservation Act (EPCA or the Act) authorizes the Department of Energy (DOE or the Department) to establish energy conservation standards for various consumer products and commercial and industrial equipment, including residential furnaces and boilers, if DOE determines that energy conservation standards would be technologically feasible and economically justified, and would result in significant energy savings. The Department publishes this Advance Notice of Proposed Rulemaking (ANOPR) to consider establishing energy conservation standards for residential furnaces and boilers and to announce a public meeting to receive comments on a variety of issues.

DATES: The Department will hold a webcast on Tuesday, August 17, 2004 from 1 p.m. to 4 p.m. If you are interested in participating in this event, please inform Mohammed Khan at (202) 586–7892.

The Department will hold a public meeting on Wednesday, September 29, 2004, starting at 9 a.m., in Washington, DC. The Department must receive requests to speak at the meeting before 4 p.m., Wednesday, September 15, 2004. The Department must receive a signed original and an electronic copy of statements to be given at the public meeting no later than 4 p.m. Wednesday, September 22, 2004.

The Department will accept comments, data, and information regarding the ANOPR before or after the public meeting, but no later than Wednesday, November 10, 2004. See section IV, ''Public Participation,'' of this ANOPR for details.

ADDRESSES: The public meeting will be held at the Ronald Reagan Building and International Trade Center, Polaris Room, 1300 Pennsylvania Avenue, NW., Washington, DC 20004. A photo ID is required to enter the building.

You may submit comments, identified by docket number EE–RM/STD–01–350 and/or RIN number 1904–AA78, by any of the following methods:

- Federal eRulemaking Portal: *http://www.regulations.gov.* Follow the instructions for submitting comments.
- E-mail: *ResidentialFBANOPRComments@ee.doe.gov.* Include EE–RM/STD–01–350 and/or RIN number 1904–AA78 in the subject line of the message.
- Mail: Ms. Brenda Edwards-Jones, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, ANOPR for Residential Furnaces and Boilers, docket number EE–RM/STD–01–350 and/or RIN number 1904–AA78, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed original paper copy.
- Hand Delivery/Courier: Ms. Brenda Edwards-Jones, U.S. Department of Energy, Building Technologies Program, Room 1J–018, 1000 Independence Avenue, SW., Washington, DC 20585.

Instructions: All submissions received must include the agency name and docket number or Regulatory Information Number (RIN) for this rulemaking. For detailed instructions on submitting comments and additional information on the rulemaking process, see section IV of this document (Public Participation).

Docket: For access to the docket to read background documents or comments received, go to the U.S. Department of Energy, Forrestal Building, Room 1J–018 (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW., Washington, DC, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards-Jones at the above telephone number for additional information regarding visiting the Resource Room. Please note: The Department's Freedom of Information Reading Room (Room 1E–190 at the Forrestal Building) is no longer housing rulemaking materials.

FOR FURTHER INFORMATION CONTACT: Mohammed Khan, Project Manager, Energy Conservation Standards for Residential Furnaces and Boilers, Docket No. EE–RM/STD–01–350, EE–2J/Forrestal Building, U.S. Department of Energy, Office of Building Technologies, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–7892. E-mail: *Mohammed.Khan commat;ee.doe.gov.*

Thomas B. DePriest, Esq., U.S. Department of Energy, Office of General Counsel, Forrestal Building, Mail Station GC–72, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–9507. E-mail: *Thomas.DePriest@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

I. Introduction

A. Purpose of the ANOPR

The purpose of this ANOPR is to provide interested persons with an opportunity to comment on:

(i) The product classes that the Department is planning to analyze;

(ii) the analytical framework, models, and tools (*e.g.*, life-cycle cost (LCC) and national energy savings (NES) spreadsheets) that the Department has been using in performing analyses of the impacts of energy conservation standards;

(iii) the results of preliminary analyses for the engineering, LCC, payback, and NES contained in the ANOPR Technical Support Document (TSD): Energy Efficiency Standards for Residential Furnaces and Boilers and summarized in this ANOPR; and

(iv) the candidate energy conservation standard levels that the Department has developed from these analyses.

B. Summary of the Analysis

The Energy Policy and Conservation Act, as amended (EPCA or Act), authorizes the Department of Energy (DOE or Department) to establish minimum energy conservation standards for certain major household appliances. The Act established efficiency standards for certain residential furnaces and boilers, with an effective date of January 1, 1992. (42 U.S.C. 6295(f)) In addition, the Act requires the Department to determine whether the standards should be amended.

The Department began the preliminary work for this rulemaking in 2001 and conducted a series of analyses. The Department conducted in-depth technical analyses in the following areas: engineering, life-cycle cost (LCC) and payback periods (PBP), and national energy savings (NES) and economic impacts. This ANOPR discusses the methodologies and assumptions for each of these analyses. Table I.1 provides a summary of the key inputs, assumptions, and methods employed for each analysis area. Table I.1 also shows where to find the results in this ANOPR. It is important to note that the analysis results presented in this ANOPR are subject to revision following review and input from stakeholders and other interested parties. The final rule publication will contain the final analysis results.

TABLE I.1—IN-DEPTH TECHNICAL ANALYSES FOR THE ANOPR

Analysis area	Methodology	Key inputs	Key assumptions	ANOPR section for results
Engineering: equipment manufacturing costs, markups, and installation costs.	Teardown analysis supplemented with design option analysis; RS-Means based cost-weighted averages of many configurations.	Component cost data; financial reports of firm costs, expenses, and profits; installation configuration weights; component and labor cost.	Industry average “Greenfield Plant;” Production volumes; updated GRI venting survey weights; labor costs from RS Means; material costs from distributors.	Section II.E
LCC and PBP	Building-by-building analysis of a representative weighted sample of residential consumers; energy consumption according to field use.	First costs from engineering analysis; AEO 2003 energy price forecasts; RECS 97 houses; virtual models from product literature with size-related parameters.	1997 RECS database subsets are nationally representative.	Section II.G
National impacts	Forecasts of national furnace and boiler costs and energy consumption.	Historical and projected shipments; average installed cost and energy consumption from the LCC analysis; and AEO 2003 energy price forecasts.	Responsiveness of shipments forecasts to installed cost; share of condensing gas furnaces in base case forecast; future trends in equipment costs.	Section II.H

During the development of the above analyses, the Department consulted with interested parties to provide as much detail as possible on the development of the analyses. The Department continues to seek input from all interested parties on the methodologies, inputs, and assumptions used to develop the analyses. Obtaining that input is a primary purpose of this ANOPR.

1. Engineering Analysis

The engineering analysis establishes the relationship between the cost and efficiency of residential furnaces and boilers. This relationship serves as the basis for cost/benefit calculations for individual consumers, manufacturers, and the Nation.

The baseline model for each product class is the starting point for analyzing technologies that provide energy-efficiency improvements. The Department defines a baseline model as an appliance having commonplace, cost-effective features and technologies while still meeting the current standard.

After defining the baseline models, the Department estimated total installed cost to the consumer through an analysis of (1) manufacturer costs, (2) markups, which are the multiplier used to determine consumer price based on manufacturing cost, and (3) installation costs. DOE estimated annual average operating costs by calculating energy consumption using the DOE test procedure, applying average energy prices, and adding annual average maintenance costs.

The Department developed manufacturing and installation costs through the use of tear-down analysis and cost modeling techniques and calibrated them to industry data sources. The Department determined all distribution markups through use of firm balance sheet data, U.S. Census Bureau data, and data from the Manufacturing Housing Institute for mobile home furnaces (use of the term ''mobile home furnace'' is discussed in section I.C.3.c, ''Treatment of Mobile Home Furnaces'' of this document).

Using the above inputs and calculation of energy consumption based on the DOE test procedure, the Department calculated payback periods for various design options to improve efficiency. The payback period represents the time needed for the increase in average, total installed equipment cost to be offset by annual, average operating cost savings. The Department presents these payback periods to address the legally established ''rebuttable'' presumption that an energy conservation standard is ''economically justified'' if the additional cost to a consumer purchasing the more efficient product is less than three times the value of the energy savings during the first year of the product's use. (42 U.S.C. 6295(o)(2)(B)(iii))

2. Life-Cycle Cost (LCC) and Payback Period (PBP) Analysis

The LCC and PBP analysis determines the economic impact of potential standards on consumers. The LCC that DOE calculated expresses the costs of installing and operating a furnace or boiler for its expected lifetime starting in the year 2012—the expected effective date for any new furnace standard, at the time the analysis occurred. The analysis compares the LCC of equipment with efficiency improvements designed to meet possible energy-efficiency standards with the LCC of the equipment likely to be installed in the absence of standards. The PBP represents the number of years of operation needed to achieve savings sufficient to pay for the increased installed cost of higher-efficiency equipment. It is the change in total installed cost due to increased efficiency divided by the change in annual operating cost from increased efficiency.

The LCC calculation considers total installed cost (equipment cost plus installation cost), operating expenses (energy use and maintenance), equipment lifetime, and the discount rate. The Department performed the LCC analysis from the perspective of the users of residential furnaces and boilers. DOE calculated the energy consumption of furnace and boilers using data from the 1997 Residential Energy Consumption Survey (RECS97) conducted by the Energy Information Administration (EIA).[1] DOE calculated future energy costs using energy price forecasts from EIA's Annual Energy Outlook 2003 (AEO 2003).[2]

The LCC analysis uses a distribution of values to account for uncertainty and variability in the inputs to the LCC calculation. For each input, there is a distribution of values with probabilities attached to each value. As a result, the analysis produces a range of LCC results. An advantage of this approach is that DOE can identify the percentage of consumers achieving LCC savings or attaining certain payback values due to an increased efficiency standard, in addition to the average LCC savings or payback period for that standard.

3. National Impacts Analysis

The national impacts analysis estimates the national energy savings (NES) and the net present value (NPV) of total customer costs and savings expected to result from new standards at specific efficiency levels. The Department calculated NES and NPV for a given standard level as the difference between a base case forecast (without new standards) and the standards case forecast (with standards). The Department determined national annual energy consumption by multiplying the number of units in the stock of residential furnaces and boilers (by vintage) by the unit energy consumption (also by vintage). Cumulative energy savings are the sum of the annual NES determined over a specified time period. The Department calculated net savings each year as the difference between total operating cost savings and increases in total installed costs. Cumulative savings are the sum of the annual NPV determined over a specified time period. Critical inputs to this analysis include shipments projections (based in part on data provided by the Gas Appliance Manufacturers Association (GAMA)), retirement rates (based on estimated equipment lifetimes), and estimates of change in equipment purchase patterns in response to change in equipment costs due to standards (based on historical parameters).

C. Authority

Part B of Title III of EPCA established the Energy Conservation Program for Consumer Products other than Automobiles (Program). The consumer products currently subject to this Program (referred to as ''covered products'') include residential furnaces and boilers, the subject of this ANOPR. (42 U.S.C. 6291 *et seq.*)

The Act authorizes the Department to prescribe new or amended standards for furnaces and boilers. (42 U.S.C. 6295(a), (f)) Any new or amended standard must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified and must result in significant conservation of energy. (42 U.S.C. 6295(o)(2)(A), (o)(3)) To determine whether the proposed standard is economically justified, the Department must determine that the benefits of the proposed standard exceed its burdens to the greatest extent practicable, weighing the following seven factors:

(1) The economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard;

(2) The savings in operating costs throughout the estimated average life of the covered products which are likely to result from the standard;

(3) The total projected amount of energy savings likely to result directly from the standard;

(4) Any lessening of the utility or the performance of the covered products likely to result from the standard;

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

(6) The need for national energy conservation; and

(7) Other factors the Secretary considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)).

[1] U.S. Department of Energy—Energy Information Administration, Residential Energy Consumption Survey: Household Energy Consumption and Expenditures 1997, 1999. Washington, DC. Report No. DOE/EIA–0321(97). <*http://www.eia.doe.gov/emeu/recs/recs97/publicusefiles.html*>

[2] U.S. Department of Energy—Energy Information Administration, Annual Energy Outlook 2003: With Projections Through 2025, January, 2003. Washington, DC. Report No. DOE/EIA–0383 (2003). <*http://www.eia.doe.gov/oiaf/aeo*>

D. Background

1. History of Standards Rulemaking for Residential Furnaces and Boilers

EPCA established efficiency standards for residential furnaces and boilers. It set the standard in terms of the Annual Fuel Utilization Efficiency (AFUE) descriptor at a minimum value of 78 percent for most furnaces.[3] EPCA set the minimum AFUE at 75 percent for gas steam boilers and 80 percent for other boilers. For mobile home furnaces, EPCA set the minimum AFUE at 75 percent. The effective date for these standards was January 1, 1992. (42 U.S.C. 6295(f)(1))

For ''small'' furnaces (those having an input rate of less than 45,000 British thermal units (Btu) per hour), the Act required the Department to publish a final rule by January 1, 1989, and to set a minimum AFUE at a specific percent not less than 71 percent and not more than 78 percent. (42 U.S.C 6295(f)(1)(B)) For these products, the Department published an Advance Notice of Proposed Rulemaking (ANOPR) (52 FR 46367, December 7, 1987), followed by a Notice of Proposed Rulemaking (NOPR) (53 FR 48798, December 2, 1988), in which the Department proposed to establish an energy conservation standard of 78 percent AFUE for small gas furnaces. In a final rule (54 FR 47916, November 17, 1989), the Department set the minimum AFUE for these products at 78 percent, with an effective date of January 1, 1992.

For mobile home furnaces, the Act directed the Department to publish a final rule before January 1, 1992, to determine whether the standard should be amended. (42 U.S.C. 6295 (f)(3)(A)) The Act required the effective date for amendments to be January 1, 1994. The Department started this activity and issued an ANOPR (55 FR 39624, September 28, 1990), followed by a NOPR (59 FR 10464, March 4, 1994). As part of this activity, the Department proposed a new energy descriptor that accounts for both natural gas and electricity use in a furnace. DOE rejected this approach because ''energy use'' is defined in 42 U.S.C. 6291(4) as ''the quantity of energy directly consumed by a consumer product at point of use,'' and therefore, furnace energy conservation standards must be based on consumption of energy at the site of the appliance, but DOE had difficulty in accounting for the source energy associated with electricity use. (61 FR 36983, July 15, 1996) Several events, including a fiscal year 1996 moratorium on proposing or issuing new or amended appliance energy conservation standards and the development of an improved process for the Department's energy efficiency standards rulemakings, interrupted further activities on this rulemaking. No final rule for mobile home furnace standards was published.

The Act also required the Department to publish a final rule to determine for all furnaces and boilers whether the standards should be amended. (42 U.S.C. 6295(f)(3)(B)) The Act required that DOE publish this final rule before January 1, 1994, and, if the Department determined that the standards should be amended, the Act required that those amendments be effective on January 1, 2002. The Department started this activity and, in September 1993, published an ANOPR in which it presented the product classes for furnaces that it planned to analyze, and a detailed discussion of the analytical methodology and models that it expected to use in this rulemaking. (58 FR 47326, September 8, 1993) The Department invited comments and data on the accuracy and feasibility of the planned methodology and encouraged interested persons to recommend improvements or alternatives to DOE's approach.

In its fiscal year 1998 Priority Setting for the Appliance Rulemaking Process, the Department assigned a low priority level to residential furnaces and boilers, which meant it did not plan to actively pursue the rulemaking over the next two years. The Department thus limited its work on these products to basic technology investigation.

In the fiscal year 2001 Priority Setting for the Appliance Rulemaking Process, DOE assigned a high level of priority to residential furnaces and boilers, including mobile home furnaces, which meant the Department planned to pursue the rulemaking actively through meetings, workshops, and published notices (*See* section I.C.2).

Table I.2 summarizes the history of the standards for furnaces and boilers.

TABLE I.2—HISTORY OF FURNACE AND BOILER STANDARDS

	Furnaces/boilers	Small furnaces	Mobile home furnaces
Original standard	78% (boilers 80%, gas steam boilers 75%).	78%	75%.
Standard Requirement Source	NAECA* **	Final Rule	NAECA.
Publication year	1987	1989	1987.
ANOPR	1993*	1993*	1993* and 1994*.
Current Rulemaking	Furnace Rulemaking beginning date FY2001.	Defined as part of Furnace Product Class as of 1989.	Included as a separate Product Class.

* Rulemaking initiated but not finished.
** National Appliance Energy Conservation Act.

2. Current Rulemaking Process

The framework presented in this ANOPR reflects the improvements and steps detailed in Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products (Process Rule) 10 CFR 430, Subpart C, Appendix A, which elaborates on the procedures, interpretations, and policies that will guide the Department in establishing new or revised energy efficiency standards for consumer products. The rulemaking process is dynamic. If timely new data, models, or tools that enhance the development of standards become available, the Department will incorporate them into the rulemaking.

The Department held a workshop on July 17, 2001, to discuss the proposed analytical framework for conducting this rulemaking. The framework presented at the workshop described the

[3] EPCA states that a ''furnace'' includes forced-air and gravity central furnaces and low-pressure steam and hot water boilers, and that it must have a heat input rate of less than 225,000 Btu/h for forced-air and gravity central furnaces, and less than 300,000 Btu/h for boilers. (42 U.S.C. 6291(23)) However, in this ANOPR, DOE has adopted the terminology used in the HVAC (Heating, Ventilation and Air Conditioning) industry, which considers furnaces and boilers as separate categories.

different analyses to be conducted (*see* Table I.3), the methods proposed for conducting them, and the relationships among the various analyses.

TABLE I.3.—RESIDENTIAL FURNACE AND BOILER ANALYSIS

ANOPR	NOPR	Final rule
Market and technology assessment	Revised ANOPR Analyses	Revised analyses.
Screening analysis	Life-cycle cost sub-group analysis.	
Markups for equipment price determination	Manufacturer impact analysis.	
Engineering analysis	Utility impact analysis.	
Energy Consumption	Environmental assessment.	
Life-cycle cost and payback period analyses	Employment impact analysis.	
Shipments analysis	Regulatory impact analysis.	
National impact analysis.		

The Department held a public workshop on May 8, 2002, to receive and discuss comments on issues related to venting installations for residential furnaces and boilers and to discuss the Department's research concerning venting systems.

Statements received after publication of the framework document for the Residential Furnace and Boiler Standards Rulemaking and at workshops mentioned above helped identify issues involved in this rulemaking, and provided information that has contributed to DOE's proposed resolution of these issues. This ANOPR quotes and summarizes many of the statements. A parenthetical reference at the end of a quotation or paraphrase provides the location of the item in the public record.

In June 2002, DOE asked GAMA to review DOE's analysis of manufacturing costs. GAMA provided comments which the Department considered in its further analysis.

In August 2002, GAMA convened a meeting to discuss approaches for analyzing electricity use in furnaces. The Department, GAMA, and the American Council for an Energy-Efficient Economy (ACEEE) presented their ideas about this issue. In December 2002, DOE reconsidered its authority to impose a standard that limits electricity consumption in residential furnaces and boilers (*See* section I.D.3.h of this ANOPR).

In September 2002, the Department posted the engineering analysis for furnaces and boilers on its website and asked for comments. GAMA, ACEEE and Natural Resources Canada (NRCanada) provided comments which DOE considered in its further analysis.

In response to stakeholder comment, the Department developed a detailed installation cost model to determine venting costs for residential furnaces and boilers. This ANOPR document (and accompanying TSD and spreadsheets) presents this ''Installation Model'' for stakeholder review and comment. Subsequently, in the spring and summer of 2003, the Department finished its analysis which is described in this ANOPR.

According to the proposed rulemaking timeline, as published in the December 22, 2003, Regulatory Agenda, DOE expects to issue a Final Rule in September 2005. The effective date for any new standards for furnaces and boilers will be eight years after its publication as a final rule in the **Federal Register**. (42 U.S.C. 6295 (f)(3)(B))

The Department received a number of comments concerning the rulemaking timeline. Several stakeholders commented that DOE should accelerate the rulemaking and implementation, while others thought the existing schedule was satisfactory. Those favoring an accelerated schedule include ACEEE, the Alliance to Save Energy (ASE), the California Energy Commission (CEC), Edison Electric Institute (EEI), Natural Resources Defense Council (NRDC), Oregon Department of Energy (ODOE), and Southern Company. ACEEE commented that DOE should commit to an effective date several years earlier than 2012. (ACEEE, No. 15 at p. 1)[4] ASE also believes that an eight-year lag in implementation of the standard is too long, and recommends a three-year lag, or, if the efficiency standard is a substantial increase, a five-year lag. (ASE, No. 18 at pp. 1 and 2) CEC commented that the eight-year lag is too long, and believes the standards should take effect in January 2007. (CEC, No. 19 at p. 3) EEI commented that DOE should accelerate the rulemaking for furnaces and boilers to maximize energy savings and avoid affecting market shares of natural gas and electric heating. (EEI, No. 6 at p. 1) NRDC commented that the proceeding is very late, and therefore DOE should accelerate the final rule. NRDC also commented that DOE has demonstrated it can go from the ANOPR through a final rule in a year, and should have this as a goal in this proceeding. (NRDC, No. 21 at pp. 1 and 2) ODOE commented that DOE should change the lead time to a three-year interval. (ODOE, No. 10 at p. 4) Southern Company commented that DOE should minimize the time between the effective dates of the air conditioner and the furnace rulemakings and stated that DOE should not give longer than a five-year lead time. (Southern, No. 14 at p. 2)

In contrast, Trane commented that DOE should keep the current time line. (Trane, No. 9 at p. 1) GAMA also supported a 2012 effective date for compliance. (GAMA, No. 8 at p. 1)

The Department intends to follow the relative timeline outlined in the National Appliance Conservation Act (NAECA). Section 325(f)(3)(B) provides the same lead time between publication of amended standards for furnaces (including mobile home furnaces) and the effective date of such standards. Therefore, DOE is using the same effective date for all furnaces including mobile home furnaces.

