DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

10 CFR Part 431

[Docket No. EE–RM/STD–01–375]

RIN 1904–AB09

Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Commercial Unitary Air Conditioners and Heat Pumps

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

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

SUMMARY: The Energy Policy and Conservation Act (EPCA) directs the Department of Energy (DOE or the Department) to consider whether to adopt the amended energy efficiency levels in the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/ Illuminating Engineering Society of North America (IESNA) Standard 90.1–1999, or more stringent levels, for certain commercial unitary air conditioners and heat pumps with rated cooling capacities of 65,000 British thermal units per hour (Btu/h) and greater, but less than 240,000 Btu/h. The Department publishes this Advance Notice of Proposed Rulemaking (ANOPR) to solicit public comments on its preliminary analyses for this equipment.

DATES: The Department will hold a webcast on Thursday, August 12, 2004, from 1 p.m. to 4 p.m. If you are interested in participating in this event, please inform James Raba at (202) 586–8654.

The Department will hold a public meeting on Thursday, September 30, 2004, from 9 a.m. to 5 p.m., in Washington, DC. The Department must receive requests to speak at the meeting before 4 p.m., Thursday, September 16, 2004. The Department must receive a signed original and an electronic copy of statements to be given at the public meeting before 4 p.m., Thursday, September 23, 2004.

The Department will accept comments, data, and information regarding the ANOPR before or after the public meeting, but no later than Friday, November 12, 2004. See section IV, ‘‘Public Participation,’’ of this ANOPR for details.

ADDRESSES: You may submit comments, identified by docket number EE–RM/STD–01–375 and/or RIN number 1904–AB09, by any of the following methods:

- Federal eRulemaking Portal: *http://www.regulations.gov*. Follow the instructions for submitting comments.
- E-mail: *commercial airconditioner.anopr@ee.doe.gov*. Include EE–RM/STD–01–375 and/or RIN 1904–AB09 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 Commercial Unitary Air Conditioners and Heat Pumps, EE–RM/STD–01–375 and/or RIN 1904–AB09, 1000 Independence Avenue, SW., Washington, DC, 20585–0121. Telephone: (202) 586–2945. Please submit one signed paper original.
- 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 (formerly Room 1E–190 at the Forrestal Building) is no longer housing rulemaking materials.

FOR FURTHER INFORMATION CONTACT:
James Raba, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies, EE–2J, 1000 Independence Avenue, SW., Washington, D.C. 20585–0121, (202) 586–8654. E-mail: *jim.raba@ee.doe.gov.* Francine Pinto, U.S. Department of Energy, Office of General Counsel, GC–72, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–9507. E-mail: *Francine.Pinto@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

I. Introduction

A. Summary of the Analysis

The Energy Policy and Conservation Act (42 U.S.C. 6311 *et seq.*) establishes minimum energy conservation standards for certain industrial and commercial equipment, including the commercial unitary air conditioners and heat pumps under consideration in this rulemaking. The EPCA further requires that, if certain industry standards are amended after the date of enactment of the Energy Policy Act of 1992, DOE must establish a new energy efficiency standard at that amended level, or at a more stringent level if DOE determines, ''by rule published in the **Federal Register** and supported by clear and convincing evidence, that adoption of a uniform national standard more stringent than such amended ASHRAE/IESNA Standard 90.1 for such product would result in significant additional conservation of energy and is technologically feasible and economically justified.'' (42 U.S.C. 6313(a)(6)(A))

The Department conducted in-depth technical analyses for this ANOPR in the following areas: (1) Engineering, (2) building energy use and end-use load characterization, (3) markups to determine equipment prices, (4) life-cycle cost (LCC) and payback periods (PBP), and (5) national impacts.

1. Engineering Analysis

The engineering analysis establishes the relationship between the cost and efficiency of commercial unitary air conditioners and heat pumps. This relationship serves as the basis for cost/benefit calculations in terms of individual consumers, manufacturers, and the Nation. The engineering analysis identifies the representative baseline equipment (using R–22 as the refrigerant), develops the bill of materials and determines the costs, constructs the industry cost/efficiency curves, and evaluates the impact of using an alternative to R–22 refrigerant on the cost/efficiency relationship of certain commercial unitary air conditioners and heat pumps. (See section II.C. of this ANOPR for further details.)

2. Building Energy Use and End-Use Load Characterization

The building energy use and end-use load characterization analysis uses building simulations to estimate the energy consumption of commercial unitary air conditioning equipment at specified candidate standards levels. The 1995 Commercial Buildings Energy Consumption Survey (CBECS 95) data set was the primary source of the data used to develop the building set and its associated characteristics. The Department modeled each building in the set using the Building Loads and System Thermodynamics (BLAST) software. (See section II.D of this ANOPR for further details.)

3. Markups To Determine Equipment Prices

The equipment price analysis derives end-user or customer prices for more energy efficient commercial unitary air-conditioning equipment. To derive those prices, the Department differentiates between a baseline (manufacturer's) markup and an incremental (wholesaler's, general contractor's, and mechanical contractor's) markup, based on the distribution channel that the customer uses to purchase such equipment. (See section II.E of this ANOPR for further details.)

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

When the Department is determining whether an energy efficiency standard for commercial unitary air-conditioning equipment is economically justified, EPCA directs DOE to consider, in part, the economic impact of potential standards on consumers. (42 U.S.C. 6313(a)(6)(B)(i)(I)) To assess that impact, the Department calculated the changes in LCCs which are likely to result from a candidate standard, as well as a distribution of PBPs. The foundation of the LCC and PBP analyses is the building set defined by the building energy use and end-use load characterization analysis. The Department created a representative sample from the building set, and determined the LCC and PBP for a given energy efficiency standard level for each building in the sample. Probability distributions characterize most other inputs to the LCC and PBP analysis. The input probability distributions combined with the building sample enabled the Department to generate LCC and PBP results as probability distributions using a simulation based on Monte Carlo statistical analysis methods. One of the most critical inputs to the LCC and PBP analysis is electricity price. The Department derived two sets of electricity prices to estimate annual energy expenses: A tariff-based estimate and an hourly based estimate. Although the Department used these two sets of electricity prices, it designated the tariff-based prices as the primary approach. In combination with the hourly electrical loads from the building simulations, the tariff-based approach estimates the annual energy expense using electricity prices determined from electric utility tariffs collected in the year 2002. (See section II.F of this ANOPR for further details.)

5. National Impact Analysis

The national impact analysis assesses the national energy savings (NES) and the net present value (NPV) of total customer LCC and NES. The Department calculated both NES and NPV for a given energy efficiency standard level as the difference between a base case (without new standards, *i.e.*, EPCA levels) and the standards case (with new standards). The Department determined national annual energy consumption by multiplying the number of units or stock of commercial unitary air conditioners (by vintage) by the unit energy consumption (also by vintage). Cumulative energy cost savings is the sum of the annual NES determined over specified time periods. The national NPV is the sum over time of discounted net cost savings due to the energy savings. The Department calculated net savings each year as the difference between total operating cost savings (including electricity, repair, and maintenance cost savings) and increases in total installed costs (including equipment price and installation cost). As with the NES, cumulative cost savings is the sum of the annual NPV determined over specified time periods. One of the most critical inputs to this analysis is shipments data. The Department developed shipments projections under a base case and certain candidate standards cases. It determined that shipment projections under the standards cases were lower than those from the base case projection, due to the higher installed cost of the more energy-efficient unitary air conditioning equipment. Higher installed costs caused some customers to forego equipment purchases. As a result, the Department used the standards case shipments projection and, in turn, the standards case stock of commercial unitary air conditioners to determine the NES and NPV to avoid the inclusion of savings due to displaced shipments.

Table I.1 summarizes the key inputs, assumptions, and methodologies for each analysis area, and provides general references for finding the corresponding analyses in the Technical Support Document (TSD), a ''stand-alone'' report that provides the technical analyses and results in support of the information presented in this ANOPR. The ANOPR and TSD are available to interested parties on the Department's website at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html*. Also, Table I.1 provides references for finding the results of each analysis in this ANOPR.

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

Analysis area	Methodology	Key inputs	Key assumptions	ANOPR section for results
Engineering (TSD Chapter 5)	Tear Down Analysis supplemented with Design Option Analysis.	Component cost data	Maximum Technologically Feasible efficiency equals 12 EER.	Section II.C.3.c.
Building Energy Use and End-Use Load Characterization (TSD Chapter 6).	Whole-Building simulations using Building Loads and System Thermodynamics (BLAST) software.	1997 Commercial Building Energy Consumption Survey (CBECS) to identify and characterize the type of building using unitary air conditioners.	(1) BLAST characterization of part-load equipment performance; (2) Ventilation rates set equal to ASHRAE 62 requirements; and (3) Fan power consumption included during times of ventilation and heating.	Section II.D.2.
Markups to Determine Equipment Price (TSD chapter 7).	Assessment of financial reports to develop markups to transform manufacturer prices into customer prices.	(1) Characterization of distribution channels and markets; and (2) Financial reports characterizing firm costs, expenses, and profits.	Differentiation between a baseline markup and an incremental markup to relate manufacturer price to customer price.	Section II.E.2.
LCC and Payback Period (TSD Chapter 8).	Building-by-building analysis of a representative sample of commercial building customers (customers are appropriately weighted).	(1) Output from the Engineering, Building Simulation, and Equipment Price analyses; and (2) Electricity prices based on current electric utility tariffs.	Sample of commercial buildings representative of all unitary air conditioner users (industrial users have been excluded).	Section II.F.3.
National Impact (TSD Chapter 10).	Forecasts of unitary air conditioner costs and energy consumption to the year 2035.	(1) Average values from the LCC analysis; (2) Historical shipment data; and (3) Commercial building stock and forecasts of commercial building starts.	Responsiveness of shipments forecasts to total installed cost, operating costs, and business income.	Section II.G.4.

The Department consulted with interested parties while developing the above analyses to make clear the sources of data and analytical processes it used. The Department continues to seek input from all interested parties on the methodologies, inputs, and assumptions used to develop the analyses. In addition, certain analyses were very complex and questions raised by stakeholders led the Department to engage independent, third-party experts to review the Department's assumptions, approaches, data, and analytical methods used in particular for: (1) The sample of buildings used to represent commercial unitary air conditioning equipment; (2) the BLAST and CBECS estimates of energy use in these buildings; (3) supply fan energy use while ventilating; and (4) incremental markup of commercial unitary air conditioning equipment prices. The third-party reviews are available to interested parties on the Department's website at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html*. The Department is requesting stakeholder comments about the third-party reviews concerning the subjects described in Issue 16, found in section IV.E., ''Issues on Which DOE Seeks Comment,'' of this ANOPR.

B. Authority

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part C of title III (42 U.S.C. 6311–6317) establishes an energy conservation program for ''Certain Industrial Equipment'' and includes commercial air conditioning equipment, the subject of this proceeding. Part C provides definitions, test procedures, labeling provisions, energy efficiency standards, and authority to require information and reports from manufacturers.

EPCA established efficiency requirements that correspond to the levels in ASHRAE/IESNA Standard 90.1–1989, that went into effect on October 24, 1992. EPCA further provides that if the efficiency levels in ASHRAE/IESNA Standard 90.1 are amended after that date for certain covered commercial equipment, including commercial unitary air conditioners and heat pumps, the Department must establish an amended uniform national standard for such equipment at the new minimum level for each effective date specified in the amended ASHRAE/IESNA Standard 90.1, unless the Department determines, through a rulemaking supported by clear and convincing evidence, that a more stringent standard is technologically feasible and economically justified and would result in significant additional energy conservation. (42 U.S.C. 6313(a)(6)(A))

Under EPCA, if DOE adopts a more stringent standard, DOE must determine whether the benefits of the standard exceed its burdens to the greatest extent practicable, by considering the following seven factors (42 U.S.C. 6313(a)(6)(B)(i)):

(1) The economic impact of the standard on the manufacturers and consumers of the affected products;

(2) The savings in operating costs throughout the estimated average life of the product compared to any increases in the initial cost, or maintenance expense;

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

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

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

(6) The need for national energy conservation; and

(7) Other factors the Secretary considers relevant.

Other statutory requirements are set forth in 42 U.S.C. 6313(a)(6)(B)(ii).

C. Background

1. History

On October 29, 1999, ASHRAE/IESNA adopted the energy efficiency standards for certain commercial heating and air conditioning equipment, including commercial unitary air conditioners and heat pumps, in ASHRAE/IESNA Standard 90.1–1999. On March 1, 2000, the Department published a notice of preliminary screening analysis to decide which of the ASHRAE/IESNA Standard 90.1–1999 standards to adopt immediately and which to analyze further. 65 FR 10984 (March 1, 2000). On January 12, 2001, the Department published a final rule adopting the energy efficiency levels in ASHRAE/IESNA Standard 90.1–1999 for 18 product categories and made a decision to further evaluate other products. 66 FR 3336 (January 12, 2001). In the final rule, DOE determined that further analysis was warranted for commercial unitary air conditioners and heat pumps with rated cooling capacities of 65,000 Btu/h and greater, but less than 240,000 Btu/h. This conclusion was based on DOE's screening analysis. As a result, the Department has conducted further analysis and is considering more stringent standards than those in ASHRAE/IESNA Standard 90.1–1999 for this equipment.

2. Rulemaking Process

The *Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products* (the ''Process Rule''), 10 CFR Part 430, Subpart C, Appendix A, applies to the development of energy efficiency standards for consumer products. DOE has decided, however, to apply its procedures to the development of energy conservation standards for industrial equipment as well, including commercial unitary air conditioners and heat pumps standards, as appropriate. 62 FR 54817.

On June 13, 2001, the Department published a *Framework Document for Commercial Air Conditioner and Heat Pump Standards Rulemaking* (Framework Document) that describes the procedural and analytical approaches available to evaluate energy conservation standards for commercial unitary air conditioners and heat pumps. This document is available at *http://www.eere.energy.gov/buildings/appliance_standards/commercial/ac_hp.html*. The Department held a Framework Workshop on October 1, 2001, to discuss the procedural and analytical approaches for use in the rulemaking, and to inform and facilitate stakeholders' involvement in the rulemaking process. The analytical framework presented at the workshop described different analyses, such as LCC and PBP, the methods proposed for conducting them, and the relationships among the various analyses (see Table I.2). The ANOPR TSD describes the analytical framework in detail.

Statements received after publication of the Framework Document and at the October 1, 2001, Framework Workshop helped identify issues involved in this rulemaking, and provided information that has contributed to DOE's proposed resolution of these issues. Many of the statements are quoted and summarized in this ANOPR. A parenthetical reference at the end of a quotation or passage provides the location index in the public record.

TABLE I.2.—COMMERCIAL UNITARY AIR CONDITIONERS AND HEAT PUMPS RULEMAKING ANALYSES PURSUANT TO THE PROCESS RULE

ANOPR	NOPR	Final rule
Market and technology assessment	Revised ANOPR analyses	Revised analyses.
Screening analysis	Life-cycle cost sub-group analysis.	
Engineering analysis	Manufacturer impact analysis.	
Building energy use and end-use load characterization	Utility impact analysis.	

TABLE I.2.—COMMERCIAL UNITARY AIR CONDITIONERS AND HEAT PUMPS RULEMAKING ANALYSES PURSUANT TO THE PROCESS RULE—Continued

ANOPR	NOPR	Final rule
Markups to determine equipment price	Environmental assessment.	
Life-cycle cost and payback period analyses	Employment impact analysis.	
Shipments analysis	Regulatory impact analysis.	
National impact analysis.		

On one hand, many stakeholders commented that DOE should immediately adopt the minimum efficiency requirements in ASHRAE/IESNA Standard 90.1–1999 for commercial unitary air conditioners and heat pumps, rather than pursue a formal rulemaking, on grounds that ASHRAE's ''continuous maintenance'' process for Standard 90.1–1999 allows for faster adoption of any necessary revisions to the commercial unitary equipment standards than does a formal DOE rulemaking process. ''Continuous maintenance'' is an industry term for ASHRAE's current process for maintaining standards. Under this process, ASHRAE accepts a continual flow of proposals from the public for changes to its standards, which in turn can result in multiple proposed addenda to an ASHRAE standard on a regular basis. The ASHRAE continuous maintenance process contrasts with the previous periodic maintenance process that updated a standard at fixed, predetermined intervals. These same stakeholders commented that DOE's preliminary screening analysis did not demonstrate that more-cost-effective efficiency standards were feasible for commercial unitary equipment. In addition, by not immediately adopting the efficiency requirements in ASHRAE/IESNA Standard 90.1–1999, the Department would forego the national energy savings that would otherwise be realized in the next six to ten years before a DOE final rule becomes effective. Finally, many of these stakeholders commented that market confusion would ensue over which standards requirements are applicable if DOE adopts ASHRAE/IESNA Standard 90.1–1999 for some equipment and not for other equipment. (Air-Conditioning and Refrigeration Institute (ARI), No. 11 at pp. 2–4; Edison Electric Institute (EEI), No. 4 at pp. 1–2; Lennox International Inc. (Lennox), No. 7 at pp. 1 and 4; Public Workshop Tr., No. 2EE at p. 46; National Rural Electric Cooperative Association (NRECA), No. 3 at pp. 1–2; Southern Company Services (Southern Company), No. 5 at p. 1).[1]

In contrast to the above comments, many other stakeholders commented that DOE should abandon the ASHRAE/IESNA Standard 90.1–1999 continuous maintenance process and pursue a formal rulemaking. Many of them participated in the ASHRAE/IESNA Standard 90.1–1999 process and asserted that it was fundamentally flawed. These stakeholders also challenged the technical merits of the analysis used to update ASHRAE/IESNA Standard 90.1–1999, stating that: (1) Manufacturing cost estimates for more efficient equipment were not representative, *i.e.*, too high; (2) electricity prices did not capture the variability associated with an industry moving toward economic deregulation; and (3) the ASHRAE process used high discount rates and short payback periods to evaluate energy efficiency measures instead of a carefully constructed life-cycle cost analysis. (Alliance to Save Energy (ASE), No. 9 at pp. 1–2; American Council for an Energy-Efficient Economy (ACEEE), No. 10 at pp. 3, 6–7, and 10; Natural Resources Defense Council (NRDC), No. 6 at pp. 2–6; Public Workshop Tr., No. 2EE at p. 77).