The American Gas Association (AGA) recommended scheduling follow-up workshops to discuss specific work as finished. (AGA, No. 11 at p. 5) The Department will document its assumptions, methods, and results, and will make these available for public review.

GAMA commented that DOE's accounting of national benefits should consider not only the net benefit to consumers, but also the net benefits or costs to manufacturers, utilities, and the net affect on the whole U.S. economy. (GAMA, No. 41 at p. 5) DOE's LCC

[4] Example: ''(GAMA, No. 8 at pp. 2–4)'' refers to a written statement that was submitted by the Gas Appliance Manufacturers Association and is recorded in the DOE Building Technologies Program Resource Room in the Docket under ''Residential Furnaces and Boilers'', as comment number 8, and the passage appears on pages 2 through 4 of that statement. Likewise, ''(Public Workshop Tr., No. 25JJ at p. 245)'' refers to an oral statement which appears on page 245 of the transcript of the Furnace and Boiler Venting Workshop held in Washington, DC, May 8, 2002.

analysis accounts for net benefits to consumers. Other analyses that DOE will perform for the NOPR stage of this rulemaking consider impacts on manufacturers (MIA), utilities in the utility and environmental analyses, and national employment impacts in the employment analysis.

AGA encouraged DOE to monetize and include indirect societal costs and environmental benefits to the extent possible. (AGA, No. 11 at p. 5) The Department will consider all the benefits and costs, both qualitative and quantitative, including the results of the consumer, environmental, employment, utility, and manufacturer impact analyses when deciding what standard level to select. DOE believes that attaching a monetary value to many impacts involves a high level of uncertainty and is not always practical.

3. Miscellaneous Rulemaking Issues

a. Separate Efficiency Standards for Different Regions

Because the cost-effectiveness of a furnace design is highly dependent on its heating load, which is affected by climate, some stakeholders suggested that DOE allow for a standard that varies by region of the country. ACEEE commented that the standard should allow individual states to require condensing furnaces and boilers whenever they are cost-effective or required for safety reasons. (ACEEE, No. 15 at p. 2) It suggested that DOE could establish a furnace and boiler standard at an efficiency level that requires condensing technology, and could allow individual states where such a level might not be cost-effective to receive an automatic exemption from the standard upon petition. (ACEEE, No. 15 at p. 2) CEC would like the Department to set a standard that requires condensing furnaces in states with cold climates and believes that individual states where such a standard might not be cost-effective should be able to use DOE data to justify petitions for waivers from preemption. (CEC, No. 19 at p. 5) Similarly, NRDC commented that the Department should issue a standard that allows individual states where such a standard might not be cost-effective to get waivers from preemption for a standard at 90 percent or higher AFUE. (NRDC, No. 21 at p. 3) GAMA said that a state option on condensing furnaces would be illegal under EPCA. (GAMA, No. 31 at p. 9) Southern believes that manufacturers should be allowed maximum flexibility in designing systems to meet varying climatic conditions. (Southern, No. 14 at p. 4) EEI said that regional standards would destroy national standards. (Public Workshop Tr., No. 25JJ at p. 251)

The Department recognizes that regional climatic effects may be important in the assessment of proposed energy efficiency standards for heating equipment because the energy demand and financial impacts to consumers can vary significantly with variations in climate. The life-cycle cost analysis considers regional impacts. However, DOE believes that the Act does not authorize the adoption of regional standards. *See* 42 U.S.C. 6291(6)(A).

b. Separate Efficiency Standards for New Construction and Replacement Markets

ASE commented that the Department should allow different efficiency levels for products installed in new versus replacement applications. ASE stated that the Department's treatment of fluorescent lamp ballasts, where the efficiency standard is different for new construction and replacement applications, is a precedent for this approach. (ASE, No. 18 at p. 2) ASE also would like the Department to grant states the option of a separate standard for equipment used in new construction. (ASE, No. 18 at p. 2)

EPCA does not allow DOE to set more than one efficiency standard for the same base model of a covered product. *See* 42 U.S.C. 6291(6)(A). *See* also 10 C.F.R. 430.62. The efficiency standard for fluorescent lamp ballasts is different for new construction and replacement applications because the products have different design characteristics and are marketed and shipped as different products. When manufacturers ship these products, they label them explicitly to show whether they are intended for new construction or for replacements. In the case of furnaces and boilers, the Department is not aware of any products separately marketed, labeled, and shipped either for new construction installations or for the replacement market. Therefore, the Department does not plan to permit the states the option of a separate standard for equipment used in new construction.

The Department received comments on products to include or exclude from the rulemaking. Both the CEC and ODOE recommended that DOE include units designed for three-phase electricity. (CEC, No. 19 at p. 2; ODOE, No. 10 at p. 2) EPCA explicitly states at 42 U.S.C. 6291 (a)(23) that the only furnace products that are covered products under the statute are those that use single-phase or DC (direct current) electricity in conjunction with natural gas, propane or home heating oil; and the Department must therefore exclude models that use three-phase electricity.

c. Treatment of Mobile Home Furnaces

Carrier and Trane believe that DOE should treat mobile home furnaces the same as other gas furnaces, and Trane suggested that the gas furnace product class should include mobile home furnaces. (Carrier, No. 7 at p. 2; and Trane, No. 9 at p. 1) GAMA commented that there should be no extra review or different lead time for amending the energy efficiency standard for mobile home furnaces. (GAMA, No. 8 at p. 1) The Manufactured Housing Institute (MHI) suggested that the Department use the term ''manufactured home'' instead of ''mobile home.'' (MHI, No. 13 at p. 1)

Because of their distinct market channels and installation restrictions, the Department decided to analyze mobile home furnaces as a separate product class. DOE currently plans to make the effective date for this product class the same as for other types of furnaces: January 1, 2012. Regarding the terminology for this product class, the Act uses the term ''mobile home furnace.'' The Department understands that the manufactured home market includes non-mobile/modular homes as well as mobile homes. Under the statute (42 U.S.C. 6295(f)(2) and (3)), the Department can only regulate the efficiency of mobile home furnaces, so it will use the term ''mobile home furnace'' until such time as Congress may amend the statutory language.

d. Potential Market Share Shifts Due to Standards

Several stakeholders, including AGA, the National Propane Gas Association (NPGA), and Trane, expressed concern that standards on gas furnaces could lead to increased purchase of electric furnaces: (1) Any standards should be fuel neutral and avoid distortion of market factors (AGA, No. 11 at p. 1); (2) if standard level efficiency is too high, consumers forced to change the venting system could choose an electric unit rather than replacing the gas-fired unit with a similar one (NPGA, No. 4 at p. 3); (3) a gas furnace standard requiring AFUE > 90 percent could encourage a shift to electric heat pumps and/or combination systems if the latter are not comparably regulated (Trane, No. 9 at p. 3); and (4) a high standard on LPG furnaces could increase the market share of electric units. (NPGA, No. 4 at p. 2) DOE's analysis accounts for potential market shifts to electric heating that may follow from a higher standard on gas furnaces. DOE's analysis is designed to determine the extent of the market shift among fuel types.

This information is used in the manufacturer impact analysis (MIA) which examines financial impacts on manufacturers and manufacturer subgroups. The MIA is provided to the Department of Justice (DOJ) to facilitate its determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy efficiency standards.

e. Inclusion of Electric Furnaces in the Rulemaking

CEC, NPGA, and ODOE all supported the inclusion of electric furnaces in the rulemaking. (CEC, No. 19 at p. 2; NPGA, No. 4 at p. 2; ODOE, No. 10 at p. 2) According to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), however, the AFUE rating for an electric furnace is already generally greater than 98 percent, and if the furnace is located within the heated space, the AFUE is 100 percent. No person has submitted to DOE any data or information to the contrary. Therefore, because of the limited opportunity for any improvement in energy efficiency as measured by AFUE and energy directly consumed by the product at the point of use, DOE decided not to include electric furnaces in this rulemaking.

f. Transparency of the Analysis

The Gas Technology Institute (GTI) would like the Department to use simple spreadsheet analyses whenever possible. (GTI, No. 5 at p. 3) The Department uses well-documented spreadsheets in its analyses. Most spreadsheets and other models used in this rulemaking are available to stakeholders for review and comment, and DOE is prepared to provide interested stakeholders explanations and some technical support in the use of the spreadsheets. To ensure the confidentiality of proprietary cost data, teardown cost model details will remain private. Methodology and aggregate industry assumptions and results are available for public comment. DOE welcomes any questions or comments on how to further simplify the analytical methods it has used in this rulemaking.

g. Data Used in the Analysis

EEI commented that DOE should use the most recent information available and recommended that DOE use the next version of the RECS when it is published. (EEI, No. 6 at p. 2) DOE makes every effort to use the most current version of RECS that is available at the time of each analysis. The analysis reflects the 1997 RECS and will be updated as a new RECS becomes available.

GTI stressed the verification of all data. (GTI, No. 5 at p. 3) The Department uses the most reliable and accurate data available at the time of each analysis in this rulemaking. All data will be available for public review, and DOE welcomes any additional data for verification.

h. Regulation of Furnace and Boiler Electricity Consumption

Furnaces and boilers use a significant amount of electricity. The Department's analytical framework described an approach to regulate the electricity use of residential furnaces and boilers that would involve specifying a maximum annual electrical consumption. The current DOE test procedure (10 CFR 430, subpart B, Appendix N) provides a means for determining electrical consumption. During the Framework Workshop, DOE asked for comments concerning whether and how to regulate electricity consumption of furnaces and boilers.

In 1995, the Department considered development of a single descriptor that combines electricity use and a measure of fuel efficiency, AFUE. At the time, the approach considered the source energy input associated with the electricity use of a furnace or boiler and was rejected in 1997 because EPCA and NAECA do not permit the regulation of source energy. EPCA and NAECA specify that efficiency must be based on the energy consumption at the point of use. (42 U.S.C. 6291 (4))

In comments on DOE's Framework, ACEEE, CEC, and NRDC supported a standard for electric efficiency. (ACEEE, No. 15 at p. 3; CEC, No. 19 at p. 3; and NRDC, No. 21 at p. 3) ODOE supported setting a standard for electricity consumption of fuel-fired furnaces and boilers. (ODOE, No. 10 at p. 2)

EEI recommended that DOE not spend any effort on electricity consumption. EEI drew a parallel to a previous rulemaking, stating that since DOE did not analyze evaporator fan energy use for central air conditioners and heat pumps because it does not affect the seasonal energy efficiency ratio (SEER), DOE should not analyze furnace fan electricity use because it does not affect AFUE. (EEI, No. 6 at p. 4)

AGA and GTI also recommended avoiding electricity consumption in this rulemaking, and suggested that DOE could address it in an electric motor rulemaking. (AGA, No. 11 at p. 3; and GTI, No. 5 at p. 3) EEI commented that DOE should not consider design options to increase fan and motor efficiencies, since furnace motors may be regulated as a separate product. (EEI, No. 6 at p. 4) NRDC said that DOE should not wait to see what Congress does in terms of regulating furnace fan energy use, as it is authorized and required to consider this issue on its own initiative. (NRDC, No. 21 at p. 3)

AGA recommended that DOE not limit a standard for electricity use to fuel-fired furnaces and boilers. (AGA, No. 11 at p. 2). Southern commented that the efficiency of fans in electric resistance furnaces makes no difference to the overall electricity use because the heat from the fan contributes to heating. (Southern, No. 14 at p. 3)

Lochinvar recommended against putting an electricity requirement on boilers, since the installation configuration determines the capacity of the pump. (Lochinvar, No. 17 at p. 2)

GAMA commented that any electricity consumption regulation should be based on parameters that exist in the current test procedure. (GAMA, No. 8 at p. 4) Lennox commented that E_{AE}, a descriptor of furnace and boiler electricity consumption that is currently described in the test procedure and is reported by manufacturers, is the best choice for an electrical energy descriptor. (Lennox, No. 16 at p. 2)

ACEEE supported measuring electric efficiency in terms of watts of electricity per cubic feet per minute (CFM) of airflow of a furnace blower and encouraged DOE to use realistic static pressures. (ACEEE, No. 15 at p. 3) NRDC recommends setting efficiency standards on fans in similar terms and believes DOE should set standards under standardized testing conditions at a fixed static pressure. (NRDC, No. 21 at pp. 3 and 2)

ACEEE, CEC, and ODOE would like to see electricity consumption regulated separately from AFUE. (ACEEE, No. 15 at p. 5; CEC, No. 19 at p. 3; and ODOE, No. 10 at p. 4) EEI stated that DOE should not include furnace fan energy use in AFUE calculations, since electricity is consumed throughout the year and AFUE is only for the heating season. (EEI, No. 6 at p. 2) Southern agrees that AFUE should not include electricity. (Southern, No. 14 at p. 3) Trane commented that AFUE does not include electric consumption and a new descriptor would delay the rulemaking process. (Trane, No. 9 at p. 2) Energy Kinetics commented that an efficiency rating should include annual electric consumption. (Energy Kinetics, No. 3 at p. 4)

In August 2002, GAMA convened a meeting to discuss the above issues at which the Department, GAMA, and ACEEE presented their ideas. In the fall of 2002, the Department considered whether it had the legal authority to regulate electricity consumption in residential furnaces and boilers. Title 42 of the United States Code provides in section 6291(6) that an ''energy conservation standard'' is either (A) ''a * * * level of energy efficiency'' or ''a * * * quantity of energy use,'' or (B) ''a design requirement for the products specified * * *'' Item (A) above seems to say that a single ''energy conservation standard'' cannot have measures or descriptions for both energy efficiency and energy use. A standard that includes both a level of energy efficiency and a quantity of energy use (kWh, thousands of watt-hours) would appear to conflict with the statutory language. Moreover, the Act, 42 U.S.C. 6291(20), states that ''the term 'annual fuel utilization efficiency' means the efficiency descriptor for furnaces and boilers, determined using test procedures prescribed under section 323 * * *'' The statute also requires DOE to use AFUE as the efficiency descriptor for furnaces and boilers. (42 U.S.C. 6295(f)(1)) Thus, DOE believes that the statute would have to be amended to include electricity use in the AFUE before DOE could regulate electricity use in furnaces and boilers. Based on the approaches DOE considered and the statutory language, the Department believes it cannot set energy conservation standards for electricity use in conjunction with energy efficiency standards for residential furnaces and boilers at the present time.

For informational purposes only, the Department did investigate a way to define an electricity use standard that would involve measuring electricity use as a function of furnace input capacity and the airflow. The details of this approach are given in Appendix 8.5 of the TSD.

4. Test Procedure

Section 7 of the Process Rule recommends that the Department identify and propose necessary modifications to relevant test procedures before issuing an ANOPR for energy conservation standards. There is an existing DOE test procedure for all furnace and boiler product classes, which DOE last revised in 1996. (10 CFR part 430, Appendix N to Subpart B, Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers) To a large extent, the DOE test procedure references ANSI/ASHRAE 103–1993, Method of Testing for Annual Efficiency of Residential Central Furnaces and Boilers.

The DOE test procedure includes a measurement of electricity consumption, Average Annual Auxiliary Electrical Energy Consumption (E_{AE}). The furnace fan accounts for about 85 percent of total furnace electricity consumption. To allow proper selection of blower capacity, manufacturers rate furnace models in nominal cubic feet per minute (CFM) of cooling airflow at 0.5 inches external static pressure; however, they do not report this as part of the test procedure.

DOE received several comments on the existing test procedure for furnaces and boilers. Energy Kinetics recommended using the same operating conditions for boilers as for furnaces and said that the existing test procedure does not fully capture the differences in characteristics between boilers and furnaces. (Energy Kinetics, No. 3 at p. 1 and p. 3, respectively) The analyses in this rulemaking are based on the existing test procedure. However, DOE is interested in additional data that would help the Department consider whether to update the existing test procedure to more accurately reflect actual boiler energy use.

The Oilheat Manufacturers Association (OMA) commented that accurate evaluation of fuel savings from jacket insulation may need changes to the AFUE test. (OMA, No. 20 at p. 3) At this point, DOE believes the test procedure adequately deals with jacket insulation issues. DOE is aware that as a part of the regular update of the ASHRAE Standard 103 test procedure, ASHRAE is looking at several areas of the test procedure, including the effect of jacket insulation. Depending on ASHRAE's findings, DOE may consider amending this part of the test procedure.

Lochinvar Corporation commented that the test procedure for boilers does not properly reflect normal residential operation, as the temperature differential range of 10°F to 40°F found in normal operation is more accurate than the range in the test procedure. (Lochinvar, No. 17 at p. 1) Lochinvar also commented that DOE should use the thermal efficiency as the descriptor for boilers. (Lochinvar, No. 17 at p. 2) DOE uses AFUE for the energy descriptor because EPCA mandates it.

OMA commented that DOE may need to revise its testing and rating procedures to evaluate electricity savings for oil-fired equipment. (OMA, No. 20 at p. 2) The current test procedure calculates the average annual auxiliary electrical energy consumption for oil furnaces using the same approach as for gas furnaces. The Department is not aware of any problems with using the existing procedure for oil-fired equipment and asks stakeholders that are aware of such problems to provide specific comments.

The Department will continue to use the assumptions and conditions in the current test procedure. However, DOE is interested in high-quality field data so it can consider whether updating the existing test procedure is warranted.

DOE received several comments regarding a test procedure for combined water and space heating appliances (combination appliances). Carrier and Southern Company commented that DOE should establish a test procedure for combined appliances. (Carrier, No. 7 at p. 1; and Southern, No. 14 at p. 3) Trane commented that DOE should include combination systems in the rulemaking using standard water heaters, and that a test procedure should start with ASHRAE 124–1991. (Trane, No. 9 at p. 1) ODOE also commented that the test procedure should reference ASHRAE 124–1991. (ODOE, No. 10 at p. 2) CEC commented that DOE should adopt the ASHRAE 124–1991 test procedure and not wait for ASHRAE revisions because the current edition of ASHRAE 124–1991 is widely approved and is adequate for this rulemaking. (CEC, No. 19 at p. 3) First Company commented that ASHRAE 124 is not a true consensus standard and that manufacturers strongly oppose it because it burdens combined appliance manufacturers. (First, No. 12 at p. 1)

The National Institute of Standards and Technology (NIST) is developing a DOE test procedure for combined water heating and space heating equipment based on the ASHRAE 124–1991 test procedure standard. DOE's process for adopting this test procedure has not yet been completed. Therefore, DOE did not analyze combined water heating and space heating equipment in the ANOPR stage of the furnace and boiler rulemaking.

II. Residential Furnace and Boiler Analyses

A. Market Assessment and Technology Assessment

The Department reviewed existing literature and interviewed manufacturers to characterize the market for residential furnaces and boilers in the United States. Industry publications and trade journals, government agencies, and trade organizations provided the bulk of the information, including: (1) Historic shipments by product class, (2) number of models by capacity and efficiency level, (3) manufacturers of various products, and (4) product distribution patterns.

GAMA provided extensive historical shipment data to the Department. Where the data from GAMA were insufficient, DOE estimated historical shipments for each of the product classes through consultations with industry experts. The GAMA data give shipments for gas furnaces, including mobile home furnaces, as a group. Thus, to estimate mobile home gas furnace shipments, the Department used data on total mobile home placements (from the Census Bureau) and data from the American Housing Survey that give the share of gas in existing mobile homes of various vintages.

The Department found no separate data on shipments for weatherized (outdoor) furnaces. It estimated shipments of weatherized gas furnaces based on estimated 1990–1997 shipments of packaged air-conditioning equipment, since the latter are typically coupled with a weatherized gas furnace. These data suggest that weatherized gas furnaces account for 12 percent of total gas furnace shipments (not including mobile home gas furnaces). The remaining gas furnaces are classified as non-weatherized (indoor) gas furnaces. Since there are few weatherized oil-fired furnaces, DOE assumed that all oil-furnace shipments are non-weatherized.

The GAMA data provide total shipments by fuel type for boilers. For each fuel, DOE estimated the split between hot water and steam types, based on estimates GAMA made in the early 1990's.

Table II.1 shows the estimated annual shipments in 2000 and the number of models in each of the product classes. Non-weatherized gas furnaces are by far the largest category.

TABLE II.1.—MARKET STATISTICS FOR FURNACES AND BOILERS BY PRODUCT CLASS

Product class	Estimated shipments in 2000	Number of models in GAMA directory (2001)
Non-weatherized gas furnaces	2,645,000	6907
Weatherized gas furnaces	325,000	4476
Non-weatherized oil-fired furnaces	120,000	868
Weatherized oil-fired furnaces	(1)	13
Mobile home gas furnaces	130,000	70
Mobile home oil-fired furnaces	(1)	16
Hot water gas boilers	190,000	990
Hot water oil-fired boilers	100,000	640
Steam gas boilers	36,000	254
Steam oil-fired boilers	13,000	140

[1] Few.

Most of the non-weatherized gas furnaces on the market have an efficiency of 80 percent AFUE. Only a few 78 percent AFUE models are still on the market. Roughly one-quarter of current sales of non-weatherized furnaces are condensing models, which range mostly between 90 percent and 92 percent AFUE.

The efficiency distribution of weatherized gas furnace models is similar to that of non-weatherized gas furnaces, except that no condensing units exist due to problems with condensate freezing. The efficiency of mobile home gas furnaces is generally either 75 percent or 80 percent AFUE, but there are a few condensing models with an efficiency of 90 to 94 percent AFUE.

There are no gas furnaces currently on the market in the 83 to 89 percent AFUE range. In this range, condensate problems begin to occur, and yet the temperature of the flue is still too high to allow the use of polyvinyl chloride (PVC) for the venting system. These problems make proper venting of such a furnace difficult, requiring the use of higher-quality stainless steel to vent wet flue gases to the outdoors.

In contrast to the available AFUE range of gas furnaces, oil-fired furnace models with an AFUE in the 82 to 86 percent range are available but unavailable in the condensing (90 percent AFUE and above) range. Because of the lower hydrogen content of fuel oil compared to natural gas or propane, condensate problems with oil-fired furnaces at the 82 to 86 percent AFUE range levels are reduced. Condensing oil-fired furnaces are not currently available in the U.S. because the complexities associated with the maintenance of a secondary heat exchanger for oil-fired furnaces make production of high-efficiency oil-fired furnaces impractical.