The Department intends to make its findings available to the ASHRAE/IESNA Standard 90.1–1999 committee and other stakeholders to inform ASHRAE's ''continuous maintenance'' process. Furthermore, consistent with the approach outlined in the Department's January 12, 2001, final rule (66 FR 3348), DOE may engage in the ASHRAE continuous maintenance process by proposing an addendum to the commercial unitary air conditioner efficiency levels in ASHRAE/IESNA Standard 90.1–1999 based on its analysis as part of this rulemaking.

Also, if during the rulemaking process the Department concludes that the EPCA criteria for a more stringent energy conservation standard are not likely to be satisfied, then the Department may either adopt the energy efficiency levels in ASHRAE/IESNA Standard 90.1–1999 or any new addendum to ASHRAE/IESNA Standard 90.1 that establishes higher levels.

3. Equipment Definitions

Unitary package air conditioning units represent the heating, ventilating, and air conditioning (HVAC) equipment class with the greatest energy use in the commercial building sector in the United States. Equipment covered under this rulemaking—air-cooled package air conditioning and heating equipment with rated cooling capacities of 65,000 British thermal units per hour (Btu/h) and greater, but less than 240,000 Btu/h—accounts for the majority of the total shipped tonnage of unitary HVAC equipment for commercial building applications.

Under EPCA, the term ''small commercial package air conditioning and heating equipment'' means ''air-cooled, water-cooled, evaporatively-cooled, or water source (not including ground water source) electrically operated, unitary central air conditioners and central air conditioning heat pumps for commercial application which are rated below 135,000 Btu per hour (cooling capacity).'' (42 U.S.C. 6311(8)) The term ''large commercial package air conditioning and heating equipment'' means ''air-cooled, water-cooled, evaporatively-cooled, or water source (not including ground water source) electrically operated, unitary central air conditioners and central air conditioning heat pumps for commercial application which are rated at or above 135,000 Btu per hour and below 240,000 Btu per hour (cooling capacity).'' (42 U.S.C. 6311(9)) These definitions parallel the categories of equipment outlined in ASHRAE/IESNA Standard 90.1–1999. The standards for the product subcategories of water-cooled unitary central air conditioners rated ≤240,000 Btu/h, evaporatively cooled unitary central air conditioners, and water-source unitary central heat pumps rated ≤240,000 Btu/h were covered under a separate standards

[1] Example: ''(ARI, No. 11 at pp. 2–4)'' refers to a written statement that was submitted by the Air-Conditioning & Refrigeration Institute and is recorded in the Resource Room of the Building Technologies Program in the Docket under ''Commercial Central Air Conditioners and Heat Pumps'' as comment number 11, and the passage appears on pages 2 through 4 of that statement. Likewise, ''(Public Workshop Tr., No. 2EE at p. 46)'' refers to the page number of the transcript of the ''Framework Workshop'' held in Washington, DC, October 1, 2001.

rulemaking (66 FR 3336 (January 12, 2001)) and currently appear under 10 CFR Part 431 Subpart Q. In this rulemaking, the Department will limit its analysis to air-cooled equipment, which is the largest subset of the small and large unitary air conditioners and heat pumps covered by EPCA.

Based on data from EIA's 1995 Commercial Buildings Energy Consumption Survey (CBECS 95), the Department estimates that a significant part of the unitary package air conditioning market has gas heating rather than either air conditioning only or electric resistance heating. Hence, the Department has elected to base the engineering analysis on equipment with a gas heating section.

Several comments questioned whether the Department planned to consider engine-driven units, units operating with 100 percent outside air, and split systems as unique categories. (Public Workshop Tr., No. 2EE at p. 82; Public Workshop Tr., No. 2EE at p. 148) The Department has decided not to analyze engine-driven units or units operating with 100 percent outside air because they represent very specialized or niche applications, but may analyze them if necessary for the Notice of Proposed Rulemaking (NOPR) in this rulemaking proceeding. The Department did not analyze split systems explicitly because they are similar in technology and application to packaged units, which represent 77 percent of the combined sales of the commercial unitary air-conditioning market. (See Market Assessment section (Chapter 3) of the ANOPR TSD.) While the size constraints (*i.e.*, cabinet requirements) may be different for the two types of systems, the technologies and design choices required to increase the efficiency are similar. The Department intends to apply the results of the single package air-conditioning equipment analysis, and the resulting efficiency levels, to both single package and split system equipment. This method is consistent with the residential central air-conditioner rulemaking where DOE applied the analysis results from split system air conditioners (the most common residential central air conditioner configuration) to packaged air conditioners. This method is also consistent with the current efficiency levels in EPCA and ASHRAE/IESNA Standard 90.1–1999, which are the same for single package and split system equipment. This is identified as Issue 1 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

4. Efficiency Levels

The language of 42 U.S.C. 6313(a)(6)(A) requires DOE to establish an amended uniform national standard for commercial unitary air conditioners and heat pumps at the minimum levels for each date specified in the amended ASHRAE/IESNA Standard 90.1–1999, unless DOE determines, by rule and supported by clear and convincing evidence, that a more stringent standard is technologically feasible and economically justified and would result in significant additional energy conservation. Because the Department cannot consider levels lower than that of the most recent ASHRAE/IESNA Standard 90.1, the Department will consider the baseline efficiency to be the minimum level specified in ASHRAE/IESNA Standard 90.1–1999, which is the most recent amendment to ASHRAE/IESNA 90.1 that changed efficiency levels. Table I.3 presents the ASHRAE/IESNA Standard 90.1–1999 minimum efficiency levels.

TABLE I.3.—ASHRAE/IESNA STANDARD 90.1–1999 MINIMUM EER REQUIREMENTS* FOR UNITARY EQUIPMENT

Equipment type	Size category	Heating section type	Sub-category	Minimum efficiency
Air Conditioners, Air Cooled	≥65,000 Btu/h and <135,000 Btu/h.	Electric Resistance (or None)	Split System and Single Package.	10.3 EER
		All Other	Split System and Single Package.	10.1 EER
	≥135,000 Btu/h and <240,000 Btu/h.	Electric Resistance (or None)	Split System and Single Package.	9.7 EER
		All Other	Split System and Single Package.	9.5 EER
Heat Pumps, Air Cooled (Cooling Mode).	≥65,000 Btu/h and <135,000 Btu/h.	Electric Resistance (or None)	Split System and Single Package.	10.1 EER
		All Other	Split System and Single Package.	9.9 EER
	≥135,000 Btu/h and <240,000 Btu/h.	Electric Resistance (or None)	Split System and Single Package.	9.3 EER
		All Other	Split System and Single Package.	9.1 EER
Heat Pumps, Air Cooled (Cooling Mode).	≥65,000 Btu/h and <135,000 Btu/h. (Cooling Capacity)		47°F db/43°F wb Outdoor Air	3.2 COP
			17°F db/15°F wb Outdoor Air	2.2 COP
	≥135,000 Btu/h (Cooling Capacity)		47°F db/43°F wb Outdoor Air	3.1 COP
			17°F db/15°F wb Outdoor Air	2.0 COP

*The current version of ASHRAE/IESNA Standard 90.1 is the 2001 version, which contains identical minimum efficiency levels to the 1999 version of the standard.

The ASHRAE/IESNA Standard 90.1–1999 rates the cooling performance of commercial unitary air conditioners and heat pumps using the energy efficiency ratio (EER) and heating coefficient of performance (COP). (These are the same energy efficiency descriptors used in EPCA for this type of equipment.) The Department received comments that it should consider part-load performance as part of the screening process and a part-load descriptor in addition to EER in the present rulemaking. (ACEEE, No. 10 at p. 3; Lennox, No. 7 at p. 3; NRDC, No. 6 at p. 7) The ACEEE provided several comments about the efficiency level used in the performance standards. Specifically, it advocates that the performance standard include efficiency ratings for both full-load and part-load conditions, reflecting that equipment operates for many more hours at part-load conditions than at full-load conditions. Further, ACEEE suggests that the performance standard incorporate integrated part-load value (IPLV) levels for commercial unitary air conditioning equipment. (ACEEE, No. 10 at pp. 3–4, and 7)

The Department understands that there are potential energy savings associated with technologies and techniques that operate under full- or part-load conditions and that can improve the net annual energy performance of a system, but which generally reduce the EER of commercial unitary air-conditioning equipment, or have no effect on EER. However, because the EPCA energy descriptor for commercial unitary air conditioners and air source heat pumps is an EER, and the test procedure does not account for part-load operation, DOE will not include a part-load performance descriptor.

Although this rulemaking covers both commercial unitary air conditioners and heat pumps, this ANOPR and the detailed analyses in the accompanying TSD cover only unitary air conditioners. The Department did not collect the necessary data for conducting the detailed technical analyses for unitary heat pumps for this ANOPR because unitary heat pumps represent only 9 percent of the total market for commercial unitary air conditioning and heat pump equipment above 65,000 Btu/h. Instead, the Department proposes to streamline the analysis for commercial unitary heat pumps and use a method similar to the ASHRAE committee's method to establish the minimum EER and COP levels for heat pumps. The Department understands that ASHRAE determined the minimum efficiency level for air conditioners and then agreed to a minimum heat pump EER after reviewing ARI's industry data. The minimum heat efficiency of the heat pump, defined by the heat pump COP, was set to correspond to the minimum EER using ARI data that correlated the heat pump COP to the heat pump EER. In section IV.E, ''Issues on Which DOE Seeks Comment,'' the Department requests input from interested parties on the need for conducting analyses specific to commercial unitary heat pumps.

5. Test Procedure

The Department began development of test procedures for commercial unitary air conditioners and heat pumps on April 14 and 15, 1998, when it held a public workshop to solicit views and information from interested parties. The Department held a second public workshop on October 18, 1998. The Department published a NOPR on August 9, 2000, and held a public workshop on September 21, 2000. 65 FR 48828. The Department intends to publish the test procedure final rule as soon as possible.

On June 12, 2001, the Department published a Framework Document that described procedural and analytical approaches to evaluate energy conservation standards for commercial unitary air conditioners and heat pumps, and presented this analytical framework to stakeholders during the workshop held on October 1, 2001. In response to DOE's Framework Document and within the context of this standards rulemaking proceeding, ACEEE filed comments on the test procedure used to assess equipment EER levels. The ACEEE believes that the temperature used for testing current EER levels represents the lowest outside temperature possible for properly evaluating peak performance, and that a higher temperature would more accurately represent peak conditions encountered in many parts of the United States. It also commented that the test procedure should include a maximum sensible heat ratio (SHR) to ensure that all equipment provides sufficient dehumidification capacity and prevents manufacturers from sacrificing dehumidification performance to satisfy minimum EER levels. (ACEEE, No. 10 at pp. 3–4, and 7)

The Department acknowledges that the test procedure for EER reflects equipment performance under a single condition and that this condition does not represent actual equipment performance under part-load conditions nor necessarily at the peak design condition, nor does it specify a maximum SHR. Furthermore, the Department understands that there are potential energy savings associated with technologies and techniques that improve the part-load performance of the equipment. However, because the Department believes that the test procedure referenced by the ASHRAE/IESNA Standard 90.1–1999 is widely accepted and well established, the Department has elected to follow the conventions of the ASHRAE/IESNA Standard 90.1–1999 and use the EER as the only descriptor for efficiency.

II. Commercial Unitary Air Conditioner and Heat Pump Analyses

This section includes a general introduction to each analysis section and a discussion of relevant issues addressed in comments received from interested parties.

A. Market and Technology Assessment

The Department reviewed existing marketing materials and literature, and interviewed manufacturers to get an overall picture of the market in the United States for commercial unitary air conditioners and heat pumps. Industry publications and trade journals, government agencies, and trade organizations provided most of the information, including: (1) Manufacturer market share, (2) equipment efficiency, and (3) shipments by capacity and efficiency level. This ANOPR discusses the information in the appropriate sections.

The Department has used the most reliable and accurate data available at the time of the analysis. All data are available for public review in the TSD that accompanies this ANOPR. The TSD is available to interested parties on the Department's Web site at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* The Department welcomes and will consider any recommendations of additional data.

1. Manufacturers

There are six major domestic manufacturers of the equipment covered under this rulemaking. Four companies, Carrier Corporation (Carrier), The Trane Company (Trane), Lennox International, Inc. (Lennox), and York International Corporation (York) each hold a major share of the market for commercial unitary air conditioners and heat pumps. Two other manufacturers, AAON, Inc. (AAON) and Rheem Manufacturing Company (Rheem), hold significant niche market shares. The AAON corporation manufactures and sells high efficiency, air-cooled equipment almost exclusively to large corporate accounts. Rheem produces mostly smaller-capacity models in all the categories. Among the six major manufacturers, Carrier and Trane command a majority of the market for commercial unitary air conditioning equipment, followed by Lennox, York, AAON, and Rheem. For more detail on major manufacturers and market share, refer to the market assessment section (Chapter 3) of the ANOPR TSD.

2. Equipment Efficiency

In its analysis of the equipment efficiency data from ARI's Unitary Large Equipment Directory, January 2002, the Department found that most models of equipment manufactured by the six major domestic manufacturers met or exceeded the ASHRAE/IESNA Standard 90.1–1999 energy efficiency levels.

Also, in its analysis of the ARI Unitary Large Equipment Directory, January 2002, the Department found it could be easy to misinterpret the number of base models for each parent company because each parent company manufactures similar models under different ''brands'' or manufactures base models with relatively superficial design changes around a base model. Consequently, the Department estimated the number of actual base models listed for each parent company in the ARI Directory. (See Market and Technology Assessment (Chapter 3, section 3.7.3) of the ANOPR TSD.)

3. Equipment Shipments

The Department extracted and documented information related to equipment shipments by domestic manufacturers from U.S. Census Bureau Current Industrial Reports. The United States (U.S.) Census Bureau data expresses cooling capacity ranges in a slightly different way from the DOE rulemaking equipment classifications. The major classifications presented in the U.S. Census Bureau data for single and split system air conditioners are for cooling capacity ratings 65,000 Btu/h to 134,999 Btu/h and 135,000 Btu/h to 249,999 Btu/h. (See U.S. Census Bureau Current Industrial Report for ''Refrigeration, Air Conditioning, and Warm Air Heating Equipment: 2001,'' (MA333M(01)–1), at *http://www.census.gov/industry/1/ma333m01.pdf*.) For heat pumps, the U.S. Census Bureau data list shipments for capacities rated greater than 65,000 Btu/h. In section II.G below, ''National Impact Analysis,'' the Department used the shipments data in its development of a Shipments Model for forecasting future equipment shipments.

B. Screening Analysis

This section describes the technology/design options and a process for screening these options as part of the DOE rulemaking. Screening eliminates certain design options from further consideration in the engineering analysis phase of the rule development. The Process Rule established four factors DOE uses for screening design options: (1) Technological feasibility; (2) practicability to manufacture, install, and service; (3) adverse impacts on equipment utility or equipment availability; and (4) adverse impacts on health and/or safety. 10 CFR Part 430, subpart C, Appendix A, under paragraph 5(b). In view of these factors, the technology/design options DOE considered as part of this rulemaking fall into two categories based on their development status and on their impacts on EER: emerging technologies that can enhance EER and commercial technologies that can enhance EER. For more detail on how the Department developed the technology options and the process for screening these options, refer to the technology and screening section (Chapter 4) of the ANOPR TSD.

First, the Department considered emerging technologies that encompass design options currently not available on the commercial market but that are being examined in the laboratory as possible means to enhance efficiency. These are:

• Electro-hydrodynamic enhanced heat transfer;
• Copper rotor motor with improved efficiency; and
• Non-hydrofluorocarbon/hydrochlorofluorocarbon (HFC/HCFC) refrigerants (*e.g.*, ammonia, hydrocarbons, carbon dioxide).

Second, the Department considered commercial technologies that are currently available for unitary air conditioners or similar equipment, and which have an impact on the EER (nominal full-load) rating under DOE's test conditions. These are:

• Evaporator coil area (keeping the number of coil rows the same);
• Condenser coil area (keeping the number of coil rows the same);
• Coil rows (keeping face area the same);
• Condenser fan diameters;
• Evaporator fan diameters;
• Air leakage paths within unit;
• Coil rows (keeping coil heat transfer performance the same);
• Microchannel heat exchangers;
• Deep coil heat exchangers;
• Low-pressure-loss filters;
• High efficiency fan motors;
• High efficiency compressors;
• Air foil centrifugal fans;
• Backward-curved centrifugal fans;
• Synchronous (toothed) belts;
• Direct-drive fans; and
• High efficiency propeller condenser fans.

Several of these technologies have penetrated the commercial equipment market and raised the available EER range. Because the EPCA energy descriptor for commercial unitary air conditioners and air source heat pumps is an EER, only those design options that improve the EER (nominal full-load) rating under DOE's test procedures were viable for consideration in the engineering analysis. DOE addresses matters with respect to other technologies that can improve the net annual energy performance of a system, but which generally reduce or have no effect on EER, as Issue 18 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

C. Engineering Analysis

The engineering analysis establishes the relationship between the cost and efficiency of commercial unitary air conditioners and heat pumps. This relationship serves as the basis for cost/benefit calculations in terms of individual consumers, manufacturers, and the Nation. The engineering analysis identifies the representative baseline equipment (using R–22 as the refrigerant), develops the bill of materials and determines the costs, constructs the industry cost/efficiency curves, and evaluates the impact of using an alternative to R–22 refrigerant on the cost/efficiency relationship of certain commercial air conditioners and heat pumps. The R–22 refrigerant is in current use and will phase out of new equipment in 2010 in compliance with the Environmental Protection Agency's (EPA's) requirements under the Clean Air Act of 1990, as amended (42 U.S.C. 7401 *et seq.*).

1. Baseline Equipment

As discussed above, the engineering analysis considered only single package commercial unitary air conditioning equipment with gas heat in the estimate of the cost/efficiency relationship for the equipment classes under consideration. The Department analyzed single package commercial unitary air conditioning equipment with gas heat rather than single package units with electric heat or no heating section, because the gas heat units represent about 77 percent of the air conditioners covered in this rulemaking. (See the Market and Technology Assessment, section 3.6.1 of the ANOPR TSD, that provides information on historical shipments and efficiencies.) Although the Department did not explicitly analyze split air conditioning systems in the engineering analysis, the Department believes that the results of the unitary air conditioning equipment analysis apply to the split systems and that both unitary and split systems have equivalent cost/efficiency relationships. (See the engineering analysis, section 5.2 of the ANOPR TSD.) The Department discussed this approach during the initial interviews with manufacturers, and it is consistent with the ASHRAE methodology used to set the ASHRAE/IESNA Standard 90.1–1999.

The Department proposes to address the energy efficiency of commercial unitary heat pump equipment in a way that is consistent with the ASHRAE methodology used to set the ASHRAE/IESNA Standard 90.1–1999 levels for unitary air conditioning systems with heat pump heating, rather than conduct an explicit analysis of the unitary and split heat pump systems. According to Census Bureau data, commercial unitary heat pumps with a capacity greater than 65,000 Btu/h represent about 10 percent of products covered under this rulemaking. Although the census data do not specify the quantity, the Department believes that most of these units have less cooling capacity and are within the 65,000 Btu/h to 135,000 Btu/h size range. (See the Market and Technology Assessment, section 3.6.1 of the ANOPR TSD, that provides information on historical shipments and efficiencies.) Under the ASHRAE process, the ASHRAE 90.1 committee worked with ARI to develop new efficiency levels for inclusion in ASHRAE/IESNA Standard 90.1–1999. For heat pumps in these capacity ranges, ARI supplied the ASHRAE 90.1 committee with curves relating the COP as a function of EER. The committee then set the minimum COP levels based on EER. The Department used a similar process in the residential central air conditioner and heat pump rulemaking, where it established minimum Heating Seasonal Performance Factors (HSPF) for heat pumps using functions relating the HSPF to the Seasonal Energy Efficiency Ratio (SEER). The Department intends to do the same for the NOPR analysis for commercial unitary air conditioning and heat pump equipment.

For more detail on baseline equipment, refer to the engineering analysis, section 5.3 of the ANOPR TSD. The Department requests comments from interested parties about this proposed approach to the engineering analysis, and has identified it as Issue 1 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

Identification of the baseline for commercial unitary air conditioning equipment requires both establishing a baseline efficiency level and selecting a size typical of that equipment to represent the different capacity ranges of commercial, unitary, air conditioning equipment classes: ≥65,000 Btu/h to <135,000 Btu/h; and ≥135,000 Btu/h to <240,000 Btu/h.

a. Efficiency Level

As described above, the Department selected ASHRAE/IESNA Standard 90.1–1999 for the baseline efficiency levels both for ≥65,000 Btu/h to <135,000 Btu/h and ≥135,000 Btu/h to <240,000 Btu/h classes of commercial unitary air conditioning equipment. To aid in analyzing the economic impact of increasing standard levels, DOE examined the costs associated with moving from EPCA levels to the ASHRAE Standard 90.1–1999 levels. Additionally, to provide a reasonable span of efficiency levels to evaluate, DOE limited the efficiency levels under consideration to those that are commercially available.

In some cases, manufacturers' product lines span efficiency ranges from levels below the baseline to levels above the baseline. To properly assess the incremental cost of increasing the efficiency level beyond the baseline level, DOE evaluated the manufacturing costs of the equipment with efficiency levels below the baseline and included these data in the industry cost/efficiency curves. The Department determined the manufacturing costs of this lower efficiency equipment in the same way as it did for the equipment above the baseline efficiency level. For more detail on efficiency levels, refer to the discussion of efficiency levels in section 5.3.1 of the ANOPR TSD.

b. Maximum Technologically Feasible Design

In previous rulemakings, the Department relied on the maximum technologically feasible design to define the highest level of energy efficiency it would evaluate. The maximum energy efficiency level that is technologically feasible is often referred to as ''max tech.'' Technological feasibility requires that a system be not only theoretically possible, but also capable of being designed, constructed, and operated. At the time the engineering analysis was conducted, the highest efficiency level for commercial unitary air conditioners in the ≥65,000 Btu/h to <240,000 Btu/h range available on the market was 11.5 EER. The engineering analysis used reverse engineering on this existing equipment to develop a cost-efficiency curve up to 11.5 EER. Extending the curve beyond 11.5 EER required extrapolation and then verification using design-option analysis modeling. The Department's modeling indicated that with some additional conventional-type design modifications, such as increases to the size of heat exchangers and modification of the airflow paths (both of which may need new and larger cabinets), the highest practical efficiency level was about 12.0 EER. To limit uncertainty associated with the extrapolated curve beyond 11.5 EER, the maximum efficiency level that DOE evaluated in the engineering analysis was 12.0 EER. The Department verified the extrapolated cost-efficiency curve using design-option modeling between 11.5 and 12.0 EER. Beyond the 12.0 EER level, the Department would need to consider technologies that are not currently available or non-conventional technologies that are not typically in use by the industry.

The Department seeks comments on commercial unitary air-conditioning equipment designs that are currently used in the engineering analysis. The Department will review public comments after the ANOPR meeting and during the NOPR phase of the rulemaking to further evaluate design options, including the following, which could achieve higher technologically feasible efficiency levels.

- Larger heat transfer surface area for the tube and fin condensers accomplished by increasing the number of rows or by increasing the face area of the condenser (or some combination of both), while limiting the minimum condensing temperature to 110 °F with 10 °F of subcooling capability.
- Larger heat transfer surface area for the tube and fin evaporators accomplished by increasing the number of rows or by increasing the face area of the evaporator (or some combination of both), but limiting the maximum evaporating temperature to 52 °F and the sensible heat ratio to 0.75.
- Use of premium efficiency motors with compressors, condenser fans, and evaporator blowers.
- Use of larger diameter airfoil or backward-curved blade blowers for evaporators.
- Use of larger diameter airfoil fans for condensers.

Since the time the engineering analysis was completed in late 2002, several new commercial unitary air conditioners, with rated efficiency levels greater that 12.0 EER, have become available on the market. The Department requests comments from stakeholders on any commercial unitary air conditioners with rated efficiency levels above 12.0 EER. This is identified as Issue 4 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

c. Representative Capacities

After reviewing the available single package equipment and interviewing four major commercial air-conditioning equipment manufacturers and two niche manufacturers, the Department set the representative capacity (*i.e.*, the equipment capacity to be analyzed in detail for this capacity range) for the ≥65,000 to <135,000 Btu/h capacity range at 7.5 tons and the representative capacity of the ≥135,000 to <240,000 Btu/h capacity range at 15 tons. An air conditioning ton is equivalent to 12,000 Btu/h of cooling capacity. Also, for consistency with the ASHRAE standards development process, DOE chose the same equipment capacities of 7.5 tons and 15 tons to represent these commercial unitary air conditioning equipment classes. These nominal capacities represent units which, according to the industry, are volume shipment points in the capacity range. Because manufacturers do not necessarily manufacture commercial unitary air conditioning equipment with the exact capacity of these units (90,000 Btu/h and 180,000 Btu/h), the Department uses the industry standard terminology of nominal ''tons'' for consistency with the current equipment catalogs.

Similarly, during the development of the ASHRAE 90.1–1999 standard, ASHRAE chose the 7.5- and 15-ton capacities as representative capacities for its analysis. In addition, these capacities fall close to the middle of the capacity range. For some manufacturers, these sizes represent their optimum design, *i.e.*, where they have optimized the ratio of cooling capacity to manufacturing cost. Increasing the efficiency of these models would generally be very difficult and expensive because the manufacturers have packed as much component equipment as possible into the smallest possible cabinet size. On the other hand, some manufacturers may have optimized their equipment at a higher capacity and, therefore, may initially use a larger cabinet for the evaluated equipment. Increasing the efficiency of this equipment would be less expensive because there intrinsically is more room in the cabinet to increase coil size and add other types of energy-saving devices without moving to the next larger cabinet.

After DOE reviewed available products in each equipment class and interviewed several manufacturers, it found that a majority of the manufacturers who were interviewed agreed that the 7.5-ton and 15-ton capacities adequately represent the ≥65,000 to <135,000 Btu/h and ≥135,000 to <240,000 Btu/h equipment classes, respectively, and the wide array of design constraints. Lennox, however, suggested that 10-ton and 20-ton units would provide a better representation of the baseline, because larger capacity units are generally the hardest to upgrade and are, therefore, the units that would force design changes in a specific line of commercial unitary air-conditioning equipment. Also, Lennox stated that 7.5-ton units are generally built off of 10-ton cabinets and 15-ton units are generally built off of 20-ton cabinets. (Public Workshop Tr., No. 2EE at pp. 87 and 88)

The Department believes that the 7.5-ton and 15-ton capacities are appropriate for the following reasons: (1) They are near the middle of the capacity range; (2) a majority of the manufacturers interviewed agreed that these capacities adequately represented the equipment classes; (3) they are consistent with the capacities chosen for the ASHRAE standards development process; and (4) these capacities represent both equipment that was cost-optimized (cabinet-size constrained), as well as equipment that was not constrained within the cabinet, to account for variations among manufacturers. In addition, data regarding commercial unitary air-conditioning system shipments by capacity, while not precise, suggest that shipments of 7.5-ton and 15-ton units are significantly higher than those of 10- and 20-ton systems, respectively. Therefore, it is more appropriate to select 7.5- and 15-ton units as representative capacities for their respective capacity ranges. Finally, the Department reviewed cabinet sizes and capacities for commercial unitary air conditioners and found a wide variation of cabinet sizes, and an equally wide variation of corresponding capacities within each cabinet size. Many 7.5-ton units are built off of 7.5-, 8.5-, 10-, 12-, and 12.5-ton cabinet sizes; and many 15-ton units are built off of 15-, 20-, and 25-ton cabinet sizes. Therefore, using 7.5- and 15-ton capacity sizes for several different manufacturers and aggregating the results will capture the diversity of cabinet sizes and space constraints for the industry. The Department will consider manufacturer-specific cabinet sizes and conversion costs when it conducts the MIA. For more detail on representative capacities, refer to the Engineering Analysis, section 5.3.2 of the ANOPR TSD.

2. Methodology

At the October 1, 2001, Framework Workshop, the Department solicited stakeholder comments on the most appropriate approach for the engineering analysis. However, there was no clear consensus among the respondents for a particular approach. The Northwest Power Planning Council (NWPPC) expressed the view that transparency should be the primary criterion for selecting one approach or another. (Public Workshop Tr., No. 2EE at p. 132) The Natural Resources Defense Council also commented on the need for a transparent approach. (NRDC, No. 6 at p. 6)

The ACEEE and NRDC commented that DOE should not use the efficiency-level approach because of concerns about the lack of transparency of data and the accuracy of cost estimates that could result from this approach. (ACEEE, No. 10 at p. 4; NRDC, No. 6 at p. 4) The ACEEE commented that developing estimates of uncertainty, *i.e.*, confidence intervals, for manufacturing cost estimates is irrelevant in the case of an efficiency-level analysis, due to the inability to validate the accuracy of those costs. It also noted that the incremental values ARI provided in the past were much greater than those the Northeast Energy Efficiency Partnerships (NEEP) and the Consortium for Energy Efficiency (CEE) found empirically. (ACEEE, No. 10 at pp. 8–10)

On a related issue, ACEEE, ASE, and NRDC argued that the Department should not use cost data that represent the 90th percentile of equipment cost used during the development of the ASHRAE/IESNA Standard 90.1–1999, because these costs are not representative of most equipment and would bias any life-cycle cost analysis away from higher standards. (ACEEE, No. 10 at p. 6; ASE, No. 9 at p. 2; NRDC, No. 6 at pp. 4–7) The NRDC further criticized the 90th percentile approach because it used the costs of the most expensive manufacturer, those costs could not be verified independently, and one erroneous data point could skew the cost data. Instead, NRDC recommended using third-party cost estimates and presenting them to the public for evaluation, even though NRDC believed that third-party estimates tended to be high because of the difficulty associated with anticipating innovation. (NRDC, No. 6 at p. 7) The ACEEE also noted that ''revealed costs,'' *i.e.*, the cost differential between high and low efficiency equipment in regions where high efficiency units have appreciable sales volumes, can provide insight into cost differentials. (Public Workshop Tr., No. 2EE at p. 65) Along these lines, NEEP submitted equipment incremental cost data related to the CEE efficiency levels. (NEEP, No. 8 at p. 3) The Alliance to Save Energy recommended applying reverse engineering analysis, particularly teardowns, to estimate future costs of different efficiency levels and supplementing this information with cost data obtained from market surveys performed in regions where products at higher efficiency levels have higher market shares. (ASE, No. 9 at p. 3)

As a result of the above comments from stakeholders, the Department used a cost assessment approach and supplemented the data with a design option analysis to develop incremental cost/efficiency curves for the two representative capacities described above. The reverse engineering analysis relied on creating bills of materials

(BOMs) for a sample of existing equipment that uses R–22 refrigerant. The Department developed the BOMs through the reverse engineering of either physical teardowns or catalog teardowns. The Department then entered the BOMs into a cost model and used that model to estimate the manufactured cost for each piece of equipment. The Department then aggregated the costs of the equipment and their associated efficiencies and fit them to a curve to represent the cost/efficiency behavior of the industry. In addition, the Department derived confidence intervals that described the accuracy of the curve, based on the variability of the estimated manufacturer costs. The Department then used the design option analysis to validate the accuracy of the curve between 11.5 and 12.0 EER, where there are no existing equipment data points, by using the cost model and a performance model to simulate equipment at higher efficiency levels. The last step in the process—the alternative refrigerant analysis—compared the cost/efficiency behavior of R–410a products to the R–22 cost/efficiency curve by using the cost model and the performance model to simulate R–410a products. For more detail on the Department's methodology, refer to the Engineering Analysis, section 5.4 of the ANOPR TSD.

3. Cost Assessment Approach

The use of the cost assessment (reverse engineering) approach provides useful information, including the identification of potential technology paths manufacturers use to increase efficiency. Under this type of analysis, the Department physically analyzes actual equipment on the market (*i.e.*, dismantles them component-by-component) or generates BOMs from publicly available manufacturer catalogs and specifications. This enables the Department to determine what technologies and designs manufacturers employ to increase efficiency. The Department then uses independent costing methods or manufacturer and component supplier data to estimate the costs of the components. This approach has the distinct advantage of using ''real'' market equipment to ascertain the technologies that manufacturers use as the bases for estimating the costs of reaching higher efficiencies.

The primary disadvantage of reverse engineering is the time and effort required to analyze the existing equipment. The Department needs several models of commercial unitary air conditioning equipment from various manufacturers to ensure that it identifies a broad representation of technological paths for increasing efficiency. In addition, because the Department only analyzes equipment in the market, the analysis might not capture prototypical designs, thus making it difficult to establish the maximum technologically feasible designs. Therefore, the Department has supplemented the reverse engineering process with a design option analysis that considers the technologies required to increase efficiency beyond what is currently available.

a. Teardown Analysis

The Department used a teardown analysis (or physical teardown) to determine the production cost of a piece of equipment by disassembling the equipment ''piece-by-piece'' and estimating the material and labor cost of each component. A supplementary method called a catalog teardown uses published manufacturer catalogs and supplementary component data to estimate the major physical differences between a piece of equipment that has been physically disassembled and another piece of similar equipment. The teardown analysis that DOE performed for the engineering analysis includes four physical teardowns and 14 catalog teardowns, for a total of 18 equipment teardowns. Tables II.1 and II.2 show the distribution of equipment teardown analyses that DOE performed for the 7.5-ton and 15-ton commercial unitary air conditioning equipment. The Department selected the equipment to provide a full range of efficiency levels and included equipment from similar product lines that had both higher and lower energy efficiency ratings. For more detail on the teardown analysis, refer to the Engineering Analysis, section 5.5 of the ANOPR TSD.

TABLE II.1.—NUMBER OF COMMERCIAL UNITARY AIR CONDITIONERS SELECTED FOR TEARDOWN ANALYSIS IN THE ≥65,000 BTU/H TO <135,000 BTU/H EQUIPMENT CLASS

EER Range	8.6–9.0	9.1–9.5	9.6–10.0	10.1–10.5	10.6–11.0	11.1–11.5
Equipment, Physical Teardown	0	0	0	1	1	0
Equipment, Catalog Teardown	2	0	0	2	0	3

TABLE II.2.—NUMBER OF COMMERCIAL UNITARY AIR CONDITIONERS SELECTED FOR TEARDOWN ANALYSIS IN THE ≥135,000 BTU/H TO <240,000 BTU/H EQUIPMENT CLASS

EER Range	8.6–9.0	9.1–9.5	9.6–10.0	10.1–10.5	10.6–11.0	11.1–11.5
Equipment, Physical Teardown	0	0	1	0	0	1
Equipment, Catalog Teardown	1	3	0	1	0	2

b. Cost Model

The cost model analysis created cost estimates for each of the 18 commercial unitary air conditioners, including all direct manufacturing costs and a manufacturer's markup, which covers corporate overhead expenses. This is the price at which DOE estimates a manufacturer sells the equipment to distributors, resellers, and similar parties; it is not the final cost to the end-user because it does not include the distribution markups and contractor installation costs.

In converting physical information about the equipment into cost information, the Department reconstructed manufacturing processes for each component, using internal expertise and knowledge of the methods used by the industry. The Department used assumptions regarding the manufacturing process parameters, *e.g.*, equipment use, labor rates, tooling depreciation, and cost of purchased raw materials, to determine the value of each component. It then summed the values of the components into assembly costs and, finally, the total equipment cost. The equipment cost includes the material, labor, and overhead costs associated with the manufacturing facility. The material costs include both direct and indirect materials. The labor rates include fabrication, assembly, and indirect and overhead (burdened) labor rates. The overhead costs include equipment depreciation, tooling depreciation, building depreciation, utilities, equipment maintenance, and rework. The Department also applied a manufacturer markup of 1.23 to the equipment cost to arrive at a final manufacturer cost. The markup accounts for the corporate overhead that DOE believes to include sales and general administration, research and development, and profit.