Most hot-water gas boilers have an AFUE in the 80 to 84 percent range. Gas boilers with higher AFUEs are vented with gas-tight stainless-steel venting systems to avoid condensate problems, until an AFUE of 90 percent is reached and PVC can be used. The AFUE for hot-water oil boilers ranges from 80 to 88 percent. Gas steam boiler models have an AFUE in the 78 to 83 percent range; the range for oil-fired models is 79 to 86 percent AFUE.

A furnace or boiler is composed of a number of components—*e.g.*, heat exchanger, fan and controls. For each of these components, manufacturers can make different choices; each of these choices is called a ''design option.'' For instance, a heat exchanger can be tubular, clamshell, or cylindrical in its design. Any individual furnace or boiler, which can be characterized by an efficiency level according to the DOE test procedure, is composed of an aggregate of design options.

The Department based its list of technically feasible design options on options included in the previous ANOPR. (58 FR 47326, September 8, 1993) The Department then updated the list through consultation with manufacturers of components and systems, trade publications, and technical papers. Since many options for improving product efficiency are available in existing equipment, product literature and direct examination provided additional information.

1. Definition of Product Classes

In general, the Department defines product classes based on information from discussions with appliance manufacturers, trade associations, and other interested parties. For this rulemaking, the Department developed product classes based on the type of energy used and performance-related features that affect utility to the consumers. Based on comments from stakeholders and the market assessment, the product classes considered in this rulemaking are:

- Gas furnaces
  —Non-weatherized
  —Weatherized
- Oil-fired furnaces
  —Non-weatherized
  —Weatherized
- Mobile home furnaces
  —Gas
  —Oil
- Electric resistance furnaces
- Hot water boilers
  —Gas
  —Oil
- Steam boilers
  —Gas
  —Oil
- Combination space/water-heating appliances
  —Water-heater/fancoil combination units
  —Boiler/tankless coil combination units

The Department received comments on whether to include combination appliances that provide both space heating and domestic water heating as a product class. CEC and Carrier favored including combination appliances in the rulemaking. (CEC, No. 19 at p. 2; and Carrier, No. 7 at p. 1) EEI and Energy Kinetics want the Department to consider combination systems as a separate product category after the finalization of a test procedure. (EEI, No. 6 at p. 1; and Energy Kinetics, No. 3 at p. 2) First Company opposed the inclusion of combination appliances in the rulemaking, stating that separate standards for combination systems are not warranted as they are already regulated as water heaters and boilers, and that including combination appliances will not result in significant energy savings. (First, No. 12 at p. 1) At this time, the Department has decided not to include combination heating and water heating appliances in the current rulemaking. DOE is working on adoption of the existing version of ANSI/ASHRAE 124–1991 ''Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances'' as a test procedure for these products.

ASE suggested separate product classes for condensing and non-condensing furnaces and boilers. (ASE, No. 18 at p. 2) Condensing furnace and boiler designs are more efficient but otherwise differ very little from non-condensing designs. The difference is the addition of a second heat exchanger; this added component represents a feature that does not change utility to the consumer. Therefore, the Department included condensing and non-condensing designs in a single product class.

Based on the market assessment and stakeholder comments, the Department grouped the product classes into four categories.

The first category consists of the most widely used product class: Non-Weatherized gas furnaces. The Department's analyses considered this product class in depth.

The second category consists of those classes that have shipments that are typically more than 100,000 per year: weatherized gas furnaces, mobile home gas furnaces, non-weatherized oil-fired furnaces, hot-water gas boilers, and hot-water oil-fired boilers. The analysis of these product classes is similar to that of the first category, but DOE considered a smaller number of design options.

The third category includes product classes that have a low level of shipments: Steam gas boilers and steam oil-fired boilers. For these classes, DOE applied the results of the analyses of the hot-water boiler product classes.

The Department did not conduct analyses on the fourth category, which includes weatherized oil-fired furnaces, mobile home oil-fired furnaces, and electric furnaces. The first two classes in this category have very low (essentially zero) shipments. The Department did not consider electric furnaces because they have limited energy-savings potential.

Lochinvar commented that DOE should separate hot water boilers into low-mass and high-mass product classes. (Lochinvar, No. 17 at p. 1) Although they use different construction materials (cast iron vs. copper or aluminum), high- and low-mass boilers are essentially the same equipment and provide the same utility to the consumer. *See* 42 U.S.C. 6295 (q)(1). Therefore, the Department included them in one product class.

Lochinvar also commented that DOE should study boilers to the same extent as furnaces. (Lochinvar, No. 17 at p. 1) DOE used separate analytic tools to separately assess the boilers product class.

B. Screening Analysis

The screening analysis eliminated certain design options from further consideration in the engineering analysis phase. Section 4 of the Process Rule lists four factors to take into account in screening design options:

1. Technological feasibility;
2. Practicability to manufacture, install, and service;
3. Adverse impacts on utility or availability to consumers; and
4. Adverse impacts on health or safety.

GAMA made a general comment that safety must always take priority over efficiency. (GAMA, No. 8 at p. 1) As the Process Rule recommends, the Department will screen out any design options that have adverse affects on the safety of consumers.

The Department received a number of specific comments regarding design options. In considering these comments and its own analysis, the Department screened out a number of options for certain product classes, as shown in Table II.2. The options eliminated include:

(1) Use of condensing secondary heat exchangers for oil-fired furnaces (sulfur content of fuel oil, soot, and heat exchanger fouling may have adverse impacts on health or safety);

(2) Fuel-driven heat pumps (the practicality to manufacture, install, and service is uncertain);

(3) Oil-fired pulse combustion (the practicality to manufacture, install, and service is not certain);

(4) Self-generation of electricity using thermo-photovoltaics (not considered technologically feasible);

(5) Smart valve for oil-fired furnaces and boilers (the practicality to manufacture, install, and service is not certain); and

(6) Flue-gas recirculation (has not yet been shown to be technologically feasible in residential-sized equipment, and it has little energy-saving potential).

For outdoor weatherized gas furnaces, the use of a condensing secondary heat exchanger that produces flue gas temperatures below the dew point temperature is not considered because condensate freezing may have adverse impacts on safety.

Some options are not applicable for certain product classes. For example, improved or increased insulation is not applicable for boilers because boilers are tested as indoor appliances according to the DOE test procedure.

The design options listed in Table II.2 with a ''Y'' (for ''yes'') pass all screening criteria, so DOE initially included them in the engineering analysis. Chapter 4 in the TSD provides more detail on the design options.

TABLE II.2.—SCREENING RESULTS FOR DESIGN OPTIONS BY PRODUCT CLASS

Design option	Gas furnaces		Oil-fired furnaces	Mobile home gas-furnaces	Hot water boilers	
	Non-weatherized	Weatherized			Gas	Oil
Improved Heat Exchanger Effectiveness	Y	Y	Y	Y	Y	Y
Modulating Operation	Y	Y	Y	Y	Y	Y
Improved or Increased Insulation	Y	Y	Y	Y	N/A	N/A
Condensing Secondary Heat Exchanger	Y	N	N	Y	Y	Y
Electronic Ignition	b	b	b	Y	Y	b
Induced or Forced Draft	b	b	b	Y	Y	b
Infrared Burner	Y	Y	Y	Y	Y	Y
Direct Vent	Y	Y	Y	Y	Y	Y
Smart Valve	N/A	N/A	N	N/A	N/A	N
Fuel Filtration	N/A	N/A	Y	N/A	N/A	Y
Pulse Combustion	Y	Y	N	Y	Y	N
Air-Atomized Burner with Modulation	N/A	N/A	Y	N/A	N/A	Y
Delayed Action Oil Pump Solenoid Valve	N/A	N/A	Y	N/A	N/A	Y
Increased Motor Efficiency	Y	Y	Y	Y	Y	Y
Increased Blower Impeller Efficiency	Y	Y	Y	Y	N/A	N/A
Self-Generation of Electricity	N	N	N	N	N	N
Fuel-Driven Heat Pumps	N	N	N	N	N	N
Flue Gas Recirculation	N	N	N	N	N	N

Y The design option is applicable to this product class and passes screening.
N The design option has been screened out from further analysis for this product class.
N/A The design option is not applicable to this product class.
b Already included in the baseline model design (*see* section C.2)

C. Engineering Analysis

The purpose of the engineering analysis is to estimate according to the DOE test procedure the energy savings potential from increased equipment efficiency levels, and to determine the incremental equipment and installation cost of achieving those levels, compared to the baseline model in each product class. The engineering analysis estimates the payback period for each of the design options in order for DOE to address the legally required ''rebuttable'' payback consideration. The Department uses the costs developed in the engineering analysis in the LCC analysis.

1. Approach

There are a large number of ways to combine design options in furnaces and boilers to attain a particular efficiency level. To explore how manufacturers would likely design products to meet a standard and to thoroughly understand the relationships between different equipment configurations and efficiency, the Department considered several design options that could meet a given efficiency level. For the engineering analysis, DOE selected the design options considered most likely to be implemented.

The baseline model for each product class is the starting point for analyzing technologies that provide energy-efficiency improvement. The Department defined a baseline model as an appliance having the commonly available, most-cost-effective features and technologies while meeting the current efficiency standard. The Department defined a baseline model for each of the product classes in the first and second categories described above.

After identifying the baseline models, the Department estimated the total cost of higher-efficiency units to the consumer through an analysis of manufacturer costs, markups, and installation costs. Costs for equipment design options are determined through tear-downs. Markups are estimated using publicly available corporate and industry data, supplemented by data from the Manufacturing Housing Institute. The Department created an ''Installation Model'' to assess venting costs, and verified it against known existing data.

2. Baseline Models

Identification of the baseline for an equipment product class requires establishing a baseline efficiency level and selecting a size typical of that equipment. For furnace and boilers, the analysis also requires defining major design features, such as the configuration (which refers to the design of the supply air pathways), heat exchanger type, ignition type, and the means of heating fluid delivery (draft type).

Several stakeholders submitted comments on recommended furnace and boiler baseline model characteristics. ACEEE commented that the Department should use the sales-weighted median size as the baseline model size in each product class. (ACEEE, No. 15 at p. 5) AGA commented that the Department should consider baseline models that include a range of building loads, airflows, regional heat demands, ignition system alternatives, and other technical variables. (AGA, No. 11 at p. 6)

For each product class, GAMA provided specific recommendations for the features of the baseline model. For example, for the baseline non-weatherized gas furnace, GAMA recommended that the baseline should have an AFUE of 78 percent (the statutory minimum efficiency), 75 kBtu/h (thousand Btu per hour) input, an induced draft combustion system, electric (hot surface) ignition, and a blower for three-ton cooling. (GAMA, No. 8 at p. 1) Trane commented that the baseline gas furnace should have electronic ignition, an induced draft, a 75 kBtu/h input, 1200 CFM at 0.5″ static pressure, and a three-ton air-conditioning capacity. (Trane, No. 9 at p. 1)

For the baseline oil-fired furnace, Lennox suggested that DOE use a 120 kBtu/h size. (Lennox, No. 16 at p. 1) GAMA recommended that the baseline have an input of 105 kBtu/h, which is the most common in the current market. (GAMA, No. 8 at p. 3)

MHI suggested that the baseline model for mobile home furnaces should have sealed combustion, a downflow configuration, and an inside thermal envelope footprint of less than 20 inches by 24 inches. (MHI, No. 13 at p. 1)

GAMA recommended that the gas boiler baseline model should have an atmospheric burner, a standing pilot, and an electro-mechanical vent damper and an input of 105 kBtu/h. (GAMA, No. 8 at p. 3) For the oil-fired boiler baseline model, GAMA recommended a boiler with a power burner and an input of 140 kBtu/h. (GAMA, No. 8 at p. 3)

In defining the baseline models, the Department took into account the above comments, as well as the technical description of the covered equipment, the definition of the product classes, and the results of the market assessment. DOE used the product features suggested by GAMA in the baseline definition, since they were consistent with most of the relevant stakeholder comments. Table II.3 summarizes the main features of the baseline models. For more detail on baseline equipment, refer to the Engineering Analysis, section 6.3 of the ANOPR TSD.

TABLE II.3.—FEATURES OF FURNACE AND BOILER BASELINE MODELS

Product class	Input capacity (Btu/h)	AFUE (%)	Configuration	Heat exchanger type	Ignition	Draft
Non-weatherized Gas Furnaces.	75,000	78	Upflow	Clam Shell/Tubular	Hot Surface	Induced.
Weatherized Gas Furnaces.	75,000	78	Horizontal	Clam Shell/Tubular	Hot Surface	Induced.
Mobile Home Gas Furnaces.	70,000	75	Downflow	Drum	Standing Pilot	Natural.
Non-weatherized Oil-Fired Furnaces.	105,000	78	Upflow	Drum	Intermittent Ignition	Forced.
Hot Water Gas Boilers	105,000	80	N/A	Sectional, Dry-base, Cast-iron.	Standing Pilot	Natural.
Hot Water Oil-Fired Boilers.	140,000	80	N/A	Sectional, Wet-base, Cast-iron.	Intermittent Ignition	Forced.

In addition to the above features, the baseline models have a blower or pump driven by a standard permanent split capacitor (PSC) induction motor.

3. Design Option Selection

From the list of options that passed the screening analysis, DOE selected those design options considered most likely to be implemented. The Department assumed that manufacturers will incorporate design options that have the least cost to attain a given efficiency level. Cost and efficiency estimates were available for a broad array of design options. The Department used the relationship between cost and percent efficiency improvement to rank all the fuel-related design options. Two options were most favorable: increasing the heat exchanger area and increasing the heat exchanger transfer coefficient. In interviews with manufacturers, the Department confirmed that these choices were the most promising design options.

The Department also included modulation technology as another design option that can provide an AFUE improvement for some of the product classes. Based on currently available products in the market, DOE applied two-stage modulation to non-condensing and condensing equipment and applied step modulation only to condensing furnaces.

The Department also included consideration of the following design options:

1. Improved heat exchanger effectiveness through electrohydrodynamic enhancement of heat exchangers;
2. Condensate venting and disposal;
3. Atomizing oil burner with two-stage modulation; and
4. Heat exchanger size optimization for oil-fired equipment.

Section 6.4 of the ANOPR TSD further discusses the above design options.

4. Manufacturing Cost Analysis

There are three ways to estimate manufacturing costs: (1) The design option approach, reporting the incremental costs of adding specific design options to a baseline model; (2) the efficiency level approach, reporting incremental costs of achieving each level of energy efficiency improvement; and (3) the reverse engineering or cost-assessment approach, which requires a ‘‘bottom-up’’ cost assessment based on a detailed bill of materials for models that operate at particular efficiency levels.

The Department received a variety of recommendations on generating manufacturer cost estimates. ACEEE recommended using reverse engineering analysis. (ACEEE, No. 15 at p. 5) ASE commented that industry cost data lack transparency and credibility and suggested that the Department use reverse engineering as the primary data source. (ASE, No. 18 at p. 2) ODOE stated that manufacturer-supplied costs have been consistently (sometimes significantly) high, and suggested that DOE not rely on this single source. (ODOE, No. 10 at p. 4) EEI recommended that DOE not disregard industry cost data. (EEI, No. 6 at p. 2) Southern Co. supported the use of industry cost data rather than reverse engineering numbers. (Southern, No. 14

at p. 4) Trane recommended the efficiency level approach because: (1) There is no good simulation model available for all designs; (2) feasible design options are limited; (3) DOE should specify a performance standard, not a design standard; and (4) GAMA can gather accurate cost data. (Trane, No. 9 at p. 2) GAMA commented that if DOE gets manufacturer cost information directly from manufacturers, it should provide draft aggregate cost data so GAMA can confirm the reasonableness of the data. (GAMA, No. 8 at p. 1)

Several comments suggested that DOE should consider historical trends or forces in estimating the retail price of equipment that would meet standards in the future. NRDC said DOE should include the ''learning curve'' effect that would come from greater cumulative production of higher-efficiency models. (NRDC, No. 21 at p. 2) ACEEE said that given historical trends and significant cost-reduction accomplishments of manufacturers, it is conceivable that they can produce higher equipment efficiency without significant increase in retail prices. (ACEEE, No. 15 at p. 5) NRDC, ACEEE, and CEC commented that actual equipment price increases have been lower than DOE's projected increases in past rulemakings. (NRDC, No. 21 at p. 3; ACEEE, No. 15 at p. 4; CEC, No. 19 at p. 4) ACEEE urged DOE to review the accuracy of past price impact projections for regulated products. (ACEEE, No. 15 at p. 4) Trane suggested that the best way to understand retail prices is to get several hundred quotes covering a variety of regions, installation types, efficiency levels, and ranges of capacities. (Trane, No. 9 at p. 2)

For other rulemakings, the Department has used production input costs and production technologies based on the best information available at the time. DOE has not made any assumptions about productivity improvements and material cost changes that may occur over time. The Department does not believe it can apply historical trends for residential furnaces or other products to forecast equipment costs where there are no data to show that the trends will continue. Therefore, the Department will not assume a productivity improvement factor in this rulemaking.

After assessing the available methods and taking stakeholder comments into account, the Department used reverse engineering of existing products to estimate the manufacturing cost of the baseline model and the considered design options. The Department believes that the reverse engineering approach, which is based on a detailed bill of materials (BOM) for the various models, is the best way to accurately and cost-effectively assess manufacturing costs. The Department supplemented this approach with a review of relevant literature, computer simulation, and other analytical techniques, as well as industry-supplied data. Throughout the analysis period, the Department provided GAMA, manufacturers, and other stakeholders several opportunities to review and comment on the cost estimates to ensure accuracy and completeness. The Department considered these comments in its analysis. Refer to section 6.4 of the ANOPR TSD for further discussion of the method used for analysis of manufacturing costs.

In estimating production costs for each potential efficiency (AFUE) level above the baseline model, the Department considered several design options that can be used to reach a given AFUE level. The Department also considered additional options that provide electrical power savings. The Department determined the efficiency levels corresponding to various design option combinations using manufacturer data submittals and DOE engineering calculations.

The Department generated the BOM by examining and disassembling (through teardown analysis) some current-market units and/or simulating design options using numerical models and creating ''hypothetical'' units that it costed as if they were real units. (In the context of this study, the terms ''reverse engineering'' and ''teardown analysis'' solely describe the estimation of production costs by examining actual equipment or designs.) The availability of a large number of residential products with a wide range of efficiency allowed DOE to consider all potential design options in a reverse-engineering approach in order to establish an accurate estimate for production costs. The Department purchased and disassembled by hand the selected units and measured, weighed, and analyzed each part. Additionally, DOE studied and reconstructed all the steps of the manufacturing processes to finish the teardown analysis. The result was detailed BOMs that DOE used as input to the cost model.

The analysis required the Department to perform teardowns at a number of efficiency levels. Multiple teardowns per point were needed to capture major design approaches. To reduce the number of possible teardowns to a manageable level, the Department focused on representative sample units sold in high volumes. Thus, the sample units included in the teardown analysis do not represent all possible efficiency levels of each product class. DOE took the following steps in creating BOMs for additional efficiency levels: (1) Identify efficiency gaps; (2) Select the most promising design options; (3) Identify possible design modifications of existing units and create a written description of ''hypothetical'' (or ''theoretical'') units; (4) Perform simulations to correlate design modifications with efficiency levels; and (5) Create BOMs for ''hypothetical'' units.

The cost model is based on production activities and divides factory costs into the following categories: (1) Material (direct and indirect materials); (2) Labor (fabrication, assembly, indirect and overhead burdened labor); and (3) Overhead (equipment depreciation, tooling depreciation, building depreciation, utilities, equipment maintenance, rework).

The Department used the cost data from all BOMs—whether obtained through teardowns or numerical simulations—in the cost model, which makes use of specific assumptions to provide cost estimates. These assumptions include industry averages for site-specific inputs (*e.g.*, labor rates), assuming the production facility is a ''greenfield'' plant (as if a new manufacturing plant were built) and assuming production volumes similar to current levels for each product class.

Even after completion of both the teardown analysis on representative units and the numerical simulations, the Department still needed information for condensing boilers (both gas- and oil-fired) and condensing mobile home furnaces. For these categories, DOE identified possible design options but did not have a methodology or a simulation tool in place to estimate the production costs. Therefore, the Department used a cost-per-pound estimation methodology for these products.

In summary, the Department took the following steps in establishing manufacturing costs as a function of fuel efficiency:

(1) Generate BOMs for products at different efficiency levels using teardown analysis and numerical simulations;

(2) Enter BOMs into a cost model, incorporating assumptions obtained through available industry data, internal expertise, visits to manufacturers, and stakeholders' input;

(3) Perform sensitivity analysis and cost-per-pound estimates; and

(4) Generate cost-efficiency data for each efficiency level.

Tables II.4a–f show the estimated incremental manufacturing costs of increasing AFUE for each product class. The reported efficiency levels are generally achieved by increasing heat exchanger area or improving the heat transfer coefficient. The incremental costs in the tables are relative to the baseline model for each product class.

For the modulation design option, the Department considered a design approach currently in the market that uses a multiple-tap, multiple-speed PSC blower motor; a two-stage gas valve; and a multiple-tap, two-speed PSC inducer motor to achieve two-stage modulation operation. For this design, DOE estimated that an additional $23 would be added to the production cost of the furnace to account for the component changes. The Department estimated that the AFUE improvement for adding two-stage modulation to a furnace would be 1 percent, based on a survey of units with and without modulation in the GAMA directory. Therefore, to estimate the cost of a modulating furnace at 81 percent AFUE, DOE added $23 to the production cost of a 80 percent AFUE furnace. An amendment to the current test procedure may be necessary to more completely characterize the energy savings from modulation. See Chapter 6 of the TSD for further details.