Both ACEEE and NRDC commented that the actual, retrospective cost of compliance with appliance energy efficiency standards has been substantially less than forecast by industry, and suggested analyzing earlier cost-impact data to derive an appropriate discount for current cost projections. (ACEEE, No. 10 at p. 9; Public Workshop Tr., No. 2EE at p. 65; NRDC, No. 6 at p. 7) In response, Trane commented that although actual future equipment costs may or may not have approached predicted future equipment costs, these changes in costs reflect improvements in manufacturing efficiency and, because they apply to all equipment, do not necessarily result in a change in the marginal cost between equipment. (Public Workshop Tr., No. 2EE at pp. 65–66) Lennox commented on the importance of understanding costs for both standard equipment and custom-built equipment because they have different cost structures. (Lennox, No. 7 at p. 7) Lastly, NWPPC commented that the cost basis for equipment meeting the ASHRAE Standard 90.1–1999 levels should not include retooling costs because manufacturers already have had to retool to manufacture equipment satisfying this level. (Public Workshop Tr., No. 2EE at p. 132)

The Department acknowledges that manufacturing efficiency evolves over time, but notes that earlier trends do not necessarily reflect future trends and that the incremental cost impact is the cost metric for evaluating appliance energy efficiency standards via LCC analysis. Thus, the Department believes that thorough and rigorous manufacturing cost analysis based on actual equipment at all efficiency levels represents the most effective and appropriate way to estimate current and near term incremental manufacturing costs.

After deriving production cost estimates from the reverse engineering analysis, the Department solicited detailed feedback on the cost estimates from specific manufacturers of individual products. The industry feedback resulted in revisions to the reverse engineering production costs of specific components including: Controls equipment, materials (sheet metal, refrigerant), labor, and buildings/capital. For more detail on how the Department developed the manufacturing costs, refer to the engineering analysis section (Chapter 5) of the ANOPR TSD.

Regarding the manufacturer markup, ARI believes that a value of 1.23 is not representative of what industry uses. Specifically, a value of 1.23 does not produce an acceptable financial return on investment, *i.e.*, it underestimates manufacturers' operating expenses and profitability. (ARI, No. 14 at p. 1)

The Department included the following expenses in the determination of the manufacturer markup: Research and development, net profit, general and administrative expenses, warranty expenses, taxes, and sales and marketing. The Department based the value of 1.23 on its analysis of industry corporate financial records and excluded shipping expenses (out-bound) because these expenses were included in the equipment cost. The Department determined research and development expenses by assuming reallocation of engineering budgets from value-engineering and new-feature development to product development and redesign. The incremental cost of the equipment captures additional capital outlays and re-tooling investments. For more detail on how the Department developed the cost model, refer to the Engineering Analysis, section 5.6 of the ANOPR TSD.

c. Cost/Efficiency Curves

Creating the cost/efficiency curves involved a three-step process: Plotting raw data points as cost versus efficiency, normalizing the cost data to go from absolute costs to incremental costs, and using a linear regression analysis using the least-squares fitting technique to determine the empirical equation and corresponding 95 percent confidence interval that best defines the normalized data. This process gives industry average cost/efficiency curves with a predicted range of accuracy.

The Department refers to the manufacturer cost—what the cost model directly provides as output—as the ''absolute cost'' in this section. The Department correlated the absolute costs from the model as a function of each commercial unitary air conditioner's rated EER. Each manufacturer publishes the rated EER of its air conditioners according to ARI specifications. The resulting two curves of absolute cost versus efficiency—one for the ≥65,000 Btu/h to <135,000 Btu/h equipment class and one for the ≥135,000 Btu/h to <240,000 Btu/h equipment class—each has nine data points.

The absolute costs, represented as output by the cost model, are not central to the rulemaking process and DOE does not present them in this document (nor in the TSD) to avoid the possibility of exposing sensitive information about individual manufacturers' equipment. Different manufacturers might have substantially different costs for their equipment at the same efficiency level, but this fact on its own does not provide the required insight. To determine the relationship of incremental cost versus EER for each of the 18 teardown commercial unitary air conditioners, DOE normalized the absolute cost data for every manufacturer. That is, DOE adjusted the costs of every manufacturer's equipment so that the cost of its equipment was zero at the baseline ASHRAE/IESNA Standard 90.1–1999 EER levels (10.1 EER for the ≥65,000 Btu/h to <135,000 Btu/h equipment class and 9.5 EER for the ≥135,000 Btu/h to <240,000 Btu/h equipment class). To do this, DOE first fit an exponential curve to each manufacturer's data points separately. Then, DOE shifted each curve until the incremental cost equaled zero at the baseline efficiency. The Department shifted all data points for a given manufacturer by the same amount as the entire curve, so that the resulting data points represent incremental cost versus EER. The Department then discarded individual manufacturer curve-fits and continued the analysis with the normalized cost data points. The engineering analysis section (Chapter 5) of the ANOPR TSD provides more explanation and details of the normalization process.

After establishing the normalized data points, the Department used a least-squares regression analysis to fit curves to the data and established two cost/efficiency curves—one for each equipment class—that represent the average incremental cost of increasing efficiency above the ASHRAE/IESNA Standard 90.1–1999 levels. The curves do not represent any single manufacturer, nor do they describe any variance among manufacturers. The curves simply represent the industry's cost to increase the efficiency of the equipment.

The Department also produced confidence intervals from the regression analysis which describe the accuracy of the cost/efficiency curves representing the mean value of the industry. The

Department selected a confidence interval of 95 percent to define the probability that the actual industry average is within these bounds. The LCC analysis (*see* section II.F of this ANOPR) uses the cost/efficiency curves and confidence intervals to compute the mean, minimum, and maximum cost cases.

At the time the engineering analysis was conducted, the highest efficiency level available in the equipment's representative capacities was 11.5 EER. Because the engineering analysis relies on reverse engineering of existing equipment, extending the curve beyond 11.5 EER required extrapolation and then verification using design/option analysis. To limit the uncertainty associated with the part of the curve that was extrapolated, the maximum efficiency level that DOE evaluated was 12.0 EER.

Tables II.3 and II.4 show the incremental manufacturer costs and confidence intervals for the systems with cooling capacities of about 7.5 and 15 tons.

TABLE II.3.—THE ≥65,000 BTU/H TO <135,000 BTU/H (7.5-TON) EQUIPMENT CLASS INCREMENTAL COST/EFFICIENCY RELATIONSHIP AND 95 PERCENT CONFIDENCE INTERVAL

EER	Incremental cost	95% Confidence interval [±]
10.1	$0	$0
10.5	47	14
11.0	139	41
11.5	292	85
12.0	543	159

TABLE II.4—THE ≥135,000 BTU/H TO <240,000 BTU/H (15-TON) EQUIPMENT CLASS INCREMENTAL COST/EFFICIENCY RELATIONSHIP AND 95 PERCENT CONFIDENCE INTERVAL

EER	Incremental cost	95% Confidence interval [±]
9.5	$0	$0
10.0	62	35
10.5	165	94
11.0	334	191
11.5	613	351
12.0	1,072	615

For more detail on how the Department developed the industry cost efficiency curves, refer to the engineering analysis, section 5.7 of the ANOPR TSD.

4. Supplemental Design Option Analysis

The Department used the design option approach to validate the accuracy of the cost efficiency curves at efficiency levels between 11.5 and 12.0 EER. As noted earlier, DOE did not evaluate any existing equipment in that EER range during the teardown analysis, so there were no data points available for the curve-fit. Therefore, DOE did not know the level of accuracy of the cost/efficiency curves in this range. The design option analysis simulates equipment with efficiency levels above 11.5 EER to compare their costs with the costs that the extrapolated curve predicts.

The Department received comments from ACEEE and Trane about using the design option approach. The ACEEE recommended using the design option approach because it can consider technologies with limited market share and take into account their cost impact at higher production volumes. (ACEEE, No. 10 at p. 4; Public Workshop Tr., No. 2EE at p. 136) At the Framework Workshop, Trane commented that all design options the Department considered were mature technologies'at least 20 years old'and that the pricing for the options also is mature. Consequently, development of costs for mature technologies should be straightforward. (Public Workshop Tr., No. 2EE at pp. 133–34)

For the equipment simulation, DOE used a combination of modeling tools and techniques. For more detail on the Department's approach to the design option analysis and equipment simulation, refer to the engineering analysis, section 5.8 of the ANOPR TSD. The Department performed the refrigerant-side heat-transfer and balance calculations with a simulation model called the Oak Ridge National Laboratory (ORNL) Heat Pump Design Model using compressor map data from commercially available compressors. A custom heat-exchanger software program provided estimates of the air-side heat transfer and pressure-drops associated with the equipment variations. The Department used a combination of manufacturer data, test data, fan curves, and motor curves to determine fan power and airflow.

To validate the accuracy of the simulations, the Department simulated the performance of the four existing, physically torn down, unitary air conditioners. In addition, DOE had a third-party testing laboratory test and measure the specific performance limits of one of the air conditioners. The Department then used the test data generated from the tests to calibrate the performance model.

After constructing and calibrating the performance model, DOE analyzed various combinations of design options to simulate equipment with increased efficiencies. Then, through discussions with manufacturers and reliance on sound engineering judgment, the Department established guidelines to limit the design option simulations.

The Department requests stakeholder comments regarding its design option analysis. This concern is identified as Issue 4 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

5. Alternative Refrigerant Analysis

The ACEEE, ARI, and Lennox noted that the engineering analysis should consider alternative refrigerants because R–22 refrigerant will phaseout in 2010 in compliance with EPA requirements and this will affect equipment component costs. (ACEEE, No. 10 at pp. 9–10; ARI, No. 11 at p. 4; Lennox, No. 7 at p. 1) Both ARI and Lennox stated that significant uncertainty exists concerning what refrigerant will be the likely replacement for R–22 in commercial unitary air conditioner and heat pump equipment, thereby complicating analyses. (ARI, No. 11 at p. 4; Lennox, No. 7 at p. 1) During the October 1, 2001, Framework Workshop, Trane commented that alternative refrigerants can behave differently than R–22 at higher temperatures. (Public Workshop Tr., No. 2EE at p. 160) The ACEEE commented that DOE should base the cost impact of alternative refrigerants on a least-cost strategy incorporating efficiency and refrigerant re-designs in a single design cycle, along with changes in assembly processes. (ACEEE, No. 10 at p. 9)

The Department acknowledges that the phaseout of R–22 will occur shortly after the effective date of any new standards and therefore it is important to consider the impact of new refrigerants on incremental cost/efficiency relationships. In addition, the Department recognizes that it is not certain that R–410a will be the ultimate replacement for R–22 in future unitary air conditioner and heat pump equipment. Two refrigerants, R–410a and R–407c, are currently under serious consideration as substitutes for R–22. While R–407c has similar pressure/temperature characteristics as R–22 and thus easily adapts to existing R–22 designs, it is less efficient. By contrast, R–410a operates at higher pressures than R–22, thus requiring redesign of R–22 equipment. However, R–410a offers efficiency benefits relative to R–407c.

During the rulemaking process, the Department contacted manufacturers and the consensus was that R–410a would be the most likely replacement for R–22 in new commercial unitary equipment as the phaseout of R–22 approaches.

Although some unitary air conditioners using R–410a are commercially available, none were available in the ≥65,000 Btu/h to <240,000 Btu/h range when the engineering analysis was conducted. However, since the analysis was conducted, the Department has learned that there is one R–410a commercial unitary air conditioner now available on the market in the 15-ton representative capacity. Most air conditioners that use R–410a are sold primarily for residential applications. Consequently, the Department's analysis compared the design differences between R–22 and R–410a equipment in smaller packaged units (*i.e.*, <65,000 Btu/h units) to gain general engineering insight. In addition, the Department used performance information from manufacturers of R–410a compressors to develop engineering models of the larger R–410a systems.

The Department carried out preliminary performance analyses to simulate R–410a equipment using the same performance models applied to the R–22 equipment, and calculated the R–410a equipment costs using the same cost model applied to the R–22 equipment. The engineering analysis section (Chapter 5) of the ANOPR TSD presents additional details of the R–410a analyses. The Department generated cost/efficiency curves that represented the R–410a equipment using the performance analysis and estimated equipment costs.

The Department realizes that the absolute costs of R–410a equipment differ from those of the R–22 equipment. However, the analysis focuses on the difference in the incremental costs between the two curves. The Department intends to consider the absolute costs of the R–22 phaseout in the manufacturer impact analysis. The alternative refrigerant analysis provided no evidence to suggest that the incremental cost/efficiency behavior of R–410a equipment in the ≥65,000 Btu/h to <135,000 Btu/h and ≥135,000 Btu/h to <240,000 Btu/h equipment classes differs substantially from the R–22 cost/efficiency behavior. For more detail on the alternative refrigerant analysis, refer to the engineering analysis, section 5.9 of the ANOPR TSD.

The Department requests comments from interested parties about its proposed approach to the alternative refrigerant analysis, and has identified it as Issue 2 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

D. Building Energy Use and End-Use Load Characterization

Energy savings from commercial unitary air conditioning equipment vary according to the rated efficiency level of the equipment and a number of other factors, including: Climate, building-type, and building occupation schedule and use. Operating cost savings are a result of reduced electricity consumption and a decrease in the peak electric demand charge. The Department conducted building simulations to estimate the energy use of the commercial unitary air conditioning equipment at candidate standard levels for various combinations of the above-mentioned factors. The simulations yielded hourly estimates of the buildings' electric loads that included lighting, plug, and air conditioning equipment. The Department uses these estimates in the life-cycle cost analysis to assess the cost savings that the air conditioning equipment provides at each of the efficiency levels analyzed. For more detail on the building energy use and end-use load characterization analysis, refer to Chapter 6 of the ANOPR TSD.

1. Approach

The 1995 CBECS (CBECS 95) data set was the primary source of the data used to develop the building characteristics. The Department considered the use of the 1999 CBECS (CBECS 99), but the entire microdata set was not available in time for this analysis. In addition, the sampling procedure for CBECS 99 specifically excluded new buildings of less than 10,000 square feet, which is the type of building that uses commercial unitary air conditioners. Using the CBECS 99 data would have resulted in a biased data set. The Department used a subset of the CBECS 95 representative building types to characterize the energy use and loads for this analysis. It selected six building types that included most of the top eight, energy-using building types in the commercial sector based on CBECS data.

The Department did not explicitly include health care buildings. Instead, because of similarities in modeling the outpatient segment of a health care building and an office building, the Department added the outpatient segment of a health care building into the office-building category. However, the Department did not include the inpatient segment of the health care building type, because there are insufficient data to characterize the buildings for the purpose of energy simulations. The Department did not consider the lodging building type because the number of observations nationwide in the CBECS data set was small and because these buildings do not typically use unitary packaged air conditioning equipment for most of their conditioned spaces. For more details on the engineering approach to building energy use, representative building types, modeling methodology, climate and building locations, and annual building energy use, refer to Chapter 6 of the ANOPR TSD.

Lennox provided comments indicating that industrial and light manufacturing applications use a large fraction of unitary equipment, which the DOE omitted from the building sample. (Lennox, No. 15 at p. 1) The CBECS data set excludes manufacturing facilities from its sample. The Manufacturing Energy Consumption Survey (MECS) includes manufacturing facilities, but the detailed data on building characteristics and operation are not available in the MECS data set. The lack of such data, including the square footage cooled by commercial unitary air conditioning equipment, makes it difficult to establish how significant this building category would be in the analysis. The Department believes that, in the case of office space attached to industrial or light manufacturing buildings, its analytical approach provides a reasonable representation of the cooling loads experienced by these building spaces. This issue is also discussed later with regard to the development of electricity prices from utility tariffs for the LCC analysis (*see* section II.F.1.b.(2)(a) of this ANOPR). This concern is identified as Issue 5 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

The Department further screened the individual CBECS buildings within the six building types to include only buildings with at least 70 percent of their total floor space cooled by unitary packaged equipment. The Department based the 70 percent value on the need to keep the sample size reasonable, yet still representative of the building stock that uses packaged cooling equipment. Using an 80 percent value would be too restrictive and using a 60 percent value would be too extensive and make the sample size too large. The total number of observations in the six building types meeting the 70 percent threshold was 1033. These buildings accounted for over 73 percent of the annual cooling energy use and 67 percent of the square footage of commercial buildings with at least part of their floor space being cooled with packaged equipment.

The Department modeled each CBECS sample building using the BLAST software. The Department computed the building loads by simulating a prototypical three-story, 48,000-square-foot building with five thermal zones per floor with schedule and envelope characteristics chosen to represent each building sampled. The Department used the ventilation requirements of ASHRAE Standard 62.1–1999 as the basis for the ventilation rates in the building simulations. The Department scaled the results of that prototype's simulation to match the specific geometry of the CBECS building being represented, e.g., conditioned floor area, aspect ratio (defined as the ratio of the length to the width of a building), number of floors, and number of thermal zones per floor. The Department simulated the buildings with equipment at ten different EER levels to determine the annual energy impacts of changes in EER.

Lennox commented that the default part-load performance curve in the BLAST simulation tool appears to be representative of equipment that uses cylinder unloading at part-load, instead of multi-compressor staging that is common in commercial unitary air conditioners. The impact of using the BLAST default part-load performance curve is some overestimation of the energy use of the compressors when lightly loaded. (Lennox, No. 15 at p. 1) Due to the lack of available published data on part-load performance of commercial unitary air conditioners, the Department requests data on the part-load operating characteristics to adjust the BLAST part-load performance curve.

Also, in view of the complexity of the BLAST analysis, and Lennox's comments concerning the selection, characterization, and simulation of the building set used for the building energy use and end-use load characterization analysis (Lennox, No. 15 at p. 1), the Department had an independent third-party expert review its analysis. The results of the third-party review are available to interested parties on the Department's website at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* This third-party review is addressed as issue 16 under ''Issues on Which DOE Seeks Comment'' in section IV.E, of this ANOPR.

Also, Lennox provided comments on the ventilation rates used in the DOE building simulation analysis. (Lennox, No. 15 at p. 1) Lennox and ARI asserted that the DOE analysis overstates the ventilation load for most buildings by assuming all commercial buildings typically operate at ASHRAE Standard 62–1989 ventilation levels (15 cfm/person typical). Lennox wrote that most existing building applications as well as half of the new building applications of unitary air conditioning equipment operate at pre-ASHRAE Standard 62–1989 ventilation levels (5 to 7.5 cfm/person typical), which accounts for nearly 85 percent of the total shipments of commercial unitary air conditioning equipment. (Lennox, No. 15 at p. 1; ARI, No. 18 at pp. 1–8) Consultation between the Department and designers suggests that designers use ASHRAE Standard 62.1–1999 for establishing design ventilation rates, particularly since many designers wish to avoid potential litigation arising from adverse health effects attributable to low ventilation rates. (See the discussion of building energy use and end-use load characterization that addresses ventilation rates in section 6.2.5.5, ''Ventilation and Infiltration,'' of the ANOPR TSD.) For commercial unitary air-conditioning equipment, the ventilation rate is typically established by an outside air damper setting on the installed equipment. It is not a function of the age of the building, but rather is set at the time of installation. Concern over the health effects of low ventilation rates are the same regardless of the age of the building or the minimum ventilation rates in effect at the time the building was constructed.

Consequently, the Department believes that the use of ASHRAE Standard 62.1–1999 for setting ventilation requirements is the approach most representative of that used in the construction industry today. The Department is unaware of any field studies that would support use of a different ventilation rate than that required by ASHRAE Standard 62.1–1999, and thus is inclined to use this as the basis for the analysis for the ANOPR. However, in view of the complexity of the analysis and issues concerning ventilation rates that Lennox addresses, the Department had an independent third-party expert review its analysis. The results of the third party review are available to interested parties on the Department's website at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* This concern is addressed as Issue 16 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

The Department received several comments that expressed concern about whether the higher efficiency equipment provided adequate humidity control while meeting ASHRAE Standard 62.1–1999 ventilation requirements. (ACEEE, No. 10 at p. 5; Public Workshop Tr., No. 2EE at p. 72; Lennox, No. 7 at p. 3; Public Workshop Tr., No. 2EE at p. 71) The Department established maximum sensible heat ratios for equipment analyzed via the design option process in the engineering analysis, indicating that there could be high EER equipment designs that provide acceptable humidity control (or adequate sensible heat ratio performance) under ARI Standard Rating Conditions for cooling.

In addition, DOE received several comments concerning the simulation of economizers. Lennox and the Oregon Office of Energy (OOE) commented that economizer operation or failure to operate is difficult to capture in a building simulation analysis. (Lennox, No. 7 at p. 4; Public Workshop Tr., No. 2EE at p. 163) The Department agrees with Lennox and OOE. However, for this ANOPR analysis, DOE assumed that if CBECS data indicated the use of an economizer then it was a fully functioning economizer. This might result in some underestimation of the actual cooling loads in the buildings.

The Department requests comments from interested parties regarding its proposed approach to economizers. This matter is identified as Issue 6 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

Fan power in the energy analysis was raised as one of the issues in the Framework Workshop. A written comment from ACEEE proposed (in addition to the EER requirement) establishing a second requirement for fan power as a function of flow rate in Watts per cubic feet per minute (Watts/cfm) using the existing fan static pressures. (ACEEE, No. 10 at p. 9) The Department notes that the current EER performance metric includes fan power and has incorporated annual fan energy use in its estimate of total system energy use for the simulations. Because DOE is not planning to amend the test procedure at this time to extract the fan power measurement, it does not anticipate adding a requirement for fan efficiency (Watts/cfm).

In a related comment on the fan power issue, Lennox raised the issue of the inclusion of supply fan energy during all operational modes of the air conditioner (cooling, heating, and ventilating) in the energy analysis. (Lennox, No. 15 at p. 1) The Department understands that the supply fan is an integral part of a unitary air conditioner and its operation contributes to the energy use of the equipment. Including supply fan energy during hours when a commercial unitary air conditioner is operating in the heating or ventilating mode will increase the energy use of that equipment, in comparison to including supply fan energy only when the equipment is providing cooling. For the purposes of the ANOPR analysis, the Department has included all energy from the supply fan and welcomes public comments on this approach. This concern is addressed in Issue 7 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

Furthermore, in view of the complexity of the analysis concerning fan energy and the issues addressed by Lennox, the Department had an independent third party review its analysis. The results of the third-party review are available to interested parties on the Department's Web site at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* Also, this concern is addressed as Issue 16 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

The end result of the simulation analysis was an hourly end-use energy stream of data for the following end-use categories:

- Cooling package equipment;
- Heating (gas);
- Lights;
- Plug and miscellaneous loads;
- Package-equipment fan;
- Nnon-package cooling; and
- Non-package fan.

2. Preliminary Results

The distribution of cooling energy use intensity (EUI) for all buildings simulated at the 8.9 EER efficiency level shows that EUI varies widely, from 0.33 kBtu/square-foot/year to a maximum of 63.3 kBtu/square-foot/year. However, the vast majority of the buildings fall into the 5 to 20 kBtu/square-foot/year range. Chapter 6 of the ANOPR TSD provides a comparison of the simulated cooling EUI for each building with the calculated cooling EUI using the CBECS estimated cooling energy use. On a square-footage-weighted basis, the BLAST simulation cooling EUIs agree reasonably well with the CBECS estimated EUIs. The CBECS estimated EUIs are higher for two of the building types (Office and Food Service), while the BLAST simulation cooling EUIs are higher for the four remaining building types (Retail, Education, Assembly, Warehouse). The square-footage-weighted cooling EUI for this set of buildings was 10.5 kBtu/square-foot/year for the BLAST simulations compared to 9.6 kBtu/square-foot/year for the CBECS estimates.

The hourly cooling energy use is only one of the energy inputs to the LCC analysis. All the electric energy end-uses play some part in determining which rate structure applies and where end-users are in the rate structure for any given hour. The electric energy use of the cooling equipment relative to the other electric energy use within a building is a strong function of the building type, climate, and time of use (seasonal as well as hourly). The peak hourly energy use becomes particularly important when analyzing the marginal cost of energy saved by higher EER levels.

In the progression to higher EER levels, the simulation runs indicated reduced cooling and fan energy consumption. The Department made a comparison of the change in cooling EUI (not including the fan energy) for two buildings from the representative building set as the equipment efficiency progressed from an EER of 8.5 to 12.0. As expected, the cooling EUI decreases with each incremental EER increase, but with a declining EUI benefit at higher EERs. This trend is the same for all buildings, even though the base EUI is different for each of them. The change in total fan energy use from the simulation as a function of EER is less pronounced. This is because, while the simulation model assumes that fan energy during the EER rating test is reduced, a substantial fraction of the fan energy consumption is a function of the external fan static pressure, which is assumed not to change between efficiency levels. The Department used the hourly simulated building electric-energy loads directly as inputs to the detailed LCC analysis discussed in the next section of this ANOPR. See Chapter 6 of the TSD for more details on this building load simulation analysis.

In determining the reduction in cooling and fan energy consumption due to higher EER levels, the Department did not take into account a rebound effect. The rebound effect occurs when a piece of equipment that is made more efficient is used more intensively, so that the expected energy savings from the efficiency improvement do not fully materialize. Because unitary air conditioners are a commercial appliance, the person owning the equipment (*i.e.*, the building owner) is often not the person operating the equipment (*i.e.*, the renter). Because the operator does not own the equipment, they will not have the information necessary to influence their operation of the equipment. In other words, a rebound effect would appear to be unlikely. 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. This matter is identified as Issue 20 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

E. Markups To Determine Equipment Price

The Department understands that the price of a commercial unitary air conditioner depends on how the customer purchases such equipment. Because the customer price of such equipment is not generally known, the Department used the manufacturers' costs developed from the engineering analysis and applied multipliers called ''markups'' to arrive at the final equipment price. The derivation of the equipment price depends on the distribution channel the customer uses to purchase the equipment. Typical distribution channels consist of wholesalers, mechanical contractors, and general contractors. The Department based the wholesale and contractor markups on a combination of firm balance sheet data and U.S. Census Bureau data. For each of the markups, DOE further differentiated between a baseline markup and an incremental markup. The Department defines baseline markups as coefficients that relate the manufacturer's price of baseline equipment to the wholesaler's or contractor's sales price of such equipment. Incremental markups are coefficients that relate changes in the manufacturer's price of baseline equipment to changes in the wholesaler's or contractor's sales price. For more detail on equipment prices and markups, refer to Chapter 7 of the ANOPR TSD.

1. Approach

To carry out the LCC calculations, DOE needed to determine the cost to the customer of a baseline commercial unitary air conditioning unit and the cost of more efficient units. The customer price of such units is not generally known. However, by applying a multiplier called a ''markup'' to the manufacturer's prices that DOE derived, DOE could estimate customer prices both for baseline and more-efficient equipment.

Both Lennox and Trane noted the importance of the methodology used to determine markups and equipment prices. Lennox stated that markups are dependent on how commercial equipment is sold and involve complex distribution channels that include distributors (also known as wholesalers), installing contractors, and business or building owners. (Lennox, No. 2 at p. 3; Public Workshop Tr., No. 2EE at p. 142) Trane also noted that any publicly available price lists are not useful for estimating equipment prices. (Public Workshop Tr., No. 2EE at p. 125) In response to Trane, OOE commented that invoices are available for estimating the installed cost of commercial unitary air conditioners. (Public Workshop Tr., No. 2EE at p. 126)

The Department understands that the equipment price to the customer depends on how the customer purchases the equipment. Based on manufacturer input, DOE defined two types of distribution channels to describe how the equipment passes from manufacturer to customer. In the first distribution channel, the manufacturer sells the equipment to a wholesaler, who in turn sells it to a mechanical contractor, who in turn sells it (and its installation) to a general contractor, who in turn sells it to the customer. In the second distribution channel, the manufacturer sells the equipment directly to the customer through a national account. The Department further subdivided the first distribution channel by mechanical contractor size (as measured in annual revenues). In its methodology for estimating equipment prices, the Department relied solely on the above approach, *i.e.*, defining distribution channels and determining markups at each point in the distribution channel. The Department could not collect any price lists or invoices to assist in its determination of equipment prices. For more detail on the distribution channels for commercial air conditioners, refer to the introduction to Chapter 7, figure 7.1.1, and section 7.7 of the ANOPR TSD.

Based on information provided by equipment manufacturers through informal interviews, as well as the judgment of individuals familiar with how commercial unitary air conditioning equipment is distributed to commercial customers, the Department assumes that end use customers purchase 50 percent of equipment through small mechanical contractors, 32.5 percent through large mechanical contractors, and the remaining 17.5 percent through national accounts. In addition, the Department understands that 30 percent of commercial unitary air conditioning equipment is purchased for the new construction market, while the remaining 70 percent serves the replacement market. In the case of the replacement market, where equipment is purchased through a mechanical contractor, the mechanical contractor generally purchases equipment directly from the wholesaler (*i.e.*, a general contractor is not involved in the distribution of equipment). The mechanical contractor markup is a function of contractor size and whether the contractor serves primarily the new construction or the replacement market. For more detail on the new construction and replacement markets and their effects on the mechanical contractor markups, refer to section 7.4.1 of the ANOPR TSD.

For each of the markups, DOE further differentiated between a baseline markup and an incremental markup. The Department defines baseline markups as coefficients that relate the manufacturer price of baseline equipment to the wholesale or contractor sales price of such equipment. Incremental markups are coefficients that relate changes in the manufacturer price of baseline equipment to changes in the wholesale or contractor sales price. For more detail on the methodology the Department used to determine baseline, incremental, and overall markups, refer to sections 7.1.1 through 7.1.3 of the ANOPR TSD.

The Department based the wholesale and mechanical contractor markups on firm balance sheet data, while it based the general contractor markups on U.S. Census Bureau data for the commercial and institutional building construction industry. The Department obtained balance sheets from the trade associations representing wholesalers and mechanical contractors. The Department put the building construction industry data into the same format as the balance sheet data for wholesalers and mechanical contractors to derive the markups for general contractors. The key assumptions used to estimate markups using this financial data are:

- The firm balance sheets faithfully represent the various average costs incurred by firms distributing and installing commercial air conditioning.
- There are two categories of costs: (1) Costs that vary in proportion to the manufacturer price of commercial air conditioners (variable costs); and (2) costs that do not vary with the manufacturer price of commercial air conditioners (fixed costs).
- Commercial air conditioner wholesale and contractor prices across different efficiency levels vary in proportion to commercial air conditioner wholesaler and contractor costs included in the balance sheets.

For more detail on the basic assumptions the Department used to estimate markups, wholesale markups, and mechanical contractor markups, refer to sections 7.2 through 7.5 of the ANOPR TSD.

Commercial unitary air conditioning equipment purchased through national accounts is an exception to the usual distribution of HVAC equipment to end users. Large customers of HVAC equipment, such as national retail chains, use national accounts to circumvent the typical chain of distribution. Due to the large volume of equipment purchased, large customers can purchase equipment directly from the manufacturer at significantly lower prices than could be obtained through the typical distribution chain.

To derive a national account markup, the Department considered costs that are added to the manufacturer price as additional markups and costs that are subtracted from the customer price as markups that are avoided in a more typical manufacturer-to-wholesaler-to-mechanical-contractor-to-general-contractor-to-customer distribution system. Costs that are added include:

- Freight charges (less-than-a-truck-load rates are higher than trailer-load rates);
- Account management and administration expenses (billing, collections and warranty issues); and
- Cost-of-sale increases (technical support and personalized service).

Costs that are deducted include:

- Wholesaler account management and administration expenses;
- Wholesaler warehousing and handling expenses;
- Mechanical contractor markup on equipment sale (profit, labor warranty, and service reserve);
- Mechanical contractor account management and administration expenses;
- Mechanical contractor warehousing and handling expenses;
- General contractor account management and administration expenses; and
- General contractor project oversight markup.

In view of these additions and deductions, the Department derived a national account markup assuming that the resulting equipment price increase was one-half of that realized from a typical chain of distribution. In other words, if the price increase resulting from the multiplicative product of the wholesale, mechanical contractor, and general contractor markups is $100, the national account markup is such that the price increase is one-half of that, or $50. The Department assumed that the resulting national account markup must fall somewhere between the manufacturer price (*i.e.*, a markup of 1.0) and the customer price under a typical chain of distribution. Because

DOE did not know precise values (between zero and one for the markups) for the actual national account equipment price, DOE used 0.5 to represent a mid-point value between manufacturer price and customer price. For more detail on national account markups, refer to section 7.7 of the ANOPR TSD.

As a final step, DOE applied a sales tax, which represents state and local sales taxes that are applied to the customer price of the equipment. The Department derived sales taxes representative of both state and local sales taxes from 1997 state sales tax data and 1997 local sales tax data. Using state unitary air conditioner shipment data from 1994, DOE weighted the state and local sales tax data by the percentage of unitary air conditioners shipped to each state. The sales tax has a mean value of 6.7 percent. The Department updated its calculation of sales taxes based on 2003 state and local sales tax data from the Sales Tax Clearinghouse (*http://thestc.com/STrates.stm*). Although the updated mean sales tax value is 6.6 percent, virtually unchanged from the value based on 1997 data, the Department intends to update the sales tax data in its analysis for the NOPR. The Department applied sales taxes to the customer equipment price irrespective of the distribution channel and the market in which the customer is located. The Department assumes the state and local sales tax rate is the same for residential products and commercial/industrial equipment.

For more detail on the Department's approach to state and local sales taxes, refer to section 7.6 of the ANOPR TSD. The Department invites comments and data from interested parties on its assumption. Also, the Department was not able to gather more recent state-by-state shipments of >65,000 Btu/h to <240,000 Btu/h commercial unitary air conditioners. The Department requests more recent data from interested parties.

2. Estimated Markups

The Department multiplied the wholesale and contractor markups described above by the sales tax to get the overall baseline and incremental markups shown in Tables II.5 and II.6, respectively. Overall markups are based on one of three assumed distribution channels as well as whether the commercial unitary air conditioning equipment is purchased for the new construction or the replacement market. The Department based the distribution channel on whether such equipment is purchased through small mechanical contractors, large mechanical contractors, or national accounts. The tables show a weighted-average overall markup, assuming that: (1) The new construction and replacement markets represent 30 percent and 70 percent of the market, respectively; and (2) end-use customers purchase 50 percent of equipment through small mechanical contractors, 32.5 percent through large mechanical contractors, and the remaining 17.5 percent through national accounts. The weighted-average overall baseline markup equals 2.31, while the weighted-average overall incremental markup equals 1.56. For more details on how the Department derived overall markups, refer to section 7.8 of the ANOPR TSD.

The Department used the overall markup to estimate the customer price of baseline equipment, using the manufacturer price of baseline equipment. For example, if the manufacturer price of a baseline commercial air conditioner is $100, DOE multiplied this by the weighted-average overall baseline markup to estimate the baseline customer price of the equipment as $231. Similarly, DOE used the overall incremental markup to estimate changes in the customer price, in view of changes in the manufacturer price above the baseline price resulting from a standard to raise equipment efficiency. For example, if a standard increases the commercial air conditioner manufacturer price by $25, DOE multiplied this by the weighted-average overall incremental markup to estimate that the customer price will increase by $39.