TABLE II.4A.—INCREMENTAL MANUFACTURING COST FOR NON-WEATHERIZED GAS FURNACES

Efficiency level (AFUE) %	Incremental cost
78 Baseline Model	0
80	$3
81	6
82	9
90	146
92	213
96	570

TABLE II.4B.—INCREMENTAL MANUFACTURING COST FOR WEATHERIZED GAS FURNACES

Efficiency level (AFUE) %	Incremental cost
78 Baseline Model	0
80	$3
81	6
82	9

TABLE II.4C.—INCREMENTAL MANUFACTURING COST FOR MOBILE HOME GAS FURNACES

Efficiency level (AFUE) %	Incremental cost
75 Baseline Model	0
80	$29
81	36
82	46
90	140

TABLE II.4D.—INCREMENTAL MANUFACTURING COST FOR OIL-FIRED FURNACES

Efficiency level (AFUE) %	Incremental cost
78 Baseline Model	0
80	$2
81	5
82	7
84	10
85	15

TABLE II.4E.—INCREMENTAL MANUFACTURING COST FOR HOT-WATER GAS BOILERS

Efficiency level (AFUE) %	Incremental cost
80 Baseline Model	0
81	$29
82	39
83	47
84	55
88	128
91	379
99	816

TABLE II.4F.—INCREMENTAL MANUFACTURING COST FOR HOT-WATER OIL-FIRED BOILERS

Efficiency level (AFUE) %	Incremental cost
80 Baseline Model	0
81	$4
82	7
83	11
84	15
86	22
90	434
95	836

The Department also identified options that decrease electricity consumption in furnaces and boilers. The details are described in Appendix 8.5 of the TSD.

5. Markup Analysis

Completing the equipment cost calculations in the engineering analysis requires determination of the cost to the customer of a baseline model furnace or boiler and the cost of more efficient units. The average customer price of such units is not generally known. To estimate the equipment costs to the customer, DOE determined typical markups on each stage of the distribution chain from the manufacturer to the consumer. The markup approach makes it possible to estimate a retail price from the manufacturing cost. In addition to estimating average markups, the Department also characterized the markups with probability distributions through a statistical analysis of U.S. Census data and used these distributions in the LCC analysis.

The Department included the following expenses in the determination of the manufacturer markup: Research and development, net profit, general and administrative, warranty expenses, taxes, and sales and marketing. The estimated average markup of 1.26 was based on analysis of corporate financial records. The Department excluded shipping expenses (out-bound) because these expenses were included in the manufacturing cost. Research and development expenses were determined by assuming that engineering budgets would be reallocated from value-engineering and new-feature development to product development and redesign. The additional capital outlays and re-tooling investments are captured in the incremental cost of the equipment.

The Department based the wholesale and contractor markups on firm balance sheet data. Builder markup (applied to new construction installations only) was estimated from U.S. Census data for the residential and commercial building construction industry and from HVAC industry data. Recent state and local sales tax data were used to estimate sales taxes (applied to replacement installations only).

An exception to the above procedure was the case of mobile home furnaces, where the distribution chain is shorter; the heating equipment manufacturer sells to the mobile home maker, who installs the furnace at the factory. In this case, the Department estimated markups using information from the Manufacturing Housing Institute.

The estimated average markups are listed in Table II.5. The markup on incremental costs (relative to a baseline model) is lower than the markup on the baseline model cost for wholesalers and contractors because only profits and other operating costs typically scale with the manufacturer price or (for contractors) the cost of goods sold. The overall markups are lower for new construction installations than for replacement installations, since different markups apply. For more detail on how the Department developed the markups, refer to Chapter 5 of the ANOPR TSD.

TABLE II.5.—AVERAGE MARKUPS ON COSTS OF RESIDENTIAL FURNACES AND BOILERS

	Baseline model cost	Incremental cost
Manufacturer	1.26	1.26
Wholesaler	1.36	1.11
Contractor (new/replacement)	1.41/1.62	1.22/1.33
Builder (new construction only)	1.43	1.33
Sales tax (replacements only)	1.07	1.07
Total markup (on manufacturing cost)		
Non-weatherized gas furnace	3.12	2.07
Weatherized gas furnace	3.12	2.07
Oil-fired furnace	2.97	1.99
Hot-water gas boiler	2.97	1.99
Hot-water oil-fired boiler	2.97	1.99
Mobile home gas furnace	2.22	2.22

6. Installation Cost

The installation cost is the cost to the consumer for installing a furnace or a boiler; it is usually not part of the retail price. The cost of installation covers all labor and material costs associated with the installation of a new unit or the replacement of an existing one. For furnaces and boilers, the installation cost is the largest single component of the total cost to the consumer. It is even larger than the equipment cost.

The predominant part of the installation cost is the venting system. The American National Standards Institute (ANSI) standard Z21.47–1993 defines four Categories (I–IV) for furnace or boiler venting systems. The categories are defined based on the operating pressure and temperature in the vent. Most non-condensing equipment operates with a Category I (high temperature, low pressure) venting system. Most condensing equipment operates with a Category IV (low temperature, high pressure) venting system, but some condensing boilers use a Category III (high temperature, high pressure) system. For a Category I venting system only, the 2002 National Fuel Gas Code (NFGC) Venting Tables 13.1 through 13.5 define the requirements for installation.

DOE devoted considerable effort to identifying appropriate costs to use in its analysis. In the process, DOE found that there is no complete data source for installation costs for the product classes under consideration. ACEEE suggested that DOE collect data from the field to help in estimating the cost of various types of installations. (ACEEE, No. 32 at p. 3) The Department concurs that this would be beneficial and will consider this approach if appropriate data are available. The Department hereby requests submittal of field installation cost data.

One source of data is a 1994 GRI report, which GAMA supplemented in 2002 with an updated summary version of the data. The installation costs in the GRI report were developed from the results of a field survey which several gas utilities conducted in 1992. These data are relatively old and, particularly for condensing furnaces, may not represent a well-established market. Differences between new and replacement installation costs may be underestimated. Further, no detailed cost breakdowns are available from the report for independent verification of the results.

A second source is a 1999 Natural Resources Canada (NRCanada) study that developed installation cost data for non-weatherized gas furnaces for four Canadian areas. A company that provides cost estimates for building contractors conducted the study. The NRCanada study provides the most current data set available, and the data are used by Canadian government agencies and are well documented. However, for condensing furnaces, there are indications that these data are applicable only to new-construction installations.

The Department looked at other possible sources of installation costs, including data from Wisconsin from a 1999 survey of HVAC contractors. The Department did not use these data because of the very small size of the sample.

Because of the shortcomings of the above sets of data, DOE performed its own study to determine installation costs for non-weatherized gas furnaces, referred to henceforth as the ''Installation Model.'' The Department has posted the Installation Model spreadsheets for furnaces and boilers on its Web site: *http://www.eere.doe.gov/buildings/appliance_standards/furnaces_boilers.html.*

The Department used RS Means, a well-known and respected construction-cost-estimation method, to develop labor costs, and got quotes from national distributors to develop material costs. The Installation Model weight-averages the detailed costs for a large variety of typical installations in the field, including both new construction and retrofit installations; single and multifamily housing; plastic, metal and masonry chimney vents; single- and double-wall vent connectors; and common venting with other appliances. Chimney relining practices and orphaned water heaters are explicitly modeled. The Department validated the Installation Model results by comparing them with the preceding three data sets under equivalent assumptions; the incremental costs agree within 15 percent. The Department is requesting comments about the Installation Model (see Issue 1 under ''Issues for Public Participation'' in section IV.E of this ANOPR).

a. Non-Weatherized Gas Furnaces

For non-weatherized gas furnaces, DOE considers the data derived with the Installation Model as the most current and comprehensive available for the analysis. It used a sensitivity analysis based on variations of installation size. The GAMA and NRCanada data sets also provide a basis for upper and lower bounds for installation cost.

The Department determined that there is a small additional average installation cost for an 80 percent AFUE furnace relative to a baseline (78 percent AFUE) furnace. This cost involves the need to reline some masonry chimneys and applies to single-stage, as well as modulating, furnaces.

When efficiency increases above 80 percent AFUE, additional costs associated with venting system modifications may be necessary.

At the DOE Venting workshop in May 2002, the differences between steady-state efficiency (SSE) and AFUE were discussed in detail. Lennox and GAMA commented that installations in accordance with NFGC Venting Table rules may sometimes exceed the expected SSE, and recommended DOE apply a margin of safety to the SSE/AFUE relationship. (Lennox, No. 35 at p. 2; and GAMA, No. 31 at p. 2) Lennox also said that some installation locations will yield operating conditions that differ substantially from test conditions. (Lennox, No. 35 at p. 2) Reflecting these concerns, DOE's approach to determining the SSE/AFUE relationship includes an uncertainty range for the fraction of installations at each efficiency level that would likely need a Category III venting system. DOE used the GAMA directory to develop data on the AFUE/SSE relationship.

Several stakeholders commented that the SSE/AFUE relationship is not affected by differences in the type of furnace heat exchanger (tubular vs. clamshell). (Public Workshop Tr., No. 25JJ at p. 68; GAMA, No. 31 at p. 6; and York, No. 33 at p. 3) DOE did not consider the type of furnace heat exchanger when evaluating the SSE/AFUE relationship.

For the 81 percent AFUE level, DOE considered two cases for installation cost. The first assumes the use of two-stage modulation technology. At present, two major manufacturers produce furnaces with 81 percent AFUE using modulation technology that allows use of a Category I venting system. By investigating existing models and manufacturers' installation manuals, the Department determined that these furnaces must use Type B double-wall vent connectors in the venting system.

The second case considers only the use of single-stage furnace models. The Department determined that at an energy efficiency of 81 percent AFUE, about 8 percent of the existing single-stage furnace models would have an SSE above 83 percent. At this SSE level, condensation in the venting system may occur, possibly leading to corrosion and carbon monoxide leakage. In this case, DOE assumed that 8 percent of installations would need a Category III stainless steel vent to allow safe operation. The remaining 92 percent would need to use Type B double-wall vent connectors in the venting system. For the 82 percent and 83 percent AFUE levels, DOE determined that 35 percent and 100 percent of units, respectively, could be above 83 percent SSE, and these units would need a Category III venting system for safe operation.

Condensing furnaces at 90 percent AFUE use a Category IV venting system, which is mostly composed of a side-wall venting system with plastic vent pipes. For condensing furnaces, the Installation Model accounts for the installation of a new vent system, resizing of the remaining common system, condensate neutralization, and condensate pumping for disposal. The Department assumed that installation costs for all condensing furnaces are similar, since available information suggests that efficiency levels higher than 90 percent do not appreciably affect the installation cost for condensing gas furnaces.

Simpson and GAMA commented that DOE should account for costs of handling the condensate disposal. (Simpson, No. 30 at p. 3; and GAMA, No. 8 at p. 1) The installation cost for condensing furnaces includes the cost of condensate disposal.

The Department's installation cost estimates are shown in Table II.6a. The cost data are presented in 2001 dollars to coincide with the manufacturing cost estimates.

TABLE II.6A.—INSTALLATION COST FOR NON-WEATHERIZED GAS FURNACES

Efficiency level (AFUE) (percent)	NRCanada (US $)	Installation Model (US $)	GRI (US $)
78—Baseline Model	382	727	773
80	382	731	965
81—two-stage, no Category III	382	760	965
81—single-stage, 8 Category III	432	810	1,104
82	634	1,012	1,671
83	1,012	1,356	2,732
90	411	980	1,239
93 and above	411	980	1,268

b. Other Product Classes

For weatherized gas furnaces, the location of the equipment (outdoors) influences the installation cost. Based on RS Means, the Department estimated a mean of $1,123 for the installation cost of the baseline model. Since limited data were available, DOE assumed that installation cost remains mostly constant as efficiency is increased. This assumption seems reasonable for single-package systems, as the increases in size and weight for more efficient, single-package systems are small relative to the large size and weight of the baseline model.

For mobile home gas furnaces, common installation costs are part of the equipment cost because mobile home gas furnaces are assembled in the factory rather than in the field. The manufacturer's markup includes these factory assembly costs. For 90 percent and over AFUE condensing furnaces, there is an additional installation cost in the field to account for condensate disposal systems.

DOE modified the Installation Model to estimate venting costs for oil-fired furnaces, hot-water gas boilers, and oil-fired boilers (see Chapter 6 of the TSD for details). For gas boilers, NFPA 54 provides Category I venting guidelines; for oil-fired appliances, the applicable venting guideline is NFPA 31. However, the efficiency level at which the use of higher-cost Category III venting becomes necessary is not defined by these codes. For the analysis of gas boilers, DOE assumed that 20 percent of installations include Category III horizontal vents for construction-related reasons for efficiencies up to 84 percent AFUE. At 85 percent AFUE, DOE assumes Category III venting must be used 100 percent of the time. For oil-fired equipment, type L stainless venting is required at all AFUE levels. DOE assumes that the vent system must be upgraded to stainless AL–4C at 85 percent and 84 percent AFUE for oil-fired boilers and oil-fired furnaces, respectively.

The Department's installation cost estimates are shown in Table II.6b through II.6f. The cost data are presented in 2001 dollars to coincide with the manufacturing cost estimates.

TABLE II.6B.—INSTALLATION COST FOR WEATHERIZED GAS FURNACES

AFUE (percent)	Average cost ($)	Incremental cost ($)
78	1,123	—
80	1,123	0
81	1,123	0
82	1,123	0

TABLE II.6C.—INSTALLATION COST FOR MOBILE HOME GAS FURNACES

AFUE (percent)	Average cost ($)	Incremental cost ($)
75	0	—
80	0	0
81	0	0
82	0	0
90	181	181

TABLE II.6D.—INSTALLATION COST FOR OIL-FIRED FURNACES

AFUE (percent)	Weighted average cost ($)	Incremental cost ($)
80	751	—
82	751	0
83	751	0
84	1,641	890
85	1,641	890

TABLE II.6E.—INSTALLATION COST FOR HOT-WATER GAS BOILERS

AFUE (percent)	Weighted average cost ($)	Incremental cost ($)
80	1,679	—
82	1,679	0
83	1,679	0
84	1,679	0
85	2,833	1,154
90+	2,091	412

TABLE II.6F.—INSTALLATION COST FOR HOT-WATER OIL-FIRED BOILERS

AFUE (Percent)	Weighted average cost	Incremental cost
80	$1,631	—
84	1,631	0
85	2,556	$925
86	2,556	925
90	2,091	460

c. Safety and Reliability Issues Related to Installation

Several stakeholders expressed concerns about safety and reliability issues associated with condensation problems that may arise with higher-efficiency furnaces and boilers. For non-weatherized gas furnaces, GAMA and NPGA stated that 83 percent SSE, which corresponds to an AFUE of 80–82.5 percent, is recognized as the threshold above which condensation may occur. (Public Workshop Tr., No. 25JJ at p. 162; and NPGA, No. 29 at p. 2) Lennox said that safety and reliability prevent manufacturers from selling products with an AFUE between 81 percent and 90 percent, and even 81 percent AFUE furnaces are not sold in all geographic regions. ((Public Workshop Tr., No. 25JJ at p. 97) The few non-condensing furnaces sold with an AFUE over 81 percent are intended for specialized applications. (Public Workshop Tr., No. 25JJ at p. 97) Carrier commented that furnaces with an AFUE of 81 to 82 percent were widely available in the 1980's and experienced numerous venting and corrosion problems. (Carrier, No. 7 at p. 1) Lennox recommended that the Department's analysis should not consider gas-fired equipment between 81 percent and 90 percent AFUE because of the difficulties in ensuring the safe operation of furnace and venting systems for the maximum useful life of the equipment. (Lennox, No. 16 at p. 1) Trane said that the fact that there are no available products with AFUE values between 82 percent and 90 percent is a very important indicator of the existing efficiency range that allows for satisfactory margins of safety. (Trane, No. 34 at p. 1) ACEEE maintains that 83 percent AFUE is technically feasible without significant risk of corroding the heat exchanger. (ACEEE, No. 15 at p. 2)

For furnaces with an AFUE in the range of 81–83 percent, the Department evaluated the impact of condensate on vent systems. Based on the common practice with higher efficiency gas boilers, the Department determined that the use of Category III venting systems can adequately address safety concerns at these AFUE levels. The Department included costs for installing Category III venting systems where the analysis determined they would be needed. Refer to section 6.5 of the ANOPR TSD for further discussion.

Battelle urged DOE to take into account the increased liabilities that may arise with higher efficiency. (Public Workshop Tr., No. 25JJ at p. 215) GAMA said that DOE must consider the risks and costs associated with venting and corrosion problems. (GAMA, No. 31 at p. 2) Trane said that increasing the AFUE above 81 percent would place an undue burden on manufacturers to protect customer safety. (Trane, No. 33 at p. 1) DOE addressed this issue by assigning Category III venting systems to an appropriate fraction of installations, thus capturing the costs associated with ensuring safe operation of higher-efficiency furnaces.

For condensing furnaces, GAMA recommended that the Department consider in its analyses regional and local building code requirements concerning venting materials and practices. GAMA also mentioned the problems with less expensive plastic materials, such as high temperature plastic vents (HTPV), to vent exhaust gases, which resulted in a recall by the U.S. Consumer Product Safety Commission, and cautioned DOE about the appropriate use of materials and approaches to reduce condensation problems (*e.g.*, vent coating, vent pre-heating, new materials, improved vent-connectors). (Public Workshop Tr., No. 25JJ at p. 174) The Department used the appropriate venting practices for condensing furnaces in its analysis and only considered materials commonly used in existing equipment designs.

Several stakeholders commented about including in DOE's analysis the cost of upgrading the venting system due to increased efficiency. ACEEE recommended that the Department include costs to address the risks to the venting system. (ACEEE, No. 15 at p. 2) GAMA commented that costs must reflect installation in complete compliance with all manufacturer instructions and code requirements, including extra installation costs for relining or resizing non-compliant venting systems for orphaned water heaters. (GAMA, No. 8 at p. 3) GAMA also said that DOE needs to consider costs of upgrade or repair when the furnace is no longer vented using a Category I system. (Public Workshop Tr., No. 25JJ at p. 87) York said DOE should consider that a large percentage of replacement furnaces are installed where masonry chimneys are used (thereby requiring chimney upgrade), and another large segment of installations use common venting with water heaters. (York, No. 33 at p. 3) GAMA and NPGA commented that the new efficiency standards for water heaters will contribute to the condensation problem because many furnaces and water heaters are vented in a common system. (Public Workshop Tr., No. 25JJ at p. 174; and NPGA, No. 35 at p. 2) ACEEE urged DOE to improve the understanding of this issue. (ACEEE, No. 32 at p.4)

The Department included all costs for installations that are in complete compliance with manufacturer instructions and code requirements. This includes upgrades when the furnace is no longer vented using a Category I system, and changes to common venting systems. See Chapter 6 of the TSD for more details on assumptions regarding orphaned water heaters and common venting systems.

During the Framework Workshop, the Department proposed to investigate controls and sensors that prevent the development of condensation in the venting system. In its response, GAMA said that by the time a sensor or CO detector works, it is too late to prevent condensation. (Public Workshop Tr., No. 25JJ at p. 171) AGA said that some control strategies would have adverse safety and health impacts. (Public Workshop Tr., No. 25JJ at p. 177) DOE agrees with the above comments but did not evaluate different control strategies in this analysis because of the potential for adverse impacts on the safety and health of consumers.

York said that venting applications for mobile home heating equipment have their own special requirements and standards, which must be considered when determining the impact of efficiency requirements on venting issues. (York, No. 33 at p. 3) The venting system of mobile home heating equipment is assembled in the factory as part of the mobile home construction, and its cost is included in DOE's markup analysis for this product class.

GAMA said that DOE should investigate corrosion and venting issues related to boilers. (GAMA, No. 31 at p. 4) DOE included in this analysis the cost of appropriate venting of higher-efficiency equipment for boiler product classes.

As this brief discussion makes clear, several stakeholders have expressed concerns that requiring higher-efficiency furnaces and boilers could result in situations where condensation could create safety problems for consumers. In addition, stakeholders have expressed concern about the use of special non-corrosive materials as well as controls and sensors to prevent condensation in the vent system. DOE believes that it has adequately addressed the safety issue by assigning Category III venting systems to an appropriate fraction of the installations in its analysis. This approach captures the costs associated with ensuring safe operation of higher-efficiency furnaces. DOE has also accounted for the effectiveness of materials as applicable to this analysis. As noted above, the Department did not consider controls and sensors to prevent condensation because of the adverse safety and health impacts on consumers.

7. Maintenance Costs

Maintenance costs include regular maintenance and repair of a furnace or a boiler when it fails. They cover all associated labor and material costs. For the discussion of the analysis of maintenance costs, refer to section 6.6 of the ANOPR TSD.

For non-weatherized and weatherized gas furnaces and gas boilers, DOE used maintenance cost data from a 1994 GRI report. The data came from a field survey sponsored by several gas utilities that repair and service furnace and boiler equipment. The survey methodology estimated the average cost per service call as the average total service charge.

The GRI study also developed the maintenance frequency as a function of the equipment efficiency level: once every four years for 80 to 81 percent AFUE equipment and once every three years for 82 to 83 percent AFUE equipment. For 90 percent and 92 percent AFUE equipment, the maintenance value represents a service contract that includes a specified set of routine repairs. The 96 percent AFUE furnace also includes a service contract that provides for regular annual maintenance. The Department annualized the costs over the estimated lifetime of the furnace (*see* Table II.7).

TABLE II.7.—ANNUALIZED MAINTENANCE COST FOR GAS FURNACES AND BOILERS

AFUE	Mean cost ($)
81% and less	35
82–83%	58
90% and 92%	61
96%	102

For oil-fired furnaces and oil-fired boilers, DOE applied the results of a survey performed for the water heater rulemaking. This survey identifies the typical cost of annual service contracts applied to all oil equipment in a house. These contracts are very common in the Northeast, where most of the oil heating equipment is located. The mean cost of an annual service contract for all considered efficiency levels is $104.