TABLE II.5.—OVERALL BASELINE MARKUPS

Market sector	New construction			Replacement			Weighted-average
	Small mech.	Large mech.	National account	Small mech.	Large mech.	National account	
Wholesale	1.36	1.36	....	1.36	1.36		
Mechanical Contractor	1.48	1.35	1.69	1.70	1.55	1.60	
General Contractor	1.24	1.24	....	NA	NA		
Sales Tax	1.07	1.07	1.07	1.07	1.07	1.07	
Overall	2.66	2.42	1.80	2.47	2.24	1.71	2.31

TABLE II.6.—OVERALL INCREMENTAL MARKUPS

Market sector	New construction			Replacement			Weighted-average
	Small mech.	Large mech.	National account	Small mech.	Large mech.	National account	
Wholesale	1.11	1.11	....	1.11	1.11		
Mechanical Contractor	1.26	1.18	1.27	1.37	1.29	1.24	
General Contractor	1.13	1.13	....	NA	NA		
Sales Tax	1.07	1.07	1.07	1.07	1.07	1.07	
Overall	1.68	1.59	1.35	1.63	1.53	1.32	1.56

Referring specifically to the above wholesaler baseline and incremental markups of 1.36 and 1.11, respectively, ARI's comments reject the assumption that incremental markups should be less than baseline markups. ARI states that these correspond to margins of 27 percent and 9 percent respectively, and that the underlying assumption is that ‘‘the wholesaler will accept one-third the margin on the incremental cost that he receives on the baseline.’’ (ARI, No. 14 at pp. 1 and 2) According to ARI, this is saying that the wholesaler is expected to sell premium goods for a lower markup than commodity goods, which is counter to the trends in all industries. Also, ARI states that ''premium goods demand premium markups.'' By using incremental markups, the effect of any increase in the standard would be to decrease the profit margins of the wholesalers and all others in the distribution chain. Further, ARI states that, over a period of time, ''this is a sure formula for bankruptcy and collapse of an industry.'' (ARI, No. 14 at p. 1)

As ARI notes, the wholesale incremental markups are one-third of the wholesale baseline markups. (ARI, No. 14 at p. 1) However, the Department does not agree with ARI's characterization of these estimates as counter to industry trends and ''a formula for bankruptcy.'' Rather, the Department believes that the above incremental markups are consistent with industry trends and sufficient to maintain industry profits. There appears to be some fundamental disagreement between ARI and the Department on whether growth in cost of goods sold (CGS) must always be matched by a proportionate growth in sales revenue. While this may be true within the context of a general business expansion, the Department believes that it is not an appropriate assumption within the context of an increase in equipment price due to an increase in the minimum efficiency standard. To develop markups, energy efficiency standards involve little or no change in the number of units sold or in the labor needed to handle those units. This situation is quite different from a market trend where both the number of units sold and CGS increase. The following example illustrates this case.

The Department uses a simple hypothetical example of a firm setting prices before and after implementation of an efficiency standard (see Table II.7). For illustration, the hypothetical standard is assumed to raise equipment cost by 25 percent, from $5 million CGS in the Baseline to $6.25 million CGS with the New Standard. For simplicity, the number of units sold in this example is assumed to remain constant. The DOE analyses of national energy savings and manufacturer impact takes into account changes in sales as a result of energy efficiency standards. Consequently, with the New Standards, labor and occupancy costs remain constant and other overhead costs and profit are assumed to rise in proportion to changes in CGS.

TABLE II.7.—EXAMPLE ILLUSTRATING IMPACT OF PROFIT ON MARKUP

Baseline		New standard (proportional profit)		New standard (fixed markup)	
Total CGS ($thousand)	$5,000	Total CGS ($thousand)	$6,250	Total CGS ($thousand)	$6,250
Labor and Occupancy ($thousand)	$659	Labor and Occupancy ($thousand).	$659	Labor and Occupancy ($thousand).	$659
Other Overhead ($thousand)	$659	Other Overhead ($thousand)	$824	Other Overhead ($thousand)	$824
Profit ($thousand)	$333	Profit ($thousand)	$416	Profit ($thousand)	$580
Total Revenue ($thousand)	$6,650	Total Revenue ($thousand)	$8,150	Total Revenue ($thousand)	$8,313
Markup	1.33	Markup	1.30	Markup	1.33

The New Standard (proportional profit) shown in the middle column of Table II.7 illustrates what would happen if the Department assumes profits are proportional to CGS. Even though baseline profit rises from $333,000 to $416,000, the apparent markup declines, compared to Baseline. The apparent decline is the result of an arithmetic change in the ratio of Total Revenue to Total CGS. In other words, if profitability increases proportionally with CGS from $333,000 to $416,000, then the markup declines from 1.33 to 1.30.

The New Standards (fixed markup) case illustrates the implications if instead the Department were to assume a fixed markup. The results (right column in Table II.7) show that if the markup is fixed at the pre-standard level of 1.33, then firm profits will rise after the standard becomes effective. In other words, with a fixed markup, revenue after the standard becomes effective would be 1.33 multiplied by the CGS, or $8,313,000. The profit that is consistent with this amount is the revenue minus the sum of CGS, labor and occupancy, and other overhead. This provides a profit of $580,000 after the standard, or a 74 percent increase in profit.

The Department does not believe that it is possible for firms to increase profits in this manner simply as a result of an increase in equipment efficiency. In a competitive market, DOE believes increases in profits do not persist because high profits attract competing firms which results in an increase in equipment supply and lower prices. The Department believes that a firm that used an efficiency standard as an opportunity to increase profits would eventually lose market share to firms that maintain profitability nearer to the pre-standard levels.

All this indicates that markups on goods sold after an energy efficiency standard becomes effective would be lower than the baseline markups. Thus, the Department believes that, due to implementation of an energy efficiency standard, CGS would increase but the number of units sold and associated labor costs would not increase.

Two sources of industry data support the Department's finding concerning incremental markups. First, the incremental markup the Department calculated is consistent with incremental markups calculated from a statistical analysis of U.S. Census Bureau data covering the HVAC sector. (See Wholesalers: U.S. Census Bureau, Gross Profit, Employment and Gross Margin for Merchant Wholesalers for NAICS 42173. By State: 1997. Refer to section 7.3 of the ANOPR TSD for details on the derivation of incremental markups based on the use of U.S. Census Bureau data.) Second, there are empirical observations of instances where industry growth in revenue exceeds growth in profits. For example, net sales of firms in the refrigeration and service industry grew at 18.6 percent over a period of five years while operating income grew by 12.6 percent. (See Ibbotson: 2001 Cost of Capital Yearbook. Statistics for SIC Code 358. Medium firm growth rates.) The Department concludes that many factors influence the relationship between CGS and operating profits.

The Department believes that the use of incremental markups is the most appropriate methodology for developing equipment prices for more energy efficient equipment. Because fewer expenses need to be covered by an incremental markup, it has a lower value than its corresponding baseline markup. Nevertheless, the Department understands that identifying expenses that need to be covered by the incremental markup is essential to deriving its value. Therefore, the Department seeks comments on whether the wholesale, general contractor, and mechanical contractor incremental markups should cover more or fewer expenses. This is addressed as Issue 8 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

In addition, in view of the complexity of the analysis and issues addressed by ARI concerning markups (ARI, No. 14 at pp. 1 and 2), the Department had an independent third-party expert review and comment on its analysis. The results of the third-party review are available to interested parties on the Department's Web site at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* This subject is addressed as Issue 16 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

Concerning the Department's characterization of distribution channels, ARI states that replacement installations often need a general contractor. (ARI, No. 14 at pp. 1 and 2) Specifically, ARI states that replacements are divided between those due to equipment failures and those required as part of a major building renovation. In the latter case, ARI states that a general contractor is almost always involved and estimates that 50 percent of the replacement market includes a general contractor markup. (ARI, No. 14 at pp. 1 and 2)

As noted earlier, the Department developed the distribution channels based on data collected from manufacturers as well as the judgment of individuals familiar with how air conditioning equipment is distributed to commercial customers. Based on ARI's input, and any future comments from other interested parties in response to this ANOPR, the Department may change the distribution channels for the NOPR to be more reflective of how equipment is actually distributed.

For equipment purchased through national accounts, ARI states that general and mechanical contractors remain involved in the distribution and installation of the equipment. However, it adds that the contractors may use a slightly lower effective markup if they do not have to cover expenses associated with the cost of the equipment. Thus, national accounts are more similar to a typical distribution channel than not. ARI comments that the principal advantage of a national account to a manufacturer is volume reduction of incremental selling cost. The result is that some savings are shared with the customer in the form of reduced cost for the installed equipment. Although there are customer savings, ARI states that the large difference between baseline and incremental markups is not representative of actual market dynamics, and that national account markups should be 0.2 to 0.25 greater than the values shown in chart 13. (ARI, No. 14 at pp. 1 and 2) The Department understands that ARI is referring to chart 13 (Image 14) in the ''Life Cycle Cost Analysis Presentation: Inputs and Results,'' on the DOE Web site at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* In this case, chart 13 (Image 14) presents the same information as Tables II.5 and II.6 in this ANOPR.

As noted earlier, the Department derived a national account markup under the assumption that the resulting equipment price increase was one-half of that realized from a typical chain of distribution. In view of ARI's comments, and any future comments received from other interested parties in response to this ANOPR, the Department may change the national account markups for the NOPR to better reflect the actual distribution of commercial unitary air conditioning equipment.

The ACEEE and ASE commented that DOE should extrapolate future equipment prices from historical producer price trends for commercial unitary air conditioners published by the U.S. Census Bureau. (ACEEE, No. 10 at pp. 9 and 10; ASE, No. 9 at p. 4)

For other rulemakings, the Department used production input costs and production technologies based on the best information available at the time. The Department has not made any assumptions about productivity improvements and material cost changes over time. The Department believes historical price trends for commercial unitary air conditioners (or other related equipment) do not apply to forecast equipment prices where there are no data to show that the trends will continue. Therefore, without specific data on the likely costs to manufacture a piece of equipment, the Department does not plan to apply a productivity improvement factor in this rulemaking.

F. Life-Cycle Cost and Payback Period Analysis

The LCC and PBP analysis determines the impact of potential standards on consumers. The effects of standards on individual commercial 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 LCCs compared to a base case. The LCC calculation considers total installed cost (equipment purchase price plus installation cost), operating expenses (energy, repair, and maintenance costs), equipment lifetime, and discount rate. The Department performed the LCC analysis from the perspective of the user of commercial unitary air conditioning equipment.

The Department also determined the economic impact of potential standards on consumers by calculating the PBP of potential standards relative to a base case. The PBP measures the amount of time it takes the commercial consumer to recover the assumed higher purchase expense of more-energy-efficient equipment through lowering operating costs. Similar to the LCC, the PBP is based on the total installed cost and the operating expenses. But unlike the LCC, only the first year's operating expenses are considered in the calculation of the PBP. Because the PBP 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. For more detail on the life-cycle cost and payback period analysis, refer to Chapter 8 of the ANOPR TSD.

The Department generated LCC and PBP results as probability distributions using a simulation based on Monte Carlo statistical analysis methods, in which inputs to the analysis consist of probability distributions rather than single-point values. As a result, the Monte Carlo analysis produces a range of LCC and PBP results. A distinct advantage of this type of approach is that the Department can identify the percentage of users achieving LCC savings or attaining certain PBP values due to an increased efficiency standard, in addition to the average LCC savings or average PBP for that standard. Because DOE conducted the analysis in this way, it can express the uncertainties associated with the various input variables as probability distributions. During the post-ANOPR consumer analysis, the Department may evaluate additional parameters and prepare a comprehensive assessment of the impacts on sub-groups of users.

Lennox and NRDC had some general concerns regarding the LCC analysis. Lennox commented that the technical analysis of the commercial air conditioner market, building loads, and equipment operation are much more complex than past analyses conducted for residential central air conditioners. (Lennox, No. 7 at p. 1) The NRDC stated that the analysis must be credible and transparent. (NRDC, No. 6 at p. 3)

To make the analysis transparent, the Department developed a spreadsheet model in Microsoft Excel. An add-on to Microsoft Excel called Crystal Ball (a commercially available software program) allows a user to characterize input variables with probability distributions. Past LCC analyses conducted for residential central air conditioners also used Microsoft Excel spreadsheets with Crystal Ball. Although the residential and commercial air conditioner analyses are similar in this respect, the commercial analysis is more complicated in that it requires conducting whole-building simulations to derive equipment energy use and demand.

In addition, the Department derived two sets of electricity prices to estimate annual energy expenses: A tariff-based estimate and an hourly based estimate. The tariff-based approach estimates an annual energy expense using electricity prices determined from electric utility tariffs collected in the year 2002. The hourly based approach estimates annual energy expense using electricity prices that may exist, assuming all electricity markets are deregulated. Under this approach, the Department collected electricity production prices that vary on an hourly basis and used them to model a scenario in which customers are directly charged for the costs incurred by an electricity provider to supply energy for air conditioning. For electricity markets that are already deregulated, the Department collected actual wholesale hourly electricity prices. For markets that are still regulated, it collected hourly system load and generation cost data and used them as a proxy for wholesale prices that might exist if those markets were deregulated.

1. Inputs to LCC Analysis

For each efficiency level analyzed, the LCC analysis requires input data for the total installed cost of the equipment and the operating cost. Table II.8 summarizes the inputs used to calculate the customer economic impacts of various energy efficiency levels. A more detailed discussion of the inputs follows.

TABLE II.8. SUMMARY OF INPUTS USED IN THE LCC ANALYSIS

Input	Description
Equipment Price	Derived by multiplying manufacturer cost by manufacturer, distributor, mechanical contractor, and general contractor markups and sales tax. Manufacturer costs and markup discussed in section II.C. and summarized in Tables II.3 and II.4. Other markups and sales tax discussed in section II.E and summarized in Tables II.5 and II.6.
Installation Cost	≥65,000 Btu/h to <135,000 Btu/h—$1585; ≥135,000 Btu/h to <240,000 Btu/h—$2142. Installation costs vary as a function of equipment weight.
Annual Energy Use and Demand	Derived through whole-building energy use simulations. Discussed in section II.D.
Annual Energy Expenses	Derived from tariff-based and hourly based electricity prices. Average marginal tariff-based electricity price—10.0¢ per kilowatt/hour (kWh). Average marginal hourly based electricity price—9.9¢/kWh.
Repair Costs	≥65,000 Btu/h to <135,000 Btu/h annual repair cost—$151; ≥135,000 Btu/h and <240,000 Btu/h annual repair cost—$279. Annual repair costs vary as a function of manufacturer price.
Maintenance Costs	Annual maintenance cost equals $200; does not vary as a function of cooling capacity or efficiency.
Lifetime	Mean lifetime equals 15.4 years.
Discount Rate	Mean discount rate equals 6.1 percent.
Effective Date*	2008.

* Refer to section II.F.1.b.(8).

As noted by its absence in Table II.8, the Department chose not to include the impact of income taxes in the LCC analysis for this ANOPR. The Department understands that there are two ways in which taxes affect the net impacts attributed to purchasing more energy efficient equipment compared to baseline equipment: (1) Energy efficient equipment typically costs more to purchase than baseline equipment, which in turn lowers net income and may lower company taxes; and (2) efficient equipment typically costs less to operate than baseline equipment, which in turn increases net income and may increase company taxes. In general, the Department believes that the net impact of taxes on the LCC analysis depends on firm profitability and expense practices (how firms expense the purchase cost of equipment). For more detail on the inputs to the life-cycle cost analysis, refer to section 8.2 of the ANOPR TSD. The Department seeks input on whether income tax effects are significant enough to warrant inclusion in the LCC analysis for the NOPR. The Department specifically requests information on how many firms that purchase commercial unitary air conditioners actually pay taxes and, if they do, what expense-accounting practices they use to depreciate the purchase costs. This is addressed as Issue 17 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

a. Total Installed Cost Inputs

The total installed cost is the sum of the equipment price and the installation cost. The equipment price includes the distribution markups (as determined in section II.E) that are applied to the manufacturer costs estimated in the engineering analysis (section II.C).

The Department derived installation costs for commercial air conditioners from data in *RS Means Mechanical Cost Data, 2002.* The Department decided that data for 7.5-ton and 15-ton rooftop air conditioners are representative of installation costs for the ≥65,000 Btu/h to <135,000 Btu/h and ≥135,000 Btu/h to <240,000 Btu/h air conditioning equipment classes, respectively. The Department derived nationally representative installation costs of $1,585 and $2,142 for 7.5-ton and 15-ton commercial unitary air conditioners, respectively. Because labor rates vary significantly in each region of the country, DOE used data from *RS Means Mechanical Cost Data, 2002* to identify how installation costs vary from state to state and incorporated these costs into the analysis.

Lennox, Trane, and ARI stated that installation costs will increase with efficiency because of the increased weight and size of more efficient equipment. (Lennox, No. 7 at p. 3; Public Workshop Tr., No. 2EE at p. 146–148; ARI, No. 14 at p. 2 and No. 17 at p. 2) Lennox added that installation costs for the replacement market would increase substantially if larger and heavier equipment requires new roof mounting frames or structural modifications. (Lennox, No. 7 at p. 3) Regarding replacements, ARI stated that most of the equipment being replaced is likely to be older and rated 8.0 EER or lower. The ARI stated that the more efficient equipment will be larger and heavier, and is likely to need an adapter curb or rebooting and perhaps structural modifications to carry the weight. Retrofit installations use adapter curbs. An adapter curb consists of structural members that provide a transition or alignment between existing roof curbs and new equipment with a different size or configuration. Also, ARI stated that the cost of adaptation may be significantly greater if parapets must be increased (to meet building codes) to hide a unit sitting on a tall adapter. The ARI provided rough estimates of $2500 for a 7.5-ton adapter curb and $3500 for a 15-ton adapter curb (parts and labor included). (ARI, No. 14 at p. 2)

The Department could not find data that explicitly showed how installation costs vary with equipment efficiency. As a result, the Department considered varying installation costs in direct proportion to the weight of the equipment. The Department developed linear relationships of operating weight as a function of equipment efficiency for 7.5-ton and 15-ton commercial unitary air conditioners and assumed the installation cost increased in the same proportion. The Department does not believe the weight increases are great enough to warrant structural modifications and so it has excluded the cost of adaptor curbs and increased parapets. Therefore, DOE did not develop a separate set of installation costs for the replacement market. Spreadsheets used in evaluating the LCC and PBP can also be used to evaluate LCC and PBP based on a constant installation cost.