For mobile home furnaces, DOE used the data from the 1993 rulemaking for this product class. It also identified an additional maintenance cost needed for the design options considered in this analysis.

GAMA commented that the added components and complexity of modern furnaces bring increased maintenance and repair costs. (GAMA, No. 8 at p. 3) ACEEE commented that continuing pressures to increase quality and reduce time and training for maintenance should be able to check increases in such costs. (ACEEE, No. 15 at p. 6) DOE believes that the maintenance costs used in the analysis reflect the best currently available data.

8. Summary of Inputs

Table II.8 summarizes the inputs used to calculate rebuttable payback periods for various energy efficiency levels.

TABLE II.8.—SUMMARY OF INPUTS USED IN THE ENGINEERING ANALYSIS

Input	Description
Equipment Cost	Uses a cost model of baseline model manufacturing costs created by tear-down analysis; design option analysis was used to fill gaps. Industry feedback from GAMA and individual manufacturers was incorporated to generate manufacturing cost versus efficiency curves for primary and secondary classes.
Markups	Markups are derived from an analysis of corporate financial data. Manufacturing costs are multiplied by manufacturer, distributor, contractor, and builder markups, and sales tax, as appropriate, to get equipment price.
Installation Cost	Uses a distribution of weighted-average installation costs from the "Installation Model." Installation configurations are weight-averaged by frequency of occurrence in the field, and vary by installation size. The Installation Model is RS Means-based, and comparable to available known data.
Maintenance Costs	Uses GRI data for gas furnaces and boilers, water heater rulemaking survey results for oil-fired equipment, and data from the 1993 rulemaking for mobile home furnaces.
Annual Energy Use	Energy use is calculated using the DOE test procedure.
Energy Prices	AEO 2003 forecast prices for year 2012.

9. Rebuttable Payback Periods

Section 325(o)(2)(B)(iii) of the Act, 42 U.S.C. 6295(o)(2)(B)(iii), establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that "the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy * * * savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure * * * ''

Using the cost inputs described above, combined with energy calculations under the DOE test procedure, the Department calculated simple payback periods for each efficiency level using the ratio of incremental total installed cost to the change in the annual operating cost (*see* Table II.9). Refer to section 6.7 of the ANOPR TSD for further discussion of the calculation methods. As can be observed in Table II.9 a number of efficiency levels higher than current standards have paybacks of less than three years. However, payback periods calculated based on energy consumption in actual field conditions may differ significantly. The LCC and Payback Period Analysis described in the following section reflects field conditions and is therefore a more accurate depiction of consumer impacts. The Department does not make a determination of economic justification based on the rebuttable payback presumption. Economic justification is based on a weighing of the seven factors described in section I.C of this ANOPR. A number of efficiency levels higher than current standards are economically justified by this metric. Payback periods calculated based on energy consumption in actual field conditions may differ significantly; the LCC analysis considers such conditions. Note that in the process of setting a standard, the Department weighs many factors in addition to the economic justification, as listed in section I.B of this ANOPR.

TABLE II.9.—EFFICIENCY LEVELS WITH LESS THAN 3-YEAR PAYBACK PERIOD USING DOE TEST PROCEDURE

Product Class	Efficiency Level (AFUE) (Percent)	Payback (years)
Non-weatherized Gas Furnace	80	1.0
Weatherized Gas Furnaces	80	0.6
	81	0.8
	82	0.9
Mobile Home Furnaces	80	2.8
Oil-fired Furnaces	80	0.2
	81	0.2
	82	0.2
	83	0.3
Hot-Water Oil-fired Boilers	81	0.4
	82	0.4
	83	0.4
	84	0.4

D. Life-Cycle Cost (LCC) and Payback Period (PBP) Analysis

When DOE is determining whether an energy efficiency standard is economically justified, EPCA directs DOE to consider the economic impact of potential standards on consumers. (42 U.S.C. 6295 (o)(2)(B)(i)(I)) To address that impact, the Department calculated changes in equipment life-cycle cost (LCC) for consumers that are likely to result from each candidate standard, as well as payback periods. The effects of standards on individual consumers include changes in operating expenses (usually lower) and changes in total installed cost (usually higher). The Department analyzed the net effect of these changes by calculating the changes in LCC compared to a base case forecast. The LCC calculation considers total installed cost (equipment purchase price plus installation cost), operating expenses (energy and maintenance costs), equipment lifetime, and discount rate. The Department performed the analysis from the perspective of the user of residential furnace and boiler products.

The LCC and PBP results are presented to facilitate stakeholder review of the LCC analysis. Similar to the LCC analysis, the PBP is based on the total cost and operating expenses. But unlike the LCC analysis, only the first year's operating expenses are considered in the calculation of PBP. Because the PBP analysis does not take into account changes in operating expense over time or the time value of money, it is also referred to as a ''simple'' payback period.

Trane commented that the LCC analysis does not reflect consumer purchasing behavior, which exhibits a preference for a simple payback of less than 3 years. (Trane, No. 9 at p. 3) As mentioned above, the Department calculated payback periods as well as LCCs, and takes both factors into account in determining the economic justification for each possible energy efficiency standard.

AGA commented that the LCC analysis should be the primary basis for economic justification. (AGA, No. 11 at p. 5) The Department will weigh all costs and benefits, including the LCC.

1. Approach

The LCC analysis estimates the LCC for representative equipment in houses that are representative of the segment of the U.S. population that is buying furnaces and boilers. The calculation of LCC is done for a representative sample of houses, one house at a time, using appropriate values for the inputs each time. To account for uncertainty and variability in specific inputs such as lifetime and discount rate, there is a distribution of values with probabilities attached to each value. For each house, DOE samples the values of these inputs from the probability distributions. As a result, the analysis produces a range of LCCs. A distinct advantage of this approach is that DOE can identify the percentage of consumers achieving LCC savings or attaining certain payback values due to an increased efficiency standard, in addition to the average LCC savings or average payback for that standard. Refer to section 8.1 of the ANOPR TSD for further discussion of the LCC analysis method.

The Department based the payback period calculations in the engineering analysis on the DOE test procedure. The test procedure uses specific, carefully prescribed values to calculate annual energy consumption. When the test procedure was written, these values were considered to be relatively typical of conditions in U.S. homes. In contrast, the LCC analysis estimates furnace and boiler energy consumption under field conditions for a sample of houses that is representative of U.S. homes. These conditions include the outdoor climates during the heating and cooling season, which influence the operating hours of the equipment.

For each product class, the LCC analysis considers all candidate standard efficiency levels, as well as the maximum-efficiency technology available. To estimate the impact of improved efficiency across a wide range of households that use furnaces and boilers, DOE selected a sample of households from the 1997 Residential Energy Consumption Survey (RECS97). For each sampled household, DOE estimated the energy consumption of furnaces and boilers with baseline model design characteristics and design options that yield higher efficiencies. DOE then calculated the LCC for all design options.

To account for the uncertainty and variability in the inputs to the LCC calculation for a given household and between different households, the Department used a Monte Carlo simulation. A Monte Carlo simulation uses a distribution of values to allow for variability and/or uncertainty on inputs for complex calculations. For each input, there is a distribution of values, with probabilities (weighting) attached to each value. Monte Carlo simulations sample input values randomly from the probability distributions.

For each product class, DOE calculated the LCC and payback period 10,000 times per Monte Carlo simulation run. For some variables, such as energy price and climate, each calculation used the values associated with the sampled RECS house. The RECS houses were sampled according to the weighting each received from the Energy Information Administration (EIA). This weighting reflects the prevalence of various features in the national population of houses. Sampling according to the weighting means that some of the RECS houses are sampled more than once and others may not be sampled at all. The Department used Microsoft Excel spreadsheets with Crystal Ball, an add-on software, to perform the Monte Carlo analysis.

GAMA commented that the cost of using Crystal Ball to perform the Monte Carlo analysis makes it difficult for stakeholders to use. (GAMA, No. 41 at p. 7) DOE seeks to minimize the hardware and software necessary to duplicate its analysis. At the same time, it wishes to handle the issues of variability among impacts and uncertainty in data and projections as comprehensively and rigorously as possible. Changing to another tool at this time for the current analysis would entail significant costs and delays since the LCC analysis tool using Crystal Ball is finished. DOE will explore the suitability of other, less expensive, analysis tools for future rulemakings.

In addition, DOE has established a process for making the analysis results available to the public, including providing extensive documentation, posting the documentation and the LCC spreadsheet on the DOE Web site, holding informal meetings with stakeholders to walk them through the data and methods, publishing Technical Support Documents (TSDs), holding workshops, and receiving and responding to verbal and written comments.

GAMA commented that DOE's use of Monte Carlo analysis to select households at random from the RECS database has no statistical validity and is potentially misleading from a policy standpoint. It noted that the sampling method: (1) Ensures that not every RECS household is represented in the analysis and that many are represented more than once; and (2) subjects each household that is selected to only one combination of variables instead of the hundreds or thousands that are needed to fully characterize the uncertainty surrounding that household. (GAMA, No. 41 at p. 3)

GAMA's comment seems to directly criticize the use of the Monte Carlo methodology in general, rather than the correctness of DOE's particular application of it. The Monte Carlo method gives an adequate picture of the average policy affect on households, the variation in impacts over the housing stock, and the fraction of households likely to benefit from the standard. The systematic accuracy of the analysis for which the Monte Carlo simulation is used depends on the available data for each variable. Statistically, the degree to which the results of the simulation represent the full range of possible outcomes depends only on the sample size and can be judged using standard statistical techniques.

GAMA said that DOE should evaluate each RECS household independently and expose each household to the full range of uncertainty and variability expected in that household. GAMA said that DOE should calculate the distribution of possible financial impacts for each RECS sample household to identify a ''most likely'' financial result for that household as well as a distribution of results, expressed within confidence intervals, on either side of the most likely result. To determine the most likely financial affect on the typical U.S. household, DOE must then compute a weighted average of all most likely financial results from each individual distribution. (GAMA, No. 41 at p. 3)

It appears that GAMA is asking the Department to estimate the probability distribution of possible economic impacts on the specific households surveyed in RECS. DOE designed the LCC analysis to answer the question of what is the variation of economic impacts of a standard for a representative national sample of consumer households. The current analysis is not designed to evaluate specific impacts on individual households that were surveyed in RECS. DOE assumes a representative national distribution of households is selected when the Monte Carlo simulation samples a statistical distribution of households from the RECS data according to the EIA assigned weights. Many of the characteristics are attached to the households in the RECS database, *e.g.*, energy prices, size of house, vintage of existing heating equipment, and type of fuel. GAMA does not provide clear evidence that the national distribution of household characteristics constructed using this method is incorrect. Overall, DOE believes that the current method is appropriate because it uses parameters for each household that have a basis in measured or sampled data from that household.

For each product class, the base case forecast assumes that the purchase of equipment in the absence of new standards reflects current patterns with respect to efficiency. The Department sampled the AFUE of the base case forecast equipment assigned to each house from a distribution of AFUEs that is representative of current shipments. Thus, the sample houses vary in terms of their base case forecast equipment. The Department assigned to some houses base case forecast equipment that is more efficient than some of the design options. For those design options, DOE considered those houses as not being affected by the standard, since there would be no energy savings.

For a given set of design options, the LCC analysis provides a distribution of households that can be divided into those for whom the LCC will decrease compared to the base case forecast (positive benefit), those for whom the LCC will increase compared to the base case forecast (negative impact), and those for whom the LCC will not change because the design option is less efficient than the base case forecast for that house.

The Department received comments on regional issues that affect the LCC analysis. GAMA stated that DOE should examine whether costs for higher efficiency furnaces and boilers vary by region and consider regional differences in product use. (GAMA, No. 8 at p. 1)

AGA and EEI stated that the LCC analysis should consider regional differences among consumer populations. (AGA, No. 11 at p. 5; and EEI, No. 6 at p. 5) GRI stated that the Department should not extrapolate atypical regional data across all segments of the U.S. (GRI, No. 5 at p. 3) The Department recognizes that regional factors are important in the assessment of energy efficiency standards for heating equipment, and it evaluated the impact of regional variations as part of the LCC analysis.

Many consumers purchase heating equipment using some type of financing. GAMA commented that DOE has been deducting rather than adding financing costs in its analyses. (GAMA, No. 41 at p. 4) DOE's method accounts for the fact that purchases financed by credit card, mortgage, or other means are paid over time—not all at once. It discounts the value of those payments in the LCC calculation. Because DOE uses the financing cost interest rate as the discount rate, the present value of payments (including principal and financing costs) for consumers purchasing equipment over time is exactly the value of the equipment costs as if paid all at once.

2. First-Cost Inputs

For each efficiency level analyzed, the LCC analysis needs input data for the total installed cost of the equipment.

a. Equipment Prices

DOE derived equipment prices by multiplying manufacturer cost by manufacturer, distributor, contractor, and builder markups and sales tax, as appropriate. The LCC analysis draws on the engineering analysis for estimating manufacturing costs.

For non-weatherized gas furnaces, to represent the majority of combinations of input capacity and maximum-rated airflow, the Department developed conceptual (''virtual'') furnace models [5] to represent 26 different combinations of those two variables. Each virtual model had its own cost and energy characteristics. (Refer to Chapter 7 of the ANOPR TSD for more details about virtual models.) To develop the cost for each virtual model, DOE reverse-engineered one model size (input capacity = 75kBTU/h and airflow capacity = 3 tons) and assigned costs for the different components. The Department scaled the cost for other input capacities from the basic model cost for both non-condensing and condensing models. A cost adder adjusted costs for furnaces of different maximum nominal airflow capacity. The virtual models include models with the most commonly occurring input capacities, with corresponding maximum nominal airflow rates.

For weatherized gas furnaces, DOE used the same virtual models as in the analysis of non-weatherized gas furnaces. For mobile home furnaces and oil-fired furnaces, the Department used a subset of the 26 virtual furnace models because the market in those product classes is limited to a smaller number of sizes of furnaces. For the boiler product classes, DOE used the sizes of the virtual models for non-weatherized gas furnaces, weighted to match the boiler sizes in the shipments data from GAMA.

b. Installation Costs

The LCC analysis draws on the engineering analysis for estimating installation costs. DOE assigned each household an installation cost from a distribution of weighted-average values. For non-weatherized gas furnaces, oil-fired furnaces, and gas and oil boilers, the distribution was calculated with the Installation Model. For weatherized gas furnaces, DOE used calculations based on the RS Means' approach to calculate a mean value and assigned a triangular distribution of ±15 percent around the mean. For mobile home furnaces, which are installed at the mobile home factory, the installation cost is included in the markup.

3. Operating-Cost Inputs

a. Annual Energy Use

Energy consumption consists of the fossil fuel and electricity used to operate a furnace or boiler year-round. While the primary focus of this rulemaking is on fossil fuel consumption, design options that save on fossil fuels may also change electricity consumption. To take this effect into account, it is necessary to model electricity consumption in detail. If the house has air conditioning, the energy consumption includes the electricity used by the furnace blower to distribute conditioned air during the cooling season.

In determining the reduction in annual energy use due to more efficient furnace and boiler designs, the Department did not take into account a rebound effect. The rebound effect occurs when an appliance that is made more efficient is used more intensively, so that the expected energy savings from the efficiency improvement do not fully materialize. The Department seeks comments on whether a rebound effect should be included in the determination of annual energy savings. If a rebound effect should be included, the Department seeks data for basing the calculation of the rebound effect.

For non-weatherized gas furnaces, DOE chose 26 generic (''virtual'') models to represent the range of input capacity and airflow capacity of models currently available on the market. The number of real models with every possible combination of characteristics is too unwieldy to model. The Department used specifications from actual models to select the specifications for each virtual model. These specifications included blower size, motor size, supply-air outlet area, power consumption of the draft inducer and the igniter, several delay times, and fan curves. The Department assigned one virtual model to each of the sample housing records. The particular virtual model assigned to each house depended on the location and characteristics of the house.

To simulate fossil fuel and electrical energy use by furnaces, DOE used the 1997 RECS to get a representative sample of houses. RECS97 is based on a sample of 5900 households that EIA surveyed for information on energy consumption and expenditures, stock of energy-consuming appliances, and energy-related behavior. The information collected represents all households nationwide—about 101 million.

The heating and cooling loads are the amount of heating and cooling that a given house needs to keep it comfortable over an entire year. Determination of annual heating and cooling loads for the house requires making certain assumptions about its size and construction, thermal efficiency, and geographical location. Determination of the energy consumption of the system installed to satisfy the heating and cooling loads requires estimating the input capacity and the efficiency of the existing furnace and the size and seasonal energy-efficiency of the existing air conditioner.

The final element of the energy use calculations involved calculating how much energy furnaces of various designs would need to meet the heating and cooling load of each sample house. At this stage, DOE calculated the energy use of the virtual model furnace assigned to each house, incorporating all design options. Each house has several dozen different energy use

[5] The Department intends these virtual furnace models to represent typical furnaces with basic features, but not to describe specific, existing furnaces. The Department derived the characteristics of the virtual furnace models from existing basic furnace models, after examining directories and product literature for existing furnaces.

values, each one reflecting the furnace's gas and electricity use with a different combination of design options. Chapter 7 of the ANOPR TSD provides more information about these calculations.

The Department based the energy calculations for the other product classes on the energy calculations for non-weatherized gas furnaces, with appropriate changes to the calculations to account for the different energy-consuming characteristics of the other product classes.

EEI commented that the Department should compare conditional demand analysis of heating loads to simulation-based modeling. (EEI, No. 6 at p. 5) DOE did not use simulation-based modeling to estimate heat loads. The analysis used heating loads from RECS that are gotten with conditional demand analysis. Detailed simulation-based modeling that considers specific equipment designs is outside the scope of the analysis for this rulemaking.

Several stakeholders pointed out that furnace blower capacity is typically sized to meet air conditioning requirements and there is no tight relationship between blower electricity use and the furnace output. (NRDC, No. 21 at p. 4; GAMA, No. 8 at p. 4; and Trane, No. 9 at p. 2) The Department is aware that the furnace blower capacity is determined by the cooling capacity of the air conditioner that the furnace is designed to accompany, and takes this into account in its analysis.

EEI commented that DOE should account for the duct system in analyzing electricity use of fan motors. (EEI, No. 6 at p. 4) DOE accounts for duct system performance in the analysis by assigning system curve coefficients to each house selected from a set of distributions appropriate for a house with that size air conditioner.

An issue regarding electricity use of furnace fans concerns whether DOE should consider fan operation in the heating season only, or year-round, since many furnaces are combined with split-system air conditioners and use the same circulating air fan during the heating and cooling modes. EEI recommended that DOE not include cooling season impacts because measures to reduce fan energy in the heating season may increase energy use for the air conditioning system during the cooling season. (EEI, No. 6 at p. 3 and 5) Trane commented that DOE should not consider electricity use in the cooling mode since fan electric use for cooling is already covered by air conditioning standards. (Trane, No. 9 at p. 2) Because the fan is an integral part of a furnace, DOE accounted for year-round furnace electricity use, but it does not intend to regulate furnace electricity use.

b. Energy Prices

The LCC analysis requires information on the price of natural gas or heating oil, as well as the price of electricity used by electrical components. A furnace fan operates during the heating season and the cooling season. Since electricity prices vary by season in much of the country, DOE separately estimated winter and summer electricity prices. Boilers do not use electricity in the summer. Refer to section 8.3 of the ANOPR TSD for further discussion of the derivation of energy prices.

For all product classes, the Department used average energy prices to calculate the energy costs of the base case equipment. DOE used marginal energy prices for the cost of saved energy associated with higher-efficiency equipment. Marginal energy prices are the prices consumers pay for the last unit of energy used. Since marginal prices reflect a change in a consumer's bill associated with a change in energy consumed, such prices are appropriate for determining energy cost savings associated with efficiency standards.

For oil-fired furnaces and boilers, as well as gas furnaces using LPG, the Department used average prices for both base case and higher-efficiency equipment, as the data necessary for estimating marginal prices were not available.

For each household sampled from the RECS database, DOE identified the average electricity and gas prices either from that household's data, if available, or from another household in the same census division for which both prices were available. The Department estimated marginal energy prices from the RECS monthly billing data. The results show that the marginal prices are very close to average prices for the RECS households.

As in past rulemakings, the Department used price forecasts by the EIA to estimate the trend in average natural gas and oil prices and average and marginal electricity prices. To arrive at prices in 2012 and beyond, it multiplied the average and marginal price for 1998 by the forecasted annual price changes in the Reference Case forecast in EIA's Annual Energy Outlook 2003 (AEO 2003).

AGA supported DOE's use of EIA energy price forecasts. (AGA, No. 11 at p. 5) ASE suggested that the Department allow for price increases beyond EIA forecasts and that DOE modify EIA forecasts by reviewing industry forecasts. (ASE, No. 18 at p. 3) It is the policy of the Department to use forecasts provided by the EIA about future trends in energy prices. Since there is uncertainty in price forecasting, the Department also evaluated the sensitivity of financial impacts to alternative energy price forecasts in AEO 2003. In addition, the Department will make available to stakeholders the ability to conduct a scenario analysis to examine the results under different energy-price conditions.

c. Maintenance Costs

For the LCC analysis, DOE drew on the maintenance cost data derived in the engineering analysis. DOE assumed a triangular distribution for maintenance costs in order to capture the variability of these costs among homes. The Department was not aware of any recent data that provide a distribution of maintenance costs. However, based on a sensitivity analysis in the 1994 GRI report, which increased maintenance costs by 20 percent, and based on engineering judgement the Department assumed that a 15 percent range is most appropriate for a distribution. Thus, the DOE assigned the minimum maintenance cost to be 15 percent below the average maintenance cost and the maximum to be 15 percent above the average.

4. Equipment Lifetime

The equipment lifetime is the age at which furnaces or boilers are retired from service. Based on industry data, DOE used lifetimes as shown in Table II.9. DOE used a triangular probability distribution to assign a lifetime to individual furnaces in the sample houses from a range for each product class. Because none of the available data on equipment lifetime shows a clear relationship between efficiency and lifetime, the Department assumed that equipment lifetime is independent of efficiency.

TABLE II.9.—EXPECTED EQUIPMENT LIFETIME

[years]

	Gas furnace	Oil-fired furnace	Gas boiler	Oil-fired boiler	Heat pump	Electric furnace
Minimum	10	10	13	12	6	11
Mean	20	15	17	15	14	17
Maximum	30	20	22	19	21	23

GAMA said that because models are becoming more complex and more expensive to repair, owners may be likely to replace rather than repair equipment, which would lower the average life of equipment. (GAMA, No. 8 at p. 4) The Department believes that the probability distribution of equipment lifetimes used in the analysis is appropriate, given available evidence of past performance and recent trends.

5. Discount Rate

The Department derived the discount rates for this analysis from estimates of the interest or ''finance'' cost to purchase furnaces or boilers. Following financial theory, the ''finance'' cost of raising funds to purchase furnaces or boilers can be interpreted as: (1) The financial cost of any debt incurred to purchase equipment, principally interest charges on debt, or (2) the opportunity cost of any assets used to purchase equipment, principally interest earnings on household equity.

The purchase of equipment for new homes entails different finance costs for consumers than those from a purchase of replacement equipment. Thus, the Department used different discount rates corresponding to the finance cost of new construction and replacement installations. Refer to section 8.3 of the ANOPR TSD for further discussion of the method used to estimate discount rates.

Furnaces or boilers purchased in new homes are financed with home mortgages. For purchases made to replace equipment, where cash or some form of credit is used to finance the acquisition, it is appropriate to establish how the purchase affects a consumer's overall household financial situation. It is assumed that consumers maintain a balance of debt and equity in their portfolio that is not likely to change as a result of the purchase of a furnace or boiler. The Department assumed that households draw on equity and debt in proportion to the shares of the different types of equity and debt holdings in U.S. households. The Department estimated the average household equity and debt portfolio based on 1995 and 1998 Survey of Consumer Finances (SCF) data, which show that the types of equity and debt include second mortgages, credit cards, transaction accounts, certificates of deposit, U.S. savings bonds, stocks, and mutual funds. For each type of equity and debt, DOE estimated an interest/return rate using time-series data, wherever possible. For each house, the Department selected a type of equity or debt and then selected a discount rate for that house from a distribution of rates. The weighted-average real interest rate across all types of household debt and equity (based on the share of each type in the average portfolio in 1995 and 1998) is 6.7 percent.

ASE suggested that, for replacement purchases, DOE should survey consumer financing patterns to determine the shares of cash, home equity credit, unsecured loans, and other credit in furnace and boiler purchases. (ASE, No. 18 at p. 3) DOE is not aware of any statistically representative data that show how households use debt and equity to purchase a replacement furnace or boiler.

Trane commented that households have a large amount of debt on credit cards, so additional expenses for higher-efficiency heating equipment will reduce funds available to pay off such high-interest debt. (Trane, No. 9 at p. 3) DOE believes that its approach accounts for the role of credit card debt in household financial portfolios.

For equipment installed in new homes, the Department estimated the discount rate based on mortgage interest rate data provided in the SCF. This survey shows that mortgage rates carried by homeowners in 1998 averaged 7.9 percent. After adjusting for inflation and interest tax deduction, real after-tax interest rates on mortgages averaged 4.2 percent. ASE suggested that DOE use current mortgage interest rates as a discount rate for products sold in new homes. (ASE, No. 18 at p. 3) Since current rates may not be representative of rates in effect in 2012, DOE used mortgage interest rates that are representative of historical rates. The Department's method uses data that provide a distribution of mortgage rates among consumers and uses the most current data available at the time of analysis which was for 1998.

To account for variation in discount rates among consumers, DOE got information about the distribution of rates of interest or return on debt and equity among households from the data sources mentioned above. The Department calculated the real, after-tax rates as described above. The Department believes that this method allows for establishing a valid distribution of discount rates over the full range of discount rates relevant to most purchasers of the products covered by this rulemaking.

GAMA commented that: (1) The discount rate used should reflect opportunity cost, which is independent of financing methods; and (2) the opportunity cost should be based on a distribution of returns on consumer portfolios, regardless of their choice of equipment purchase financing. (GAMA, No. 41 at p. 6) DOE used a distribution of discount rates for replacement furnaces to reflect the suggestions made by GAMA.

GAMA suggested that implicit discount rates, while not a financial calculation, are a valid way to evaluate consumer decision making. (GAMA, No. 41 at p. 6) Because the LCC analysis is a financial analysis, DOE does not use implicit discount rates. In addition, DOE finds it difficult to measure implicit discount rates because of market imperfections, such as the cost of getting information about efficient appliances.

6. Effective Date

The effective date is the date on and after which a manufacturer must comply with an energy conservation standard in the manufacture of a covered product. (10 C.F.R. § 430.2) DOE had anticipated that the effective date for any new energy efficiency standard for residential furnaces and boilers would be January 1, 2012. This date was based on the assumption that a final rule would be published by January 1, 2004. Thus, the Department calculated the LCC for all consumers as if each one purchased a new residential furnace or boiler in 2012, the year it assumed the standard would take effect.

For purposes of conducting the analyses for this ANOPR, DOE based the cost of the equipment on year 2012; however, because the Department collected manufacturing cost data for the ANOPR engineering analysis in 2001, it expresses all dollar values as year 2001 dollars. Under 42 U.S.C. 6295 (f)(3)(B), any revised energy standards for these products will become effective eight years after its publication as a final rule in the **Federal Register**.

7. Inputs to Payback Period Analysis

The payback period (PBP) is the amount of time it takes the consumer to recover the assumed higher purchase expense of more energy efficient equipment through lower operating costs. This type of calculation is known as a ''simple'' payback period because it does not take into account changes in operating expense over time or the time value of money.

The inputs to the calculation of the PBP are the total installed cost of the equipment to the customer for each efficiency level and the annual (first year) operating expenditures for each efficiency level. The PBP calculation uses the same inputs as the LCC analysis, except that electricity price trends and discount rates are not needed. The calculation needs energy prices only for the year in which a new standard is expected to take effect, in this case the year 2012.

8. Summary of Inputs

Table II.10 summarizes the inputs used to calculate the customer economic impacts of various energy efficiency levels.

TABLE II.10.—SUMMARY OF INPUTS USED IN THE LCC AND PAYBACK ANALYSIS

Input	Description
Equipment Price	Derived by multiplying manufacturer cost by manufacturer, distributor, contractor, and builder markups and sales tax, as appropriate.
Installation Cost	Uses a distribution of weighted-average installation costs from the ''Installation Model.'' Installation configurations are weight-averaged by frequency of occurrence in the field, and vary by installation size. The Installation Model is RS Means-based, and comparable to available known data.
Maintenance Costs	Uses GRI data for gas furnaces and boilers, water heater rulemaking survey results for oil-fired equipment, and data from the 1993 rulemaking for mobile home furnaces.
Annual Heating Cooling Load	Heating and cooling loads calculated using 1997 RECS data. The furnace input capacity versus airflow capacity is assumed based on the vintage of the equipment and characteristics of each house.
Annual Energy Use	26 virtual models based on actual furnace characteristics capture the range of common furnace sizes. Energy calculations reflect actual house characteristics.
Energy Prices	1997 average and marginal energy prices are calculated for each house. AEO 2003 forecasts are used to estimate future average and marginal energy prices.
Lifetime	Uses Appliance Magazine survey results.
Discount Rate	Data from Survey of Consumer Finance and other sources were applied to estimate a discount rate for each house.

9. LCC and PBP Results

For each set of sample houses using equipment in a given product class, DOE calculated the average LCC savings and the median PBP for various ways of achieving each efficiency level. The Department calculated the average LCC savings relative to the base case forecast in each product class. As mentioned above, the base case forecast assumes that equipment purchases in the absence of new standards will reflect current purchasing patterns, with respect to efficiency. Therefore, the base case forecast is not limited to baseline model equipment.

Tables II.11a–f show the percentage of households that have a net cost and a net benefit for each design option. EEI commented that a minimum criterion for a standard level should be that at least 90 percent of affected consumers should receive a benefit, and that if DOE chooses not to use 90 percent, then it should use the same criterion as it used for central air conditioners (CAC) and heat pumps.[6] (EEI, No. 6 at p. 2) Southern also suggested that the Department use the same criteria as it did in the CAC rulemaking. (Southern, No. 14 at p. 1) EEI also recommended that the Department show the overall percentage of consumers who would gain and lose from a given standard level. (EEI, No. 6 at p. 3) NRDC believes that ''winners'' and ''losers'' should be analyzed on a state-by-state basis so these results can be compared to a national standard. NRDC also commented that DOE should accept a higher proportion of losers for climate-sensitive products such as furnaces than it does for other products. (NRDC, No. 21 at p. 3)

DOE will consider the overall percent of consumers with net benefit and with net cost in the course of this rulemaking. The economic impact of a standard level on consumers is one of several factors that the Department weighs in determining whether economic justification exists for energy efficiency standards. As part of the consumer subgroup analysis, DOE will report fractions of households with net benefit or net cost at a regional level. The available data are not sufficient to produce statistically significant results at a state-by-state level.

For non-weatherized gas furnaces (Table II.11a), the 81 percent AFUE level using single-stage (8 percent Category III venting system) shows a slightly negative LCC impact (−$3), but the 81 percent AFUE level using two-stage modulation (no Category III systems required) has a positive LCC savings of $72. The positive LCC savings for the 81 percent two-stage modulation design are due, in part, to its having lower energy consumption than the single-stage furnace of the same AFUE. To estimate the energy use of this furnace under field conditions, DOE adopted the assumptions for two-stage modulation that appear in the DOE test procedure (see Appendix 6.3 of the TSD). DOE is requesting comments on this issue; see section IV.E.4 of this ANOPR. The 90 percent AFUE condensing level has a negative average LCC impact.

[6] In the analysis of standards for CAC and heat pumps, the Department considered the share of consumers that would receive a net LCC benefit, among other factors. However, it did not use a specific criterion with respect to the percent of consumers that would receive a net benefit.

TABLE II.11A.—LCC AND PBP RESULTS FOR NON-WEATHERIZED GAS FURNACES

AFUE: design option	LCC					Payback	
	Average $	Average savings $	Net cost %	No impact %	Net benefit %	Median years	Average years
78%	9,966						
80%	9,795	0	0	99	1	2.1	37.8
80% 2-stage modulation	9,718	41	33	27	40	8.6	13.5
81% 8% Cat. III	9,789	−3	32	27	41	8.8	27.8
81% 2-stage modul., no Cat. III	9,680	63	29	27	45	7.6	17.0
82%	10,170	−292	70	26	4	28.7	84.6
82% 2-stage modulation	10,103	−256	65	26	9	18.5	60.2
83%	10,400	−468	73	26	1	63.3	121.3
90%	9,917	−154	56	26	18	17.9	42.5
92% Incr. HX Area	9,924	−166	60	15	25	16.1	41.7
96% Step Mod ECM	10,723	−954	89	2	9	32.3	88.9

For weatherized gas furnaces (Table II.11b), the results show positive average LCC savings for AFUE levels through 82 percent. The exception is the 80 percent Improved Heat Transfer Coefficient design option due to the higher cost of this design.

TABLE II.11B.—LCC AND PBP RESULTS FOR WEATHERIZED GAS FURNACES

AFUE: design option	LCC					Payback	
	Average $	Average savings $	Net cost %	No impact %	Net benefit %	Median years	Average years
78% Baseline Model	8,545						
80% Incr. HX Area	8,457	2	0	98	2	1.1	1.5
80% Improved Insulation	8,454	4	26	46	28	9.0	8.2
80% Improved Heat Xfer	8,467	−4	52	46	2	2.8	3.7
81% Incr. HX Area	8,418	23	2	46	52	2.0	2.6
81% Improved Insulation	8,415	25	20	20	60	5.2	6.4
81% Improved Heat Xfer	8,424	18	32	20	48	3.8	5.1
82% Incr. HX Area	8,380	53	3	20	77	2.1	2.9
82% Improved Insulation	8,377	56	18	0	82	4.3	5.6
82% Improved Heat Xfer	8,382	51	24	0	76	2.5	3.4

For mobile home gas furnaces (Table II.11c), the results show positive average LCC savings for the 80 to 82 percent AFUE levels using single-stage technology. The 90 percent AFUE condensing level shows an average LCC saving of $192, but 45 percent of the households are negatively impacted.

TABLE II.11C.—LCC AND PBP RESULTS FOR MOBILE HOME GAS FURNACES

AFUE: design option	LCC					Payback	
	Average LCC $	Average savings $	Net cost %	No impact %	Net benefit %	Median years	Average years
75% Baseline Model	7,904						
80%	7,480	64	1	85	14	2.4	4.7
80% 2-stage	7,718	−163	80	5	15	26.0	60.5
81%	7,428	112	10	5	85	4.4	6.3
81% 2-stage Modulation	7,670	−117	75	5	20	24.9	60.3
82%	7,385	153	14	5	81	5.1	7.5
82% 2-stage Modulation	7,630	−80	70	5	25	22.9	56.3
90%	7,352	184	46	5	49	12.1	22.7

For oil-fired furnaces (Table II.11d), the results show positive average LCC savings for AFUE levels from 80 percent through 83 percent.

TABLE II.11D.—LCC AND PBP RESULTS FOR OIL-FIRED FURNACES

AFUE: design option	LCC					Payback	
	Average $	Average savings $	Net cost %	No Impact %	Net benefit %	Median years	Average years
78% Baseline Model	16,194						
80%	15,900	11	0	96	4	0.2	0.2
81%	15,762	95	2	39	59	0.4	0.5
81% Atom Burner 2-stage Mod	15,885	8	42	30	28	11.7	19.4
82%	15,625	190	2	30	68	0.3	0.4
82% Atom Burner 2-stage Mod	15,753	89	35	22	42	8.5	13.8
83%	15,492	293	3	22	75	0.3	0.4
83% Atom Burner 2-stage Mod	15,626	178	31	15	54	6.8	11.2
84%	15,967	−111	58	15	27	13.7	20.8
84% Atom Burner 2-stage Mod	16,106	−240	71	7	22	16.3	25.1
85%	15,845	1	49	7	44	10.0	13.8
85% Atom Burner 2-stage Mod	15,989	−143	69	0	31	13.7	20.1

For hot-water gas boilers (Table II.11e), the results show positive average LCC savings for the AFUE levels from 81 percent through 84 percent using single-stage technology.

TABLE II.11E.—LCC AND PBP RESULTS FOR HOT-WATER GAS BOILERS

AFUE: design option	LCC					Payback	
	Average LCC $	Average savings $	Net cost %	No impact %	Net benefit %	Median years	Average years
80% Baseline Model	10,635						
81%	10,371	93	0	65	35	2.1	2.4
81% 2-stage Modulation	10,599	−36	38	44	18	9.9	14.8
82%	10,314	125	3	44	53	2.5	3.3
82% 2-stage Modulation	10,542	−36	48	30	22	9.3	19.6
83%	10,256	166	5	30	66	2.5	3.3
83% 2-stage Modulation	10,483	−29	59	15	27	9.9	23.3
84%	10,199	215	6	15	79	2.5	3.4
84% 2-stage Modulation	10,426	0	62	6	32	10.5	22.7
88%	10,741	−294	67	6	27	17.5	29.8
91%	10,823	−372	75	3	22	19.3	43.0
99%	11,304	−853	85	0	15	21.7	46.1

For hot-water oil-fired boilers (Table II.11f), the AFUE levels through 84 percent (without use of atomized burner) have positive average LCC savings.

TABLE II.11F.—LCC AND PBP RESULTS FOR HOT-WATER OIL-FIRED BOILERS

AFUE: design option	LCC					Payback	
	Average $	Average savings $	Net cost %	No impact %	Net benefit %	Median years	Average years
80%	14,890						
81%	14,772	6	0	95	5	0.6	0.8
81% Atomized Burner	15,166	−36	11	89	0	70.4	104.9
82%	14,657	18	0	89	11	0.7	0.8

TABLE II.11F.—LCC AND PBP RESULTS FOR HOT-WATER OIL-FIRED BOILERS—Continued

AFUE: design option	LCC					Payback	
	Average $	Average savings $	Net cost %	No impact %	Net benefit %	Median years	Average years
82% Atomized Burner ..	15,051	−45	16	84	0	35.0	64.3
83%	14,545	36	0	84	16	0.7	0.8
83% Atomized Burner ..	14,939	−119	37	61	2	23.0	45.0
84%	14,435	79	0	61	39	0.7	0.8
84% Atomized Burner ..	14,830	−169	58	37	5	26.7	57.6
86%	14,943	−234	52	37	11	23.0	31.6
86% Atomized Burner ..	15,338	−602	91	7	2	53.0	98.1
90%	15,260	−527	81	7	12	19.6	23.8
95%	15,561	−829	88	0	12	19.1	23.0

The Department seeks information and comments relevant to the assumptions, methodology, and results for the LCC and PBP analyses.

E. National Impact Analysis

The national energy savings and economic impacts anlaysis assesses the national energy savings (NES) and the net present value (NPV) of total customer costs and savings expected to result from new standards at specific efficiency levels. The Department calculated the NES and NPV for a given standard level as the difference between a base case forecast (without new standards) and the standards case (with standards). National annual energy consumption is determined by multiplying the number of units in the stock of residential furnaces and boilers (by vintage) by the unit energy consumption (also by vintage). Cumulative energy savings are the undiscounted sum of the annual NES determined over a specified time period. The Department calculated net savings each year as the difference between total operating cost savings and increases in total installed cost. Cumulative savings are the sum of the annual NPV determined over a specified time period. The NES analysis which will accompany the NOPR will include both discounted and undiscounted values for future energy savings to account for their timing.

The Department assessed the NES and NPV using the NES Spreadsheet Model. DOE developed this method for standards rulemakings and tailors it for each specific rulemaking. The Department posts NES spreadsheets for furnaces and boilers on its Web site to make the analysis more accessible and transparent to all stakeholders. See *http://www.eere.doe.gov/buildings/appliance_standards/furnaces_boilers.html*.

1. Approach

The Department calculated national energy consumption for each year, beginning with the expected effective date of the standards (2012), for the base case forecast and for each candidate efficiency level. For each product class, DOE calculated the site energy consumption for the base case forecast and each considered efficiency level by summing the energy consumption of equipment operating in each year. The survival fraction of equipment shipped in previous years is equivalent to the percentage not replaced. The Department aggregated the differences in annual energy consumption between the base case forecast and standards cases forecast to arrive at the cumulative national energy savings in the 2012–2035 period for each candidate efficiency level.

The shipments forecast accounts for shifts in market share from gas to electric equipment as a result of an increase in gas equipment price. Projected shipments of gas equipment, and hence gas consumption, are lower in the higher-efficiency cases, but there is an increase in electricity consumption by electric heating equipment, for which the model also accounts.

The Department calculated the NPV to the Nation of new efficiency standards from the incremental costs of higher-efficiency equipment minus the change in associated operating costs over the period considered. The Department accounted for operating cost savings until all the equipment installed through 2035 is retired.

GAMA commented that the NES analysis should be based on an aggregation of individual consumer life-cycle cost results. (GAMA, No. 41 at p. 4) The NES and the LCC analyses are intended to answer different questions, so they use different methods. The LCC analysis provides a snapshot of the impact of standards on individual consumers purchasing new equipment in the first year the standards take effect. It analyzes the effect on a wide range of consumers and is designed to reflect the diversity of the situation for a cross-section of all the households in the U.S. In contrast, the NES calculates the impacts of potential standard levels for the entire Nation over a period of many years, using the average energy consumption and average total installed price from the LCC analysis for each considered efficiency level. In the NES, only a fraction of U.S. households is assumed to purchase new equipment each year.

GAMA commented that there has been almost no consideration of uncertainty or variability in the National Benefits analysis in DOE's rulemakings. (GAMA, No. 41 at p. 5) The Department's NES analysis uses a scenario approach to address uncertainty in key variables. The Department conducts sensitivity analyses as needed by running alternative scenarios for input variables that are of interest to stakeholders.

2. Inputs

a. Shipments

Furnace and boiler shipments comprise units used for (1) replacements of retired units with the same type, (2) conversions at retirement to another fuel type, and (3) installations in new homes. Almost all new construction has central heating equipment and most equipment is replaced at retirement.

The Department estimated the number of replacements based on past shipments and expected retirement rates. Forecasting future replacements requires estimates of shipments to new housing, since the replacements 20–30 years from now will replace the equipment shipped in the next few years. Consumers most commonly replace equipment with equipment in the same product class (replacement-in-kind). Some fraction of households switch fuels, retiring an oil or electric unit and replacing it with a gas system (conversion away from natural gas is rare). The Department estimated future conversions based on historical data from AGA.

The Department estimated the total number of shipments to new housing based on projections of new housing construction. Market shares of heating equipment in newly constructed homes reflect a choice that is influenced by fuel costs and equipment prices. For gas furnaces, the Department modeled this choice as described below.

i. Replacement and Conversions

The replacement model estimates what fraction of the historically shipped units are still in service and how many will be replaced each year. The replacement model uses estimates of how long each type of equipment is expected to operate before it is replaced. Depending on the age of a piece of heating equipment, there is a certain probability of its being replaced. The model uses a replacement probability distribution based on distributions of expected equipment lifetimes. Two basic assumptions generated the probability distribution. First, DOE expects equipment to have a maximum probability of being replaced at the mean lifetime. Second, replacement probability goes to zero in the minimum and maximum lifetime years. Assuming a linear slope in probability produces a triangular distribution.

Given the probability of replacement as a function of equipment age or vintage, the calculation of expected replacements in any given year follows directly from past shipments. In a given year, the number of replacements is equal to the portion of the previous year's shipments expected to retire plus the number of shipments from two years ago expected to retire, etc.