The Department will review the engineering analysis data for the NOPR to determine when manufacturers increase box size and in what direction (height, footprint, or both). Based on that review, the Department will determine whether the current installation cost analysis captures all the associated costs of installing more efficient equipment. The Department did not include in the analysis the incremental cost of replacing older equipment (*i.e.*, equipment rated 8.0 EER or lower). This is because the analysis establishes the incremental cost of installations exceeding the baseline efficiency levels (*i.e.*, the ASHRAE/IESNA 90.1–1999 efficiency levels of 10.1 EER for the ≥65,000 Btu/h to <135,000 Btu/h equipment class, and 9.5 EER for the ≥135,000 Btu/h to <240,000 Btu/h class), not the cost of upgrading older equipment to baseline EER levels. Therefore, if baseline equipment requires adaptor curbs or increased parapets to replace older equipment, but upgrading baseline equipment to more efficient equipment does not need further curb adaption or parapet increases, then the analysis would not include the costs of adaptor curbs or increased parapets. For more detail on the total installed cost inputs, refer to section 8.2.2 of the ANOPR TSD.

b. Operating Cost Inputs

The operating costs consist of a series of discounted cash flows that capture the cost of the electricity needed to operate the equipment, the repair costs, and the maintenance costs over the lifetime of the equipment beginning at the effective date of the standard. The Department calculated the annual electricity expense from the energy use data supplied by the whole-building simulations and electricity prices. As discussed above, the Department used two approaches to estimate electricity prices: A tariff-based approach and an hourly based approach. Because data were not available to indicate how repair costs (*i.e.*, those costs associated with the repair or replacement of failed components) vary with equipment efficiency, the Department assumed that repair costs vary directly with the cost of the equipment. Because equipment costs increase with efficiency and, to a large extent, equipment replacement costs drive repair costs, the Department reasonably assumes that repair costs will vary directly with the cost of the equipment. On the other hand, the Department assumed that maintenance costs remain constant regardless of equipment cost. Because maintenance costs correspond to the upkeep of equipment operation (*e.g.*, cleaning heat-exchanger coils and recharging refrigerant) and are not associated with repair or replacement of system components, the Department reasonably assumed that maintenance costs are not part of the cost of the equipment and, therefore, will not vary with the equipment cost. Also, the Department used a survival function to define the probable lifetime of the equipment with the mean being 15.4 years. For the analyses conducted for this ANOPR, the Department assumed that an energy efficiency standard for commercial unitary air conditioning equipment would become effective in 2008. (42 U.S.C. 6313(a)(6)(C)) For more detail on operating cost inputs to the life-cycle cost analysis, refer to section 8.2.3 of the ANOPR TSD.

(1) Use of Whole-Building Simulations

As discussed in the building energy use and end-use load characterization analysis (section II.C of this ANOPR), the whole-building simulation analysis generates building energy consumption data for each hour of a typical meteorological year. For each of the 1,033 records in the building sample, DOE disaggregated the hourly whole-building energy consumption into the air conditioning energy consumption (*i.e.*, the consumption due to the compressor and condenser fan), the supply or ventilation fan energy consumption, and the energy consumption due to all other electric end-uses in the building. Since the supply fan is integral to commercial unitary air conditioning equipment, DOE included energy consumption for ventilation even during periods where mechanical cooling is not required for space-conditioning (*i.e.*, when the compressor is not operating).

(2) Electricity Price Analysis

The electric power industry is currently in a state of transition between two different business models, from regulated monopoly utilities providing bundled service to all customers in their service area, to a system of deregulated independent suppliers who compete for customers. While it is unclear when this transition will be finished, it is possible that in the future customers will see a very different pricing structure for electricity. To account for the impacts of this change on the LCC, DOE used two different electricity price models in this analysis. The first analysis uses information on utility tariffs for commercial customers collected in 2002. The Department based the second analysis on electricity production prices that vary on an hourly basis and used them to model a scenario in which customers are directly charged for the costs incurred by an electricity provider to supply energy for air conditioning. The Department refers to the two analyses as tariff-based and hourly based, respectively.

To account for the wide regional variation in electricity usage patterns, wholesale costs, and retail rates across the country, the Department divided the continental U.S. into 17 subdivisions. The breakdown started with the nine census divisions, which were further subdivided to take into account significant climate variation and the existence of different electricity market or grid structures. The Department based climate divisions on the nine climate regions defined for the continental U.S. by the National Climatic Data Center. It separated out Texas, Florida, New York, and California because their electric grids operate independently. Finally, it assigned each record from the 1,033 building sample to one of the 17 subdivisions. Both the tariff-based and hourly based approaches used the complete set of 1033 buildings to develop electricity prices.

(a) Tariff-Based Approach

The tariff-based analysis uses tariffs for commercial customers collected for a sample of 90 utilities across the country. The Department used three main criteria in developing the utility sample: (1) The sample of utilities should reflect the distribution of population across the country, with more utilities drawn from more populated areas; (2) the sample should reflect the proportion of customers served by privately owned utilities (investor-owned utilities (IOUs) and power marketers) versus publicly owned utilities (municipals, cooperatives, State, and Federal); and (3) the sample should cover as many customers as possible. The Department used data from DOE's Energy Information Administration (EIA) Form 861 filings for the year 2000 to determine the number of customers served by utilities of different types. The Department determined the representativeness of the sample by the percentage of the total number of commercial and industrial (C&I) customers who were covered. The sampled utilities serve 60 percent of the C&I customers of private utilities, and 14.4 percent of C&I customers for public utilities. The combined total for the U.S. is 48.5 percent of all C&I customers. For more detail on the tariff-based approach, refer to subsection 8.2.3.1 of the ANOPR TSD.

Pacific Gas and Electric (PG&E), ACEEE, NRDC, OOE, and NWPPC stated that electricity prices should reflect actual rates faced by customers. (Public Workshop Tr., No. 2EE at p. 202; ACEEE, No. 10 at p. 4; NRDC, No. 6 at pp. 4–5; Public Workshop Tr., No. 2EE at pp. 197 and 210; Public Workshop Tr., No. 2EE at p. 195) All but PG&E commented that electricity rates used in the LCC analysis must reflect demand or peak load pricing as well as time-of-use (TOU) or time-of-day (TOD) pricing. (ACEEE, No. 10 at p. 4; NRDC, No. 6 at pp. 4–5; Public Workshop Tr., No. 2EE at pp. 197 and 210; Public Workshop Tr., No. 2EE at p. 195) The OOE also stated that electricity prices should be based on marginal rates. (Public Workshop Tr., No. 2EE at pp. 194 and 195) Counter to the above comments, Southern Company stated that pricing strategies will be much more simple in a deregulated electricity market, so [DOE] should not consider real-time or TOU pricing in the analysis. (Public Workshop Tr., No. 2EE at p. 194)

The Department collected tariff documents for the 90 utilities in the sample to establish the actual electricity prices paid by commercial air conditioner customers. The tariff documents encompassed a variety of pricing strategies, including TOU rates. Because the Department did not want to speculate whether TOU rates would exist in a partially or fully deregulated market, DOE kept TOU rates in the tariff-based analysis. As will be described below, based on the electricity prices described in the tariffs, marginal pricing is the basis for establishing electricity expenses in the LCC analysis. For most of the utilities in the sample, the Department collected tariff documents directly from their web sites. When web documents were not available, the Department contacted the utilities directly. An archive of the tariff documents is available at: *http://eetd.lbl.gov/ea/ees/tariffs/index.php*. The tariff documents reflect actual rates that customers pay for electricity.

Utility companies have many tariffs separated into residential, non-residential, and special-use, such as public street-lighting or agricultural uses. Typically, a specific tariff is assigned to a particular customer based on that customer's annual peak demand. Following common utility practice, in the tariff analysis the Department combined commercial and industrial customers into one category. The Department's sampling strategy was to take the default tariff for each customer type, including TOU tariffs where appropriate. The Department assigned every building in the 1033 building simulation sample to one of the 17 subdivisions, and treated each building as a single customer. To increase the sample size and avoid bias in the electricity bill calculations, the Department assigned each customer to each utility in its subdivision. In other words, if the Department assigns six utilities to a particular subdivision, it then assigns the default tariff from each of the six utilities to each customer residing in that subdivision. Then the Department calculates an electric utility bill from each tariff assigned to the customer (the calculation of customer bills is explained below). Because the Department assigned, on average, almost six utilities to each of the 17 subdivisions, the above customer assignment method enabled the Department to effectively expand its building sample from 1033 to 6178 buildings. The particular tariff assigned to each customer was based on the annual peak demand for the base case EER level. The Department kept the customer on the same tariff for all standard levels.

For each of the 1033 buildings simulated, the Department processed the hourly simulation data for each standard level to compute the peak demand and total energy consumption for the 12 calendar months. For buildings assigned to TOU tariffs, DOE re-processed the hourly data to compute the peak demand and total energy consumption for the 12 calendar months during the peak, off-peak, and shoulder hours as defined by the utility. The Department entered into a bill-calculating spreadsheet tool that estimated the total customer bill in each month. The Department repeated the calculation for each standard level and then totaled the monthly bills to arrive at an annual electricity bill. The difference between the annual bills for each standard level gave the associated operating cost savings. To compute the base case air conditioning expense, DOE took the annual bill and multiplied it by the ratio of the total air conditioning energy use to the total building electricity use. It calculated customer marginal prices as the net change in the total bill divided by the net change in energy consumption between two standard levels. The Department implemented a version of the "Bill Calculator" in a spreadsheet that includes customer data for a set of representative buildings. Interested parties can get the Bill Calculator spreadsheet at *http://eetd.lbl.gov/ea/ees/tariffs/index.php*.

Lennox commented that the energy analysis does not include the effect of units operating on industrial tariffs. In particular, Lennox stated that: (1) The building set analyzed is a subset of the CBECS data set for commercial buildings; (2) the exclusion of manufacturing sites excludes 30 percent of the electricity used for cooling; and (3) the average rate for electricity in buildings specified in the MECS is 40 percent less than in CBECS buildings. As a result, Lennox commented that the energy analysis overstates the cost of energy consumption by 10 to 15 percent and has the effect of biasing the life-cycle cost and payback period analyses so that higher efficiency levels would look more favorable to customers. (Lennox, No. 15 at p. 1)

Overall, while the Department agrees that the analysis would be improved by explicitly considering industrial buildings, it does not believe that this will result in a meaningful change to the LCC results.

First, the tariff data collection and analysis do, in fact, include the effect of units operating on industrial tariffs. Through its research, DOE found that utilities typically do not distinguish between commercial and industrial customers in their tariffs. Instead, utilities assign customers General Service tariffs where customer classes are based on annual peak load. The Department's analysis for this ANOPR included only tariffs for customers taking electrical service at secondary voltage, which represents the largest non-residential customer sub-class. The Department understands that utilities could charge different rates to customers taking service at primary voltage and plans to expand its database to include them, although only about 10 percent of utility customers are on primary voltage tariffs.

Concerning the issue of industrial electricity rates, Lennox cited EIA data on estimates of U.S. electric utility average revenue per kWh as the basis for its statement that the average electricity rate for industrial/manufacturing buildings is 40 percent less than that for commercial buildings. (Lennox, No. 15 at p. 1) The Department's analysis for this ANOPR confirms the Lennox observations and shows that the average revenues per kWh for the commercial and industrial categories are 7.4 cents/kWh and 4.6 cents/kWh, respectively. However, because of ambiguities in the definition of customer type and the weighting of customer electricity bills, the Department believes that 4.6 cents/kWh cannot be a proxy for the marginal price charged to customers in industrial buildings. For example, EIA calculates average electricity rates by dividing total electricity revenues by total sales, which is equivalent to assigning equal weight to each kWh sold and giving much greater weight to large consumers. Since most consumers in the Department's analysis are relatively small, DOE believes that EIA's weighting greatly exaggerates the effect of any difference in the per-kWh average price paid by industrial and commercial customers. Also, the Department believes that the average electricity rate is not appropriate for an LCC analysis because energy savings are priced at marginal rates that are heavily dependent on both the building load and the marginal load for a particular end use. The Department's analysis, as detailed in the LCC section (Chapter 8) of the ANOPR TSD, found no clear dependence of the marginal price on the size of the customer. As a result, the Department sees no reason that customers with large peak loads will automatically see significantly lower marginal prices.

Lennox commented that excluding manufacturing sites from the DOE analysis excludes 30 percent of the energy used for cooling. (Lennox, No. 15 at p. 1) According to Manufacturing Energy Consumption Survey (MECS) of 1998, the industrial contribution to the total of commercial and industrial buildings facility heating, ventilating, and air conditioning energy use is about 30 percent. It is likely that manufacturers ship a much smaller percentage of the commercial unitary air conditioning equipment within the scope of this rulemaking to industrial buildings because, on average, industrial buildings are larger than commercial buildings and there is some correlation between building size and equipment size. Therefore, it is not expected that industrial buildings will use a large fraction of unitary air conditioners in the >65,000 Btu/h to <240,000 Btu/h range for their air conditioning needs.

Section II.D.1 addresses the impact of industrial/manufacturing facilities on the Department's analysis and is addressed as Issue 5 under the list of ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR. Also, in view of the above issues concerning industrial tariffs and their impact on electricity prices, the Department had an independent third-party expert review its analysis for this ANOPR. The results of the third-party review are available to interested parties on the Department's website at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html*. The Department intends to make the results of that review available for public comments concurrently with this ANOPR.

In summary, the Department made approximations that led both to over- and under-estimations of electricity prices. Moreover, the Department believes that the results are uncertain but not biased. In making further refinements to the LCC and PBP analyses, the Department believes that it is important not to introduce bias by including only refinements that lower the electricity price. Issues such as primary voltage tariffs, de-correlation between the hour of building peak load and air conditioning peak load, putting small buildings on large-building tariffs, using a distribution of fan power ratio, and so forth are second-order effects that tend to lower the energy cost savings. There are other second-order effects, such as sales taxes, seasonal ratchets, and additional riders (particularly fuel cost adjustments) that, when included, tend to raise the energy cost savings. The Department believes that all these effects have roughly the same order of magnitude and the net effect of their inclusion in the calculation of the LCC will be to reduce uncertainty but leave the results essentially unchanged.

(b) Hourly Based Approach

The goal of the hourly based electricity price analysis was to estimate the real cost of meeting air conditioning loads for each building in each subdivision, and to translate these to cost savings that result from a given standard level. In this analysis, the Department treated each subdivision as if it were a single electricity system or control area, with a single hourly varying marginal generation price. The dependence of system load on weather, and system price on load, creates a correlation between the weather-sensitive air conditioning load in each building and the time-varying generation marginal price. This substantially increases the cost of meeting air conditioning loads relative to base loads. Because DOE carried out the building simulations using Typical Meteorological Year (TMY) weather data to represent the correlations correctly, the Department had to produce a set of corresponding TMY system loads and prices for each subdivision. This was done by constructing a model for the load/temperature relationship, and a model for the price/load relationship, from historical data.

The analysis required hourly data for customer loads, local temperatures, system loads, and system prices. The Department took customer loads from the building simulations described above. Historical data on hourly loads are available to the public from the Federal Energy Regulatory Commission (FERC) website through Form 714 filings. See *http://www.ferc.gov/docs-filing/eforms-elec.asp#714*. Historical data on hourly prices come from two sources: Annual data submitted to FERC from regulated utilities and data developed from independent system operator websites. The FERC requires that each year a regulated utility submit FERC Form 714, which includes the ''control area hourly system lambda'' for each hour of the year in dollars per megawatt. A system lambda is the price of generating one additional unit of electricity. In the FERC Form 714, the system lambda represents the cost to meet the next kilowatt of load, as computed for the local control area of a particular utility using FERC's automatic dispatch methodology. For areas in which there is substantial wholesale electricity market competition, *e.g.*, New England, New York, California, and Pennsylvania-New Jersey-Maryland (PJM), DOE collected load data and day-ahead market clearing prices directly from the independent system operator (ISO) websites. The analysis used data from 2000 for New York, PJM, and New England, and from 1999 for all other areas. The analysis required two types of weather data: Historical and year-typical data. The Department purchased historical data used to construct the models for the years 1999 and 2000 from the National Climatic Data Center. Refer to ANOPR TSD section 8.2.3.1.3 for more information.

The Department computed the energy-cost savings due to a given standard level, assuming that the electricity provider passed all savings on to the customer. The savings have two components: Avoided generation costs and avoided capacity costs. The Department computed avoided generation costs as the sum over each hour of the customer's marginal energy savings times the hourly marginal price, multiplied by factors accounting for additional costs that scale with generation (such as ancillary services) and energy losses. The Department computed the total avoided capacity costs as a total cost per kilowatt of capacity times the customer's load reduction during the hour of the system peak. The total cost per kilowatt for capacity included generation, transmission, and distribution capacity, and factors that account for losses and reserve margins. The Department converted the electricity provider's avoided capacity costs to annual customer savings by applying a fixed charge rate (FCR). The FCR is a factor that converts a given capacity investment to the annual revenue requirement needed to cover all costs associated with the investment. In deregulated wholesale markets, hourly prices are assumed to include a margin to cover generation capacity investments, so DOE did not include these costs in the model. Instead, the Department computed reductions to the electricity provider's annual installed capacity payments that result from the standard. For more detail on the hourly based approach, refer to subsection 8.2.3.1.3 of the ANOPR TSD. The computation of the hourly price is Issue 9 under "Issues on Which DOE Seeks Comment" in section IV.E of this ANOPR.

(c) Comparison of Tariff-Based and Hourly Based Prices

Table II.9 summarizes the results for the Department's electricity price analysis for both the tariff-based and hourly based methodologies. The Department computed the marginal price associated with air conditioning loads in each subdivision by taking the ratio for each building of the total cost savings to the total energy-savings between standard levels 9.5 EER and 11.0 EER. The Department then computed the weighted-average value for each subdivision. The table also includes the percentage of the marginal price attributable to demand charges for the tariff-based analysis and to capacity charges for the hourly based analysis.