GAMA suggested that the retirement function should be applied randomly in the NES analysis, as DOE does in the LCC analysis. (GAMA, No. 41 at p. 4) In the NES analysis, DOE tracks shipments year by year and applies the retirement function to all equipment installed in each year. The Department does not apply the retirement function randomly to keep the NES model transparent and to avoid the need to use Monte Carlo calculation methodology (which uses a distribution of values to allow for variability and/or uncertainty on the inputs).

AGA commented that standards that are not cost-effective will encourage consumers to defer replacement of equipment. (AGA, No. 11 at p. 2) DOE developed and applied modeling of equipment retirement and replacement that reflects the available information on market behavior.

To estimate future conversions, DOE used data from the annual house-heating survey conducted by the AGA, which reports the numbers of households that converted to natural gas space heating from 1990 to 1995. On average, about 100,000 oil-heating households and 75,000 electricity-heating households converted to natural gas annually. Nearly a third of oil-heating customers and more than a quarter of electricity-heating households decided to convert to natural gas instead of replacing their old system with the same fuel type. The number of conversions from gas to oil or electricity is negligible.

The conversion rate is the fraction of oil or electric equipment retirements in which the consumer decides to change to gas heating. Based on available information, DOE assumed that there is no early replacement (*i.e.*, before end of useful life) for conversion. The Department assumed that the conversion rates estimated from the AGA data, 33 percent for oil equipment (furnaces and boilers) and 26 percent for electric heating equipment will continue in the future. Since the oil-fired furnace and boiler markets are mostly replacements, oil-to-gas conversions will have a significant negative affect on shipments of these product classes in the future.

ii. Shipments to New Housing

New housing includes single- and multi-family units, referred to as ''new housing completions,'' and mobile home placements. For new housing completions and mobile home placements, DOE adopted separate projections for the South and non-South regions from AEO 2002 for the 2002–2020 period. The Department assumed that completions grow at 0.5 percent per year (the projected average annual growth rate in the 2000–2020 period) for the 2021–2035 period. For mobile home placements, DOE extrapolated the trend of flat growth in 2010–2020 out to 2035.

In DOE's method, the number of annual shipments of each product class going to new housing units is equal to housing completions for that year, multiplied by the market share estimated for each product class. The Department expects changes in equipment cost or operating expense associated with a particular product class to affect relative market shares in new construction much more significantly than in the replacement market. Evidence suggests that changes in first cost and operating cost have had an effect in the past on the choice of installing either a gas furnace or an electric central heating system in a new home.

For non-weatherized and weatherized gas furnaces and mobile home gas furnaces, the shipments model takes into account possible market-shift effects from changes in fuel prices and equipment price increases related to efficiency standards. The Department estimated future market shares using historical relationships between gas and electricity prices, gas and electric heating equipment prices, and gas furnace market shares, combined with estimated increases in equipment cost associated with higher efficiency. The model predicts changes in market share produced by a proportional change in the energy and equipment price variables. For a given heating load, gas furnaces are less expensive to operate than electric heating equipment, and forecasts of fuel prices predict that this will continue to be the case. Therefore, the Department does not expect a large shift from gas to electric heating due to increased cost of gas-fired equipment. This is especially true of colder regions, where electric heating is prohibitively expensive. In the Southern census region and in mobile homes, however, operating cost is less of a factor relative to the first cost of equipment. Purchasers of mobile housing often have relatively low incomes and therefore may be more sensitive to first costs than other households. For the above reasons, DOE estimated gas furnace market share independently for three groups: Single-family and multi-family homes in regions other than the Southern census region, single-family and multi-family homes within the Southern census region, and mobile homes in all census regions.

DOE received several comments on the issue of market share shift due to standards. AGA called for better, more self-consistent estimates of future market shares, with cross-elasticities that do not vary across product classes. (AGA, No. 11 at p. 6) As described above, DOE used historical data to develop consistent market share estimates and it does not make use of cross-elasticities. EEI said that DOE should use the same type of parameters for its analysis of fuel-switching in furnaces as for its analysis of electric heat pumps. (EEI, No. 6 at p. 5) AGA commented that standards on electricity use of fuel-fired furnaces would encourage fuel-switching to electric resistance furnaces, especially in manufactured housing. (AGA, No. 11 at p. 3) DOE's analysis accounts for market shifts to electric heating and considers mobile housing separately. Market share shifts are reflected in the MIA, which is provided to the Department of Justice (DOJ) to facilitate its determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy efficiency standards.

The analysis projects the market share of gas furnaces to fall slightly by 2012 due to somewhat higher growth in natural gas prices relative to electricity prices. The Department expects the relationship between gas and electricity prices to be relatively stable beyond 2012. The analysis does not project a significant market share shift due to operating cost changes, which were historically the dominant driver of market shares.

The Department based its estimate of future market share shifts on the equipment costs estimated in the engineering analysis and on the Installation Model data. Since equipment cost varies with the efficiency level, the projected market share of gas furnaces is different for each efficiency level. The Department assumed that all shipments will incur the equipment price increase after the date of the standard implementation, but that prices will not rise further nor decline over time in real terms.

The model estimates the combined market share of non-weatherized and weatherized gas furnaces in new housing completions in the South and non-South regions based on the historical parameters and their projected values. Table II.12 shows that the higher equipment prices associated with higher AFUE slightly decrease the share of gas furnaces in total new housing completions. The Department estimated shipments of weatherized gas furnaces by assuming that the latter have the same share of total gas furnace shipments in future years as estimated for year 2000.

TABLE II.12.—SHIPMENTS OF NON-WEATHERIZED AND WEATHERIZED GAS FURNACES TO NEW HOUSING FOR DIFFERENT EFFICIENCY LEVELS

Year	Total completions (million)	Gas furnace share (%)	Gas furnace shipments (million)
2010	1.62	54.6	0.88
2020	1.72		
Base		54.9	0.94
80%		54.9	0.94
81%*		54.7	0.94
90%		54.4	0.92
92%		53.0	0.91

* The values are about the same for the single-stage and modulating furnaces.

For mobile home gas furnaces, DOE used an approach similar to that used for non-weatherized gas furnaces. In this case, however, the impact of higher equipment cost associated with higher efficiency is greater than for non-weatherized gas furnaces. The historical data show a relatively large shift away from gas furnaces associated with the increase in the price of gas relative to electricity.

The Department estimated the future market shares of oil-fired furnaces and gas and oil-fired boilers in total new housing completions based on the average shares in homes built in 1997–1999. The Department assumed that these market shares will not be affected by changes in equipment price due to standards implementation. They remain constant after 2012.

iii. Total Projected Shipments

The Department calculated total shipments in each class by adding new housing shipments in each year to replacements-in-kind and conversions. Table II.13a shows that efficiency levels up to 90 percent AFUE have little effect on total non-weatherized gas furnace shipments. Table II.13b shows the total shipment projection for selected years for all other product classes. For mobile home furnaces, higher efficiency levels up to 82 percent AFUE have a small effect on shipments.

TABLE II.13A.—TOTAL SHIPMENTS OF NON-WEATHERIZED GAS FURNACES FOR DIFFERENT EFFICIENCY LEVELS

[Million]

Year	New housing	Replacements-in-kind	Conversions to gas	Total
2010	0.78	1.72	0.14	2.64
2020				
Base	0.83	2.30	0.16	3.28
80%	0.83	2.30	0.16	3.28
81%*	0.83	2.30	0.16	3.28
90%	0.80	2.30	0.16	3.26
92%	0.76	2.30	0.16	3.21

* The values are about the same for the single-stage and modulating furnaces.

TABLE II.13B.—TOTAL SHIPMENTS IN OTHER PRODUCT CLASSES

[Million]

Product Class	2012	2020	2030
Weatherized gas furnaces	0.369	0.429	0.469

TABLE II.13B.—TOTAL SHIPMENTS IN OTHER PRODUCT CLASSES—Continued
[Million]

Product Class	2012	2020	2030
Mobile home gas furnaces:			
Base Case Forecast	0.082	0.080	0.075
81% AFUE	0.080	0.078	0.073
Oil-fired furnaces	0.102	0.093	0.079
Hot-water gas boilers	0.105	0.113	0.117
Hot-water oil-fired boilers	0.135	0.113	0.118

b. Annual Unit Energy Consumption

The annual unit energy consumption (UEC) for the base case forecast and each efficiency level come from the LCC analysis. It includes a value for gas (or oil) consumption and a value for electricity consumption.

The base case forecast reflects the expected pattern of equipment purchase in the absence of any new standards. For non-weatherized gas furnaces, DOE forecasted the share of condensing furnaces in total shipments based on historic trends. The projected share rises from 23 percent in 2000 to 37 percent in 2035. For each of these two types, the base case forecast assumes that the average AFUE in 2012 is equal to the estimated current average AFUE (based on data from GAMA). These average values are 80 percent for non-condensing furnaces and 93 percent for condensing types. The base case forecast assumes that these values remain constant through 2035.

For other product classes, there is little evidence of change in recent years in the average AFUE, so DOE used the current averages for the base case forecast. These are 80.6 percent AFUE for weatherized gas furnaces, 79.8 percent AFUE for mobile home gas furnaces, 81.1 percent AFUE for oil-fired furnaces, 81.9 percent AFUE for hot-water gas boilers, and 83.9 percent AFUE for hot-water oil-fired boilers.

AGA commented that data from GAMA suggest market movement toward higher efficiency without standards, and DOE should take these data into account. (AGA, No. 11 at p. 4) As mentioned above, DOE used the base case forecast which incorporates continued growth in the market share of high-efficiency condensing furnaces.

c. Site-to-Source Conversion Factors

Primary energy consumption includes energy used in the production and transmission of the energy consumed at the site. For natural gas and electricity, the Department used annual site-to-source conversion factors based on the LBNL version of NEMS, which corresponds to EIA's *Annual Energy Outlook 2002* (AEO 2002). The factors used are marginal values, which represent the response of the system to an incremental decrease in consumption. Natural gas losses include pipeline leakage, pumping energy, and transportation fuel. AEO 2002 forecasts losses of about 7 percent for the natural gas used on site for the period 2000–2020, with only slight variation from year to year. For electricity, the conversion factors vary over time due to projected changes in generation sources (*i.e.*, the power plant types projected to provide electricity to the country). The Department assumed that conversion factors remain constant at 2020 values through 2035. The Department assumed no losses for delivery of site heating oil.

AGA said that DOE should account for energy consumption over the full fuel cycle. (AGA, No.11 at p. 1) DOE considers the complete primary energy consumption impacts of standards, including changes in consumption associated with market shifts induced by the standard.

d. Installed Equipment Costs

The Department calculated the potential effect on consumers of higher-efficiency standards based on the incremental costs of higher-efficiency equipment minus the change in operating costs over the period considered. The Department took average equipment costs for the base case forecast and each efficiency level from the LCC analysis. Total equipment costs for each efficiency level equal the average cost multiplied by shipments in each year. The Department assumed no change in real equipment costs at each level after 2012. In cases where a market shift away from gas furnaces is projected, DOE accounted for the equipment costs of the electric heating equipment.

e. Energy Prices

For a given efficiency level, total operating cost in each year is the product of total site energy consumption by type and the appropriate energy prices. The calculation uses marginal energy prices, which represent the cost of the last unit of energy used, and thus the savings on a consumer's energy bill from consuming one fewer unit of energy. The Department determined 1998 marginal gas and electricity prices in the LCC analysis. To project prices out to 2025, DOE used energy price projections from AEO 2003. For the years after 2025, DOE applied the average annual growth rate in 2010–2025 for gas and heating oil prices and the average annual growth rate in 2015–2025 for electricity prices.

f. Discount Rate

A final step in assessing financial impacts of standards is to discount future monetary impacts using an appropriate discount rate. The Department used both a discount rate of seven percent and three percent real rate of return, in accordance with the Office of Management and Budget's (OMB) guidelines contained in Circular A–4, Regulatory Analysis, September 17, 2003 (see Chapter 10 of the TSD). (OMB Circular A–4, section E (September 17, 2003)) The Department defines the present year as 2001 for consistency with the year in which the Department collected manufacturer cost data.

g. Summary of Inputs

Table II.14 summarizes the inputs used to calculate the NES and NPV values.

TABLE II.14.—SUMMARY OF NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE INPUTS

Parameter	Data description
Shipments	Annual shipments from shipments model.
Effective Date of Standard	2012.

TABLE II.14.—SUMMARY OF NATIONAL ENERGY SAVINGS AND NET PRESENT VALUE INPUTS—Continued

Parameter	Data description
Annual Unit Energy Consumption	Annual weighted-average values are a function of efficiency level via an assumed correlation of RECS data.
Installed Cost per Unit	Annual weighted-average values are a function of efficiency level (established from the LCC analysis).
Maintenance Cost per Unit	Annual weighted-average values are a function of efficiency level (established from the LCC analysis).
Energy Prices	EIA Annual Energy Outlook 2003 forecasts to 2025 and extrapolation beyond 2025.
Energy Site-to-Source Conversion	Generated by DOE/EIA's National Energy Modeling System (NEMS) program (includes electric generation, transmission, and distribution losses) .
Discount Rate	7 percent and 3 percent real.
Present Year	Future expenses are discounted to year 2001.

3. National Impact Analysis Results

The cumulative national energy savings (NES) in the 2012–2035 period, and the net present value (NPV) for equipment installed in the 2012–2035 period, are shown in Tables II.15 a-f for the various product classes.

TABLE II.15A.—CUMULATIVE NES AND CONSUMER NPV FOR NON-WEATHERIZED GAS FURNACES

Efficiency level (AFUE)	NES (Quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
80%	0.03	0.05	0.15
81%, 2-stage mod., no Cat. III	1.12	0.75	3.22
81%, single-stage, 8% Cat. III	0.44	−0.29	0.06
82%	0.82	−2.03	−3.08
90%	4.10	−0.56	5.11
92%	4.83	−1.66	3.36
96%	7.16	−11.59	−14.48

TABLE II.15B.—CUMULATIVE NES AND CONSUMER NPV FOR WEATHERIZED GAS FURNACES

Efficiency level (AFUE) (Percent)	NES (Quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
80	0.01	0.02	0.05
81	0.08	0.07	0.21
82	0.18	0.14	0.43

TABLE II.15C.—CUMULATIVE NES AND CONSUMER NPV FOR MOBILE HOME GAS FURNACES

Efficiency level (AFUE) (percent)	NES (quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
80	0.01	0.01	0.05
81	0.02	0.01	0.03
82	0.02	−0.01	−0.01
90	−0.09	−0.38	−1.00

TABLE II.15D.—CUMULATIVE NES AND CONSUMER NPV FOR NON-WEATHERIZED OIL FURNACES

Efficiency level (AFUE) (percent)	NES (quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
80	0.005	0.01	0.03
81	0.02	0.04	0.10
82	0.04	0.07	0.19
83	0.05	0.11	0.29
84	0.07	−0.15	−0.20

TABLE II.15D.—CUMULATIVE NES AND CONSUMER NPV FOR NON-WEATHERIZED OIL FURNACES—Continued

Efficiency level (AFUE) (percent)	NES (quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
85	0.09	−0.11	−0.10

TABLE II.15E.—CUMULATIVE NES AND CONSUMER NPV FOR HOT-WATER GAS BOILERS

Efficiency level (AFUE) (percent)	NES (quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
81	0.03	0.02	0.09
82	0.09	0.10	0.37
83	0.16	0.20	0.70
84	0.24	0.33	1.10
88	0.57	−0.65	−0.42
99	1.43	−1.00	0.25

TABLE II.15F.—CUMULATIVE NES AND CONSUMER NPV FOR HOT-WATER OIL-FIRED BOILERS

Efficiency level (AFUE) (percent)	NES (quads)	NPV (billion 2001 $)	
		7% Discount rate	3% Discount rate
81	0.003	0.007	0.02
82	0.01	0.02	0.05
83	0.02	0.03	0.10
84	0.03	0.07	0.20
86	0.09	−0.28	−0.40
90	0.25	−0.53	−0.62

The Department seeks information and comments relevant to the assumptions, methodology, and results for the national energy savings and economics impacts analysis (see section IV.E of this ANOPR).

F. Life-Cycle Cost (LCC) Sub-Group Analysis

The life-cycle cost sub-group analysis examines the economic impacts from possible revisions to U.S. residential furnace and boiler energy-efficiency standards on different population groups of consumers. The analysis determines whether or not a particular segment of consumers would be adversely affected by different trial standard levels in terms of increased LCC of equipment. DOE also calculated the fraction of the population that would have net benefits (reduced LCC) or net costs (increased LCC) from particular trial standard levels.

Stakeholders said DOE should: (1) Conduct consumer sub-group analyses by region (ACEEE, No. 15 at p. 6); (2) provide stakeholders with a list of consumer sub-groups, reach consensus on major subgroups, and identify consumer subgroups expected to experience distinct levels of impacts (AGA, No. 11 at p. 5); and (3) segment householders into owners and renters, and ensure that renters (a majority of low income households) are not disadvantaged by standards. (ASE, No. 18 at p. 3) In the NOPR phase, DOE will examine three consumer sub-groups: low-income households, senior-only residences, and renters.

G. Manufacturer Impact Analysis

The policies outlined in the Department's Process Rule called for substantial revisions to the analytical framework of the manufacturer impact analysis. The Department held a public meeting on March 11 and 12, 1997, to describe and get comment on a new generic methodology to be used in performing future manufacturing impact analyses of products covered under NAECA. The Department intends to apply this methodology to other EPCA-related efficiency standards as well, tailoring the methodology for each rule on the basis of stakeholder comments.

During the NOPR phase, DOE intends to assess the impacts of new energy efficiency standards on residential furnace and boiler manufacturers. In addition to the more obvious financial impacts, a wide range of quantitative and qualitative effects may occur following adoption of a standard that may require changes to the manufacturing practices for these products. The Department will identify these effects through interviews with manufacturers and other stakeholders.

1. Sources of Information for the Manufacturer Impact Analysis

Many of the analyses described earlier provide important information for the manufacturer impact analysis. Information includes manufacturing costs, shipments forecasts, and price forecasts. DOE will supplement this information with company financial data, and other information gathered during interviews with manufacturers. The interview process has a key role in the manufacturer impact analysis, since it allows DOE to consider confidential or sensitive information in the rulemaking decision.

The Department and/or contractors will conduct detailed interviews with as many manufacturers as is necessary to gain insight into the range of potential impacts of new standards. During the interviews, the Department solicits information on the possible impacts of potential efficiency levels on sales, direct employment, capital assets, and industry competitiveness. Both qualitative and quantitative information is valuable. DOE will schedule interviews well in advance, to provide every opportunity for key individuals to be available for comment. Although a written response to the questionnaire is acceptable, DOE prefers an interactive interview process, because it helps clarify responses and provides the opportunity for DOE to identify additional issues.

Before the interviews, the Department will prepare and distribute to the manufacturers estimates of the financial parameters that DOE plans to use in the impact analysis. During the interviews, the Department will seek comment and suggestions regarding the values selected for the parameters.

The Department will ask interview participants to identify all confidential information that they have provided, either in writing or orally. DOE will consider all information collected, as appropriate, in its decision-making process. However, DOE cannot make confidential information available in the public record. The Department also will ask participants to identify all information that they wish to have included in the public record, but that they do not want to have associated with their interview. DOE will incorporate this information into the public record, but will report it without attribution.

The Department and/or contractors will collate the completed interview questionnaires and prepare a summary of the major issues.

2. Industry Cash Flow Analysis

The industry cash flow analysis relies primarily on the Government Regulatory Impact Model (GRIM). The Department uses the GRIM to analyze the financial impacts of more stringent energy efficiency standards on the industry that produces the products covered by the standard.

The GRIM analysis uses a number of factors to determine annual cash flows from a new standard: Annual expected revenues; manufacturer costs (including cost of goods, capital depreciation, R&D (research and development), selling, and general administrative costs); taxes; and conversion expenditures. DOE compares the results against baseline model projections that involve no new standards. The financial impact of new standards is the difference between the two sets of discounted annual cash flows. Other performance metrics, such as return on invested capital, also are available from the GRIM.

ACEEE would like to see inter-annual variability of cash flows or profitability forecasts, for context and perspective. (ACEEE, No. 15 at p. 6) DOE uses the GRIM which is based on multi-year forecasts, and does not analyze intra-year variability directly. Collecting this information would impose a large data-gathering burden on manufacturers.

3. Manufacturer Sub-Group Analysis

Using industry cost estimates is not adequate for assessing differential impacts among sub-groups of manufacturers. Smaller manufacturers, niche players, or manufacturers exhibiting a cost structure that differs significantly from the industry average, could experience a more negative impact. Ideally, the Department would consider the effect on every firm individually; however, it typically uses the results of the industry characterization to group manufacturers exhibiting similar characteristics.

During the interview process, the Department will discuss the potential sub-groups and sub-group members that it has identified for the analysis. DOE will look to the manufacturers to suggest what sub-groups or characteristics are most appropriate for the analysis.

4. Competitive Impacts Assessment

Southern Co. commented that DOE should make sure competition is not reduced as a result of the rulemaking. (Southern Co., No. 14 at p. 4) ACEEE was concerned that DOE should show how standards would change the historical trend to consolidation. (ACEEE, No. 15 at p. 6) EPCA directs the Department to consider any lessening of competition, as determined in writing by the Attorney General, that is likely to result from imposition of standards. (42 U.S.C. 6295 (o)(2)(B)(i)(V)) The Department will make a determined effort to gather and report firm-specific financial information and impacts. The competitive analysis will focus on assessing the impacts to smaller, yet significant, manufacturers. DOE will base the assessment on manufacturing cost data and on information collected from interviews with manufacturers. The manufacturer interviews will focus on gathering information that will help in assessing greater-than-average cost increases to some manufacturers, increased proportions of fixed costs that could potentially increase business risks, and potential barriers to market entry (*e.g.*, proprietary technologies).

5. Cumulative Regulatory Burden

The Department recognizes and seeks to mitigate the overlapping effects on manufacturers of amended DOE standards and other regulatory actions affecting the same equipment or companies. *See* 10 CFR part 430, subpart C, Appendix A, 10(g)(1). The Department is not aware of any other regulations pending or planned that will increase the regulatory burden resulting from this rulemaking on furnace and boiler manufacturers.

H. Utility Impact Analysis

To estimate the effects of proposed furnace and boiler standard levels on the electric utility industry, the Department intends to use a variant of DOE/EIA's National Energy Modeling System (NEMS [7]). DOE/EIA uses NEMS to produce its Annual Energy Outlook (AEO). The Department will use a variant, known as NEMS–BT, to provide key inputs to the analysis. Utility impact analysis is a comparison between model results for the base case forecast and policy cases in which proposed standards forecast are in place. The analysis will consist of forecasted differences between the base and standards cases for electricity generation, installed capacity, sales, and prices.

The use of NEMS for the utility analysis offers several advantages. As the official DOE energy forecasting model, it relies on a set of assumptions that are transparent and have received wide exposure and commentary. NEMS allows an estimate of the interactions between the various energy supply and demand sectors and the economy as a whole. The utility analysis will report the changes in installed capacity and generation by fuel type which result for each trial standard level.

DOE conducts the utility analysis as a policy deviation from the AEO, applying the same basic set of assumptions. For example, the operating characteristics (*e.g.*, energy conversion efficiency, emissions rates) of future electricity generating plants are as specified in the AEO reference case, as are the prospects for natural gas supply.

The Department also will explore deviations from some of the reference case assumptions to represent alternative futures. Two alternative scenarios use the high and low economic growth cases of AEO 2003 (The reference case corresponds to medium growth). The high economic

[7] For more information on NEMS, please refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is National Energy Modeling System: An Overview 2000, DOE/EIA–0581 (2000), March, 2000. DOE/EIA approves use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on DOE/EIA assumptions, DOE refers to it by the name NEMS–BT (BT is DOE's Building Technologies office, under whose aegis this work has been performed previously named NEMS–BRS).

growth case assumes higher projected growth rates for population, labor force, and labor productivity, resulting in lower predicted inflation and interest rates relative to the reference case and higher overall aggregate economic growth. The opposite is true for the low-growth case. While supply-side growth determinants are varied in these cases, AEO assumes the same reference case energy prices for all three economic growth cases. Different economic growth scenarios will affect the rate of growth of electricity demand.

Because the current (AEO 2003) version of NEMS forecasts only to the year 2025, DOE must extrapolate results to 2035. The Department will use the approach developed by EIA to forecast fuel prices for the Federal Energy Management Program (FEMP). FEMP uses these prices to estimate the LCC of Federal equipment procurements. For petroleum products, the average growth rate for the world oil price over the years 2010–2025 is used in combination with the refinery and distribution markups from the year 2025 to determine the regional price forecasts. Similarly, natural gas prices are derived from an average growth rate figure in combination with regional price margins from the year 2025. Results of the analysis will include changes in residential electricity sales and installed capacity and generation by fuel type for each trial standard level, in five-year increments extrapolated to the year 2035.

AGA commented that DOE should consider AGA's analytical approach to assess impacts on utilities and should provide a venue to discuss power plant heat rates and emission factors. (AGA, No. 11 at pp. 6–7) DOE plans to use the NEMS model for analysis of affect on utilities. In past rulemakings, DOE has used NEMS to evaluate the impact on utilities because NEMS is a comprehensive and transparent model which provides estimates for the interactions between the various supply and demand sectors and the economy as a whole. The Department routinely updates the power plant heat rates to reflect the latest available version of NEMS, the model used to generate the utility and environmental results. This tool, which is available to stakeholders, uses national-average, power-plant-heat-rate forecasts that can be replaced or modified by users to conduct sensitivity analysis.

ACEEE commented that DOE should evaluate the impact of new standards on winter and summer peak loads. (ACEEE, No. 15 at p. 6) During the NOPR stage of the rulemaking, the Department will consider in its analysis impacts of standards on electricity system loads.

I. Environmental Assessment

DOE will conduct an assessment of the impacts of proposed furnace and boiler standard levels on certain environmental indicators, using NEMS–BT to provide key inputs to the analysis, as well as some exogenous calculations. Results of the environmental assessment are similar to those provided in AEO.

The environmental assessment provides emissions results to policymakers and interveners and fulfills requirements that the environmental effects of all new Federal rules be properly quantified and considered. The environmental assessment considers only two pollutants, sulfur dioxide (SO_2) and nitrogen oxides (NO_X), and one emission, carbon dioxide (CO_2). The only form of carbon tracked by NEMS–BT is CO_2, so the analysis will discuss carbon only in the form of CO_2. For each of the standard levels, DOE will calculate total emissions using NEMS–BT in part and using external analysis as needed.

The Department will conduct the environmental assessment as a policy deviation from the AEO, applying the same basic set of assumptions. For example, the emissions characteristics of an electricity generating plant will be exactly those used in AEO. Forecasts conducted with NEMS–BT also take into consideration the supply-side and demand-side effects on the electric utility industry. Thus, the Department's analysis takes into account any factors affecting the type of electricity generation and, in turn, the type and amount of airborne emissions the utility industry generates.

NEMS–BT tracks carbon emissions using a detailed carbon module which provides good results because of its broad coverage of all sectors and inclusion of interactive effects. Past experience with carbon results from NEMS suggests that emissions estimates are somewhat lower than emissions estimates based on simple average factors. One of the reasons for this divergence is that NEMS tends to predict that conservation displaces renewable generating capacity in the out years. On the whole, NEMS-BT provides carbon emissions results of reasonable accuracy at a level consistent with other Federal published results.

NEMS–BT also reports the two airborne pollutant emissions that DOE has reported in past analyses, SO_2 and NO_X. The Clean Air Act Amendments of 1990 set an SO_2 emissions cap on all power generation. The attainment of this target, however, is flexible among generators through the use of emissions allowances and tradable permits. NEMS includes a module for SO_2 allowance trading and delivers a forecast of SO_2 allowance prices. Accurate simulation of SO_2 trading tends to imply that physical emissions effects will be zero as long as emissions are at the ceiling. This fact has caused considerable confusion in the past. However, there is an SO_2 benefit from conservation in the form of a lower allowance price as a result of additional allowances from this rule, and, if it is big enough to be calculable by NEMS–BT, DOE will report this value. The NEMS–BT model also has an algorithm for estimating NO_X emissions from power generation. Two recent regulatory actions proposed by the EPA regarding regulations and guidelines for best available retrofit technology determinations and the reduction of interstate transport of fine particulate matter and ozone are tending towards further NO_X reductions and likely to an eventual emissions cap on nation-wide NO_X. 69 FR 25184 (May 5, 2004) and 69 FR 32684 (June 10, 2004). As with SO_2 emissions, a cap on NO_X emissions will likely result in no physical emissions effects from equipment efficiency standards.

The results for the environmental assessment are similar to a complete NEMS run as published in the AEO. These include power sector emissions for SO_2, NO_X, and carbon, and SO_2 prices, in five-year-forecasted increments extrapolated to the year 2035. DOE reports the outcome of the analysis for each trial standard level as a deviation from the AEO reference cases.

AGA commented that DOE should use full fuel-cycle emissions from the EPA's E–GRID system, and the Department should consider using AGA information on emission characteristics. (AGA, No. 11 at p. 7) DOE will consider these comments in conducting the environmental assessment in the NOPR phase of the rulemaking.

GAMA commented that residential furnaces and boilers are not vented in-house, so the Department may need to consider in-house emissions in the environmental assessment. (GAMA, No. 8 at p. 4) The Department will analyze environmental impacts of potential standards on furnaces and boilers, including in-house emissions (the local emissions from combustion in the furnace or boiler) in the NOPR phase of the rulemaking. The Department will use the same approach as it applied during the residential water heating rulemaking.

EEI commented that a primary output of NEMS should be impacts on oil and gas production, refining, transportation and delivery systems and asked how DOE will handle emissions impacts on domestic and foreign oil refining and impacts on oil imports. (EEI, No. 6 at p. 3) The NEMS model takes into consideration impacts on domestic oil and gas production, refining, transportation and delivery systems, as well as the imports of various petroleum products from outside the United States. It does not consider the emissions impacts from domestic or foreign oil refining. Thus, DOE will not be considering these emissions.

J. Employment Impact Analysis

The July 1996 Process Rule, 10 CFR part 430, subpart C, Appendix A4(7)(vi) includes employment impacts among the factors the Department should consider in selecting a proposed standard. The Process Rule states if the Department determines that a candidate standard level would be the direct cause of plant closures or significant losses in domestic manufacturer employment, that standard level will be presumed not to be economically justified. (10 CFR part 430, subpart C, Appendix A5(e)(3)(i)(B))

The Department estimates the impacts of standards on employment for equipment manufacturers, relevant service industries, energy suppliers, and the economy in general. DOE separates employment impacts into indirect and direct impacts. Direct employment impacts would result if standards led to a change in the number of employees at manufacturing plants and related supply and service firms. DOE estimated direct impacts in the manufacturer sub-group analysis.

Indirect impacts are impacts on the national economy other than in the manufacturing sector being regulated. Indirect impacts may result from both expenditures shifting among goods (substitution effect) and changes in income, which lead to a change in overall expenditure levels (income effect). DOE defines indirect employment impacts from standards as net jobs eliminated or created in the general economy as a result of increased spending on the purchase price of equipment and reduced customer spending on energy.

DOE expects new furnace and boiler standards to increase the total installed cost of equipment. DOE expects the same standards to decrease energy consumption, and therefore to reduce customer expenditures for energy. Over time, the increased total installed cost is paid back through energy savings. The savings in energy expenditures may be spent on new commercial investment and other items. Using an input/output model of the U.S. economy, this analysis seeks to estimate the effects on different sectors, and the net affect on jobs. DOE will estimate national impacts for major sectors of the U.S. economy in the NOPR. DOE will use public and commercially available data sources and software to estimate employment impacts. DOE will make all methods and documentation available for review.

BT has developed a spreadsheet model, Impact of Building Energy Efficiency Programs (IMBUILD), that it could use to analyze indirect employment impacts. IMBUILD is a special-purpose version of the Impact Analysis for Planning (IMPLAN) national input-output model which specifically estimates the employment and income effects of building energy technologies. IMBUILD is an economic analysis system that focuses on those sectors most relevant to buildings, and characterizes the interconnections among 35 sectors as national input-output matrices. The IMBUILD output includes employment, industry output, and wage income. One can introduce changes in expenditures due to appliance standards to IMBUILD as changes to existing economic flows, allowing estimation of the resulting net national impact on jobs by sector.

ACEEE commented that DOE should carefully consider impacts on service providers and the manufacturer employment impact analysis should include the employment impacts of consumer energy cost savings. (ACEEE, No. 15 at p. 6) The Department will consider these comments in its analysis during the NOPR stage of the employment impacts of furnace and boiler standards.

DOE believes increases or decreases in the net demand for labor in the economy estimated by the input/output model due to standards are likely to be very small relative to total national employment. It is difficult to project changes in employment for the following reasons:

(1) If unemployment is very low during the period when the standards are put into effect, it is unlikely that the standards alone could result in any change in national employment levels;

(2) Neither the Bureau of Labor Statistics (BLS) data nor the input-output model used by DOE include the quality or wage level of the jobs. The losses or gains from any potential employment change may be offset if job quality and pay also change; and

(3) The net benefits or losses from potential employment changes are a result of the estimated NPV of benefits or losses likely to result from standards. It may not be appropriate to separately identify and consider any employment impacts beyond the calculation of NPV.

The Department invites comments on the appropriate methodology that DOE should use in its employment impacts analysis.

K. Regulatory Impact Analysis

DOE will prepare a draft regulatory analysis under Executive Order 12866, ''Regulatory Planning and Review,'' which will be subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA). 58 FR 51735 (October 4, 1993).

As part of the regulatory analysis, the Department will identify and seek to mitigate the overlapping effects on manufacturers of new or revised DOE standards and other regulatory actions affecting the same equipment. Through manufacturer interviews and literature searches, the Department will compile information on burdens from existing and impending regulations affecting furnaces and boilers.

DOE's NOPR will include a complete quantitative analysis of alternatives to the proposed conservation standards. The Department plans to use the NES Spreadsheet Model (as discussed earlier in the section on the national impact analysis) to calculate the NES and the NPV corresponding to specified alternatives to the proposed conversation standards.

III. Candidate Energy Conservation Standards Levels

The Process Rule gives guidance to the Department to specify candidate standards levels in the ANOPR, but not to propose a particular standard. 10 CFR part 430, subpart C, appendix A, 4(c)(1). The Department intends to review the public comments received during the public comment period following the ANOPR public meeting and update the analyses appropriately for each equipment class before issuing the NOPR.

IV. Public Participation

A. Attendance at Public Meeting

The time and date of the public meeting are listed in the DATES section at the beginning of this notice of proposed rulemaking. Anyone who wants to attend the public meeting must notify Ms. Brenda Edwards-Jones at (202) 586–2945. As stated in the Addresses section of this document, a photo ID is required to enter the Ronald Reagan Building and International Trade Center.

B. Procedure for Submitting Requests To Speak

Any person who has an interest in today's notice, or who is a representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation. Please hand-deliver requests to speak, along with a computer diskette or CD in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format to the address shown at the beginning of this advance notice of proposed rulemaking between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. They may also be sent by mail or e-mail them to: *Brenda.Edwards-Jones@ee.doe.gov.*

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. The Department requests persons selected to be heard to submit an advance copy of their statements at least two weeks before the public meeting. At its discretion, DOE may permit any person who cannot supply an advance copy of his or her statement to participate, if that person has made advance alternative arrangements with the Building Technologies Program. The request to give an oral presentation should ask for such alternative arrangements.

C. Conduct of Public Meeting

The Department will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with 5 U.S.C. 553 and section 336 of EPCA. (42 U.S.C. 6306) A court reporter will be present to record the transcript of the proceedings. The Department reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

The public meeting will be conducted in an informal, conference style. The Department will present summaries of comments received before the public meeting, allow time for presentations by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a prepared general statement (within time limits determined by DOE) before the discussion of specific topics. The Department will permit other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. Department representatives may also ask questions of participants concerning other matters relevant to the public meeting. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

The Department will make the entire record of this ANOPR rulemaking, including the transcript from the public meeting, available for inspection at the U.S. Department of Energy, Forrestal Building, Room 1J–018 (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW., Washington, DC, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

The Department will accept comments, data, and information regarding all aspects of this ANOPR before or after the public meeting, but no later than the date provided at the beginning of this advance notice of proposed rulemaking. Please submit comments, data, and information electronically. Send them to the following e-mail address: *ResidentialFBANOPRComments@ee.doe.gov.* Submit electronic comments in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format and avoid the use of special characters or any form of encryption. Comments in electronic format should be identified by the docket number EE–RM/STD–00–550, and wherever possible carry the electronic signature of the author. Absent an electronic signature, comments submitted electronically must be followed and authenticated by submitting the signed original paper document. No telefacsimiles (faxes) will be accepted.

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: one copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. The Department of Energy will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to the Department when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by, or available from, other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

E. Issues on Which DOE Seeks Comment

The Department is interested in receiving comments and/or data to improve its analysis. The Department has asked for comments in a number of areas throughout this ANOPR. The Department is particularly interested in responses to the following questions and/or concerns:

1. Installation Model

Installation costs are a major part of the total consumer cost of a furnace or boiler and hence are a factor in the LCC analysis of potential standard levels. Due to the shortcomings of existing installation cost data, the Department developed an Installation Model to estimate installation costs (see section II.C.6 of this ANOPR). The Installation Model assumptions, methodology, and results regarding installation costs of residential furnaces and boilers are a recent development that stakeholders have not reviewed. In particular, the Department seeks information relevant to venting categories, markets, installation sizes, and the application of these components to establish installation costs for product classes under consideration in this rulemaking.

2. Venting Issues

Proper selection of vent materials and correct configuration of vent systems are essential for safe operation of any combustion appliance (see section II.C.6.c of this ANOPR). For gas boilers, NFPA 54 provides Category I venting guidelines; and for oil-fired appliances, the applicable venting guideline is NFPA 31. However, the efficiency level at which the use of higher-cost Category III venting becomes necessary is not defined by these codes. For the analysis of gas boilers, DOE assumes that 20 percent of installations include Category III horizontal vents for construction-related reasons for efficiencies up to 84 percent AFUE. At 85 percent AFUE, DOE assumes Category III venting must be used 100 percent of the time. For oil-fired equipment, type L venting is required at all AFUE levels up to 84 percent. DOE assumes that at 85 percent and 84 percent AFUE for oil-fired boilers and oil-fired furnaces, respectively, the vent system must be upgraded to stainless AL–4C.

The Department seeks further data and comment relevant to the above assumptions. In particular, the Department is interested in getting data regarding: (1) The fraction of total gas boiler installations at each efficiency rating that use Category III horizontal venting; and (2) the fraction of total oil boiler and total oil furnace installations at each efficiency level that use stainless AL–4C (as opposed to type L).

3. Efficiency Distribution of Weatherized Gas Furnaces

For weatherized gas furnaces, estimates of national energy savings depend on the baseline model efficiency level. The Department has limited data on the efficiency distribution of current sales of this product class, and has estimated the baseline model efficiency level using historical data. The Department seeks information on the efficiency distribution of current sales of weatherized gas furnaces from manufacturers of packaged air conditioners (which incorporate weatherized gas furnaces), or others.

4. 81 Percent AFUE Furnaces With and Without Two-Stage Modulating Controls

Two-stage modulation is used in both condensing and non-condensing, non-weatherized gas furnaces. Because there are at least two major manufacturers that market a series of 81 percent AFUE, two-stage modulating furnace models and specify, for these furnaces, Category I vent systems incorporating Type B vent and Type B vent connectors, it appears that 81 percent AFUE, two-stage modulating furnaces do not pose vent safety issues associated with premature corrosion. For non-modulating 81 percent AFUE furnaces, the Department established that special venting treatments such as the use of Category III systems/components may be needed for many installations, and estimated the cost for these vent systems.

Because of the higher initial venting costs and increased safety concerns associated with non-modulating furnaces, DOE assumes that manufacturers would choose to manufacture two-stage modulating furnaces if DOE established a minimum standard of 81 percent AFUE. This assumption seems to be supported by recent developments in the marketplace. Based on information available to DOE, it appears that manufacturers have ceased to produce non-modulating models with AFUE of 81 percent or higher, and that at least two manufacturers are offering 81 percent AFUE modulating furnaces.

The current DOE test procedure incorporates an adjustment factor for two-stage modulating furnaces to reflect the impact of their different operation (''time on/time off'') compared to single-stage furnaces. The presence of this adjustment in the test procedure results in a national energy savings estimate for two-stage modulating furnaces that is nearly three times as great as the savings for 81 percent AFUE furnaces using non-modulating technology. DOE is uncertain whether the adjustment for modulating furnaces that is included in the test procedure yields an accurate estimate of the expected energy use of the product and solicits public comment on this issue. Even if the test procedure presents an accurate representation of this product's energy use, DOE solicits public comment on whether the test procedure should be modified to provide modulating furnaces with an AFUE rating that is a better reflection of its expected energy use. Based on the current test procedure, estimates for a two-stage modulating furnace with an AFUE rating of 81 percent is likely to show annual gas consumption in line with a non-modulating furnace with a higher AFUE rating.

The Department also wishes to receive data on venting installation practices/guidelines and any additional information/data on vent safety issues for all 81 percent AFUE non-weatherized gas furnaces.

5. Regulation of Furnace Electricity Consumption

The Department's analytical framework for the current rulemaking described an approach to regulate the electricity use of furnaces and boilers that would involve specifying a maximum annual electrical consumption. The current DOE test procedure provides a means to determine electrical consumption (kWh). However, 42 U.S.C. 6291(6) states that an ''energy conservation standard'' is either (A) ''a * * * level of energy efficiency'' or ''a * * * quantity of energy use,'' or (B) ''a design requirement for the products specified * * *. '' Item (A) above strongly suggests that a single ''energy conservation standard'' cannot have measures or descriptions for both energy efficiency and energy use. A standard that includes both a level of energy efficiency and a quantity of energy use (kWh of electricity) conflicts with the statutory language. 42 U.S.C. 6291(20) states that ''the term 'annual fuel utilization efficiency' means the efficiency descriptor for furnaces and boilers, determined using test procedures prescribed under section 323 * * *.'' Since the AFUE descriptor does not include electricity use, DOE cannot regulate the use of electricity by furnaces and boilers.

Based on the considered approaches and the statutory language, the Department has decided not to regulate electricity consumption of residential furnaces and boilers at this time using the above-mentioned descriptor approaches. The Department seeks comment on the above methods and information on any other method for developing a standard that would be consistent with the existing statutory authority.

V. Regulatory Review and Procedural Requirements

This advance notice of proposed rulemaking was submitted for review to OIRA in the Office of Management and Budget under Executive Order 12866, ''Regulatory Planning and Review.'' 58 FR 51735. If DOE later proposes amended energy conservation standards for residential furnaces and boilers, the rulemaking would likely constitute a significant regulatory action, and DOE would prepare and submit to OIRA for review the assessment of costs and benefits required by section 6(a)(3) of the Executive Order. In addition, various other analyses and procedures may apply to such future rulemaking action, including those required by the National Environmental Policy Act, 42 U.S.C. 4321 *et seq.*; the Unfunded Mandates Act of 1995, Public Law 104–4; the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.*; the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*; and certain Executive Orders.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's Advance Notice of Proposed Rulemaking.

Issued in Washington, DC, on July 13, 2004.

David K. Garman,

Assistant Secretary, Energy Efficiency and Renewable Energy.

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