TABLE II.9.—MARGINAL PRICES COMPUTED FROM AIR CONDITIONING LOAD REDUCTIONS USING THE TARIFF-BASED AND HOURLY BASED ELECTRICITY PRICE MODELS

Subdivision	Weight	Census division	Region	Tariff-based		Hourly based	
				Marginal ¢/kWh	% Demand	Marginal ¢/kWh	% Capacity
1	4.7	New England	New England	9.5	53	10.7	43
2.1	7.4	Middle Atlantic	New York	14.6	53	10.5	35
2.2	5.6	Middle Atlantic	PA, NJ	10.5	27	8.7	48
3	13.7	East North Central	WI, IL, IN, OH, MI	10.8	46	11.0	65
4.1	0.8	West North Central	MN, IA, MO	6.2	44	8.4	60
4.2	4.7	West North Central	ND, SD, NE, KS	7.1	30	9.8	60
5.1	5.6	South Atlantic	DE, MD, VA, WV	7.9	41	9.9	63
5.2	7.9	South Atlantic	NC, SC, GA	7.3	22	7.4	68
5.3	6.6	South Atlantic	Florida	8.0	36	11.0	66
6.1	5.1	East South Central	KY, TN	6.5	38	8.0	68
6.2	5.4	East South Central	MS, AL	6.1	39	12.8	70
7.1	5.3	West South Central	OK, AR, LA	5.8	26	11.6	76
7.2	9.5	West South Central	Texas	10.0	23	10.8	75
8.1	0.6	Mountain	MT, ID, WY	6.1	20	4.5	43
8.2	4.2	Mountain	NV, UT, CO, AZ, NM	8.8	35	9.5	69
9.1	1.7	Pacific	WA, OR	4.5	33	5.4	24
9.2	11.2	Pacific	California	18.5	21	8.5	46
USA	100.0		USA	10.0	35	9.9	60

As Table II.9 shows, the national average effective marginal prices computed from the two approaches are relatively close (within one percent). Thus, on a national basis, the estimated marginal electricity price a provider would charge customers to supply electricity for an air conditioning end use is not substantially different from the price a customer currently pays under today's tariffs. As a result, the LCC results from the two different approaches are not significantly different. The LCC results are discussed later in this section. Also, for more detail on the results of the tariff-based and hourly based electricity price analysis, refer to subsection 8.2.3.1.4 of the ANOPR TSD.

(3) Electricity Price Trend

The electricity price trend in this ANOPR provides the relative change in electricity prices for future years out to the year 2035. The ACEEE and ASE commented that future electricity prices will be difficult to forecast during a period of electricity price restructuring and early indications show that there will be greater price volatility under deregulated markets. To substantiate its assertion of higher electricity rates in deregulated electricity markets, ACEEE referred to a report by Synapse Energy Economics, ''Marginal Price Assumptions for Estimating Customer Benefits of Air Conditioner Efficiency Standards,'' December 4, 2000, which demonstrates that summer, daytime, wholesale electric prices exceeded average prices by 2.5 ¢/kWh more than annual average wholesale prices and, as markets restructure, suppliers will increasingly pass these higher summer prices on to consumers as higher rates. Refer to *http://www.synapse-energy.com/publications.htm#repo*. The ACEEE also commented that price projections from EIA would not, at this time, be a good indicator of future electricity prices. (ACEEE, No. 10 at pp. 4 and 10; ASE, No. 9 at p. 2)

Rather than speculate on how current volatility in energy markets will affect future electricity prices, DOE has consistently relied on EIA energy price forecasts and has used other forecasts, including the various EIA scenarios, to delimit the energy prices used in standards analyses. For this commercial unitary air conditioner analysis, DOE applied a projected trend in national average electricity prices to each customer's marginal energy expenses. The default electricity price trend scenario used in the LCC analysis is the trend from EIA's *Annual Energy Outlook (AEO) 2003* Reference Case, which presents forecasts or energy supply, demand, and prices through 2005. Spreadsheets used in determining the LCC can be useful tools in evaluating other electricity price trend scenarios, namely, the *AEO 2003* High and Low Growth price trends and constant energy prices. The high economic growth case incorporates higher population, labor force, and productivity growth rates than the reference case. Due to the higher productivity gains, inflation and interest rates are lower compared to the reference case. Investment, disposable income, and industrial production are increased. Projections indicate that economic output will increase by 3.5 percent per year. The low economic growth case assumes lower population, labor force, and productivity gains, with resulting higher prices and interest rates and lower industrial output growth. In the low economic growth case, projections indicate that economic output will increase by 2.4 percent per year over the forecast horizon. The Department will update the analyses conducted for the NOPR to reflect the most recently available AEO.

The *AEO 2003* recognizes that, over the past few years, energy markets have been extremely volatile. (See U.S. Department of Energy-Energy Information Administration (EIA), Annual Energy Outlook 2003 with Projections to 2025, DOE–EIA–0383(2003), January 2003. EIA website: *http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2003).pdf*.) As a result, *AEO 2003* incorporates recent energy market volatility in its short-term projections. The impact of recent energy market volatility is evidenced from the average commercial electricity price estimated by *AEO 2003* for the year 2001. The average rate estimated by *AEO 2003* for 2001 is 5.7 percent greater (or 0.4 ¢/kWh) than that estimated by the *AEO 2000*.[2] Although the *AEO 2003* short-term projections took into account recent events, EIA expects that long term volatility in energy markets will not occur from such future events as supply disruptions or political actions. In other words, EIA estimates that recent electricity market volatility will not impact long term electricity price trends.

Concerning Synapse Energy Economics' wholesale electricity price analysis, DOE does recognize that wholesale summertime electricity costs are on average 2½ ¢/kWh greater than average wholesale costs. The Department's own analysis of hourly based electricity prices showed that marginal generation costs for commercial air conditioning ranged from 0.4 to 3.2¢/kWh greater than average generation costs, depending on regional location. Although generation costs associated with supplying electricity to commercial air conditioning are higher than average generation costs, the national average of resulting customer marginal electricity rates (based on the Department's methodology for converting generation costs into customer rates) is no greater than the national average of those marginal rates derived from current electric utility tariffs. Although the marginal electricity rates can be higher than average rates, the Department sees no reason to adjust EIA's projections of future electricity prices. For more detail on electricity price trend, refer to subsection 8.2.3.2 of the ANOPR TSD. The Department's reliance on EIA's electricity price projections is addressed as Issue 10 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

[2] In the AEO 2003, EIA reports 2001 electricity prices from their ''*Annual Energy Review 2001*.''

(4) Repair Cost

The repair cost is the cost to the consumer for replacing or repairing components in the air conditioning equipment that have failed. The Department estimated the annualized repair cost for baseline efficiency commercial unitary central air conditioning equipment (*i.e.*, the cost the customer pays annually for repairing the equipment) as half of the equipment price divided by the average lifetime of the equipment. Because data were not available to show how repair costs vary with equipment efficiency, the Department considered two scenarios: repair costs that varied in direct proportion with the manufacturer price of the equipment, and repair costs that remained flat (*i.e.*, did not increase with efficiency).

The Department used repair costs that vary with manufacturer price as the default annualized repair cost scenario in the LCC and PBP analysis. The resulting weighted-average annualized repair cost is $151 and $279 for 7.5-ton and 15-ton commercial unitary central air conditioners, respectively. The repair cost increases with weight and efficiency. Because equipment prices are a function of distribution variables rather than single point-values (*i.e.*, manufacturer price, markups, and sales tax), repair costs reflect a distribution of values. For more detail on repair cost, refer to subsection 8.2.3.3 of the ANOPR TSD.

(5) Maintenance Cost

Maintenance cost is the cost to the commercial consumer of maintaining equipment operation. It is not the cost associated with the replacement or repair of components that have failed (this is covered by the repair cost discussed above). Rather, the maintenance cost is associated with general maintenance (*e.g.*, checking and maintaining refrigerant charge levels and cleaning heat-exchanger coils).

The Department took annualized maintenance costs for commercial air conditioners from data in *RS Means Facilities Maintenance & Repair Cost Data, 1995* (RS Means '95). These data provide estimates of person-hours, labor rates, and materials required to maintain commercial air conditioning equipment. Because data were not available to show how maintenance costs vary with equipment efficiency, the Department decided to use costs that stayed constant as equipment efficiency increased. The estimated, nationally representative, annualized maintenance cost for a commercial unitary air conditioner rated between 36,000 Btu/h and 288,000

Btu/h is $200. For more detail on maintenance cost, refer to subsection 8.2.3.4 of the ANOPR TSD.

ARI believes that the annual maintenance cost that the Department developed is too low. ARI states that commercial air conditioning units need servicing not less than four times per year for filter check/replacement and general cleanliness. As a result, the annual cost is closer to $800 per unit rather than $200. (ARI, No. 14 at p. 3)

As noted above, the Department based the annualized maintenance costs for commercial air conditioners on RS Means '95 data. In addition to providing estimates of person-hours, labor rates, and materials required to maintain commercial air conditioning equipment, RS Means '95 specifies eleven actions that constitute required annual maintenance, including a thorough check of all components in the unit. Because RS Means '95 provides an explicit accounting of the actions and costs of maintaining commercial unitary central air conditioning equipment, and no commenter has done so, the Department will retain its use of $200 annual maintenance cost in its analysis.

(6) Lifetime

The Department defines lifetime as the age at which a commercial unitary air conditioner is retired from service. It based the median lifetime of commercial unitary air conditioners on data from the 1999 *ASHRAE HVAC Applications Handbook*, which estimates a median lifetime of 15 years for commercial unitary air conditioners. The Department found no other data to show a different median lifetime for commercial unitary air conditioning equipment. Because a range of values rather than a single-point value more accurately represents the lifetime of such equipment, DOE created a survival function for commercial unitary air conditioners based on data for residential heat pump systems. Although residential heat pump systems are smaller in cooling capacity than commercial air conditioners, they are vapor compression systems that have components and designs that are similar to those of commercial systems. Thus, DOE believes that residential heat pumps provide a valid basis from which to construct a survival function for commercial unitary air conditioners. The Department created a Weibull distribution to approximate the actual survival function for residential heat pumps. The Department then modified the approximated residential-heat-pump-based survival function to yield a median lifetime equal to that for commercial air conditioners. The mean lifetime from the derived Weibull-based commercial air conditioner survival function is 15.4 years. For more detail on the lifetime analysis, refer to subsection 8.2.3.5 of the ANOPR TSD.

ARI provided an analysis of EIA's 2001 Residential Energy Consumption Survey (RECS) to show that the median life of air conditioning equipment is 7 years, as opposed to 15 years. Acknowledging the difficulty in getting lifetime data for commercial unitary air conditioning equipment, ARI stated that, although the RECS data are based on residential equipment, they are the best available surrogate data for commercial air conditioning. (ARI, No. 14 at p. 2)

After reviewing ARI's analysis, the Department determined that the data in RECS represent the age of the equipment, not the age at which the equipment was retired from service (*i.e.*, the equipment lifetime). In view of this important distinction, the equipment lifetime required for the commercial unitary air conditioner analysis is the operational life of the equipment. The RECS data do not represent the lifetime, rather, they simply represent the age of the equipment at the time of the survey. Thus, even if DOE assumes that the residential equipment data are a surrogate for commercial unitary air conditioning, the RECS data are not useful for establishing equipment lifetime. The Department continues to seek input from interested parties concerning equipment lifetime. This concern is addressed in Issue 11 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

(7) Discount Rate

The discount rate is the rate at which DOE discounted future expenditures to establish their present value. Both ACEEE and NRDC commented that DOE should use the weighted-average cost of capital (or the avoided return on capital) as the basis for estimating discount rates. (ACEEE, No. 10 at p. 6; NRDC, No. 6 at pp. 8 and 9) In stating that there is a wide range of expected payback periods for investments made in the commercial sector, Southern Company also appeared to imply that discount rates should be based on the weighted-average cost of capital. (Public Workshop Tr., No. 2EE at p. 119) The NRDC added that a valid estimate of market rates of return on capital investments requires a long-term perspective to factor out risk and short-term market volatility. It also noted that, when adjusting for survivorship biases and transaction costs, real rates of return on investments should range from zero to five percent, even for risky corporate investments. (NRDC, No. 6 at pp. 8–9) Advocating an approach based on the cost of capital, ACEEE also stated that discount rates used in the process of setting equipment standards for the ASHRAE/IESNA Standard 90.1–1999 were too high. (ACEEE, No. 10 at pp. 6 and 11) The Alliance to Save Energy concurred with ACEEE about the discount rates used in the process to update the ASHRAE/IESNA Standard 90.1–1999 equipment standards. (ASE, No. 9 at p. 2) Although not advocating a specific approach for developing discount rates, Trane stated that discount rates in the range of 12–15 percent are appropriate for users of commercial unitary air conditioning. Trane also noted that the Department should consider income tax effects if it intends to include them in the development of discount rates. (Public Workshop Tr., No. 2EE at pp. 189–190)

The Department believes the most accurate method for estimating the discount rate is by evaluating the cost of capital of companies that purchase commercial unitary air conditioning equipment. Most companies use both debt and equity capital to fund investments. Therefore, for most companies, the discount rate is the weighted average cost of debt and equity financing, or the weighted-average cost of capital (WACC), less the expected inflation. The Department calculated the expected inflation (2.3 percent) from the average of the last five quarters' change in gross domestic product (GDP) prices.

Because the WACC method is specific to commercial firms, the technique is specific to commercial equipment and, therefore, was not applied in past rulemakings covering residential products. However, recent residential product rulemakings, specifically central air conditioners and heat pumps, use a discount rate technique that is conceptually similar to the WACC methodology. The technique for residential products determines how an air conditioner or heat pump purchase would affect a household's financial situation, which is similar to what the WACC method attempts to do for commercial firms. (See U.S. Department of Energy, Energy Efficiency and Renewable Energy: *Technical Support Document: Energy Efficiency Standards for Consumer Products: Residential Central Air Conditioners and Heat Pumps (Including: Regulatory Impact Analysis)*, May, 2002, Washington, DC, Chapter 5, p. 5–71, at *http://www.eere.energy.gov/buildings/appliance_standards/residential/ac_central.html*.) For more detail on the discount rate for future expenditures, refer to subsection 8.2.3.6 of the ANOPR TSD.

Lennox questioned who the consumer is and who would benefit from a life-cycle cost analysis: The person that owns the commercial unitary air conditioner, the person that owns the building, or the person that leases the building? Lennox then stated that consumers more often lease this equipment, which needs to be factored into the analysis. (Public Workshop Tr., No. 2EE at pp. 118 and 199) Trane and NRDC also addressed the issue of the user's identity. Trane noted that the analysis should encompass all users, whether they are building owners or occupants. The NRDC stated that a split incentive exists between building lessees and owners, *i.e.*, there is no incentive for building owners to purchase more efficient equipment because the lessee is paying the electricity bill. As a result, the market fails to encourage the use of more efficient air conditioning equipment, and standards are a way to correct this market failure. (Public Workshop Tr., No. 2EE at p. 215; NRDC, No. 6 at p. 5)

In addressing the user's identity, the Department included both building owners and lessors in its development of discount rates, established a sample of companies that use commercial air conditioning according to ownership categories, and collected pertinent financial data from those companies to derive an appropriate set of discount rates. Ownership here is defined by the building occupant. Included in these ownership categories are the owners of commercial buildings (property owners), retail firms, medical service and hospital companies, industrial firms, hotels, and food service companies (restaurants and grocery stores). The Department determined ownership shares by building square footage from the 1999 CBECS data. According to CBECS, about 60 percent of buildings are owner-occupied and the remaining 40 percent either are non-owner-occupied or leased by property owners. Of the 40 percent of buildings that are leased, half realized a WACC based on the building's occupancy, and the other half realized discount rates based on the WACC of the property owner. Pertinent financial data from companies using commercial air conditioning equipment were taken from Damodaran Online. (See Damodaran Online at *http://pages.stern.nyu.edu/~adamodar/New_Home_Page/data.html* and the ''compfirm.xls'' spreadsheet.)

The NRDC commented that values of 0 to 5 percent were appropriate, while Trane maintained that DOE should use values ranging from 12 to 15 percent. (NRDC, No. 6 at pp. 8 and 9; Public Workshop Tr., No. 2EE at pp. 189 and 190) Deducting expected inflation from the cost of capital provides estimates of the real discount rate by ownership category, shown in Table II.10. The mean real discount rate for these companies varies between 3.0 percent (public for-profit) and 7.3 percent (public not-for-profit). The weighted-average or mean discount rate across all companies is 6.1 percent. The Department's approach for estimating the cost of capital provides a measure of the discount rate spread as well as the average discount rate. The discount rate spread by ownership category represented by the standard deviation ranges between 0.7 percent and 3.2 percent. Thus, the variability in the discount rate is as low as less than 1 percent and as high as 14 percent. By characterizing the discount rates with probability distributions based on a standard deviation, the range of discount rates used in the analysis captures almost the full breadth of values suggested by the interested parties.

TABLE II.10.—REAL DISCOUNT RATES BY OWNERSHIP CATEGORY*

Ownership category	Standard industrial classification (SIC) code	Ownership shares (percent)	Mean real discount rate (WACC) (percent)	Standard deviation (percent)	Number observations
Retail stores	53, 54, 56	16.5	7.1	2.1	218
Property owners and managers	6720	21.2	5.2	0.7	11
Medical services	8000	6.7	7.0	1.7	115
Industrial companies	1000–4000	4.9	6.9	3.2	253
Hotels	7000	4.0	5.6	1.5	51
Food service companies	5400, 5812	5.3	6.1	1.4	88
Office/Service sector	5910–9913	19.4	6.9	2.1	128
Public for profit	N.A	11.0	3.0	0.7	41
Public not for profit	7950, 8299	11.0	7.3	1.8	68
Weighted Average		N.A	6.1	1.6	N.A.

*Sources: CBECS (1999), Damodaran Online (2002) and LBNL calculations.

(8) 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 covered equipment. (See 10 CFR 430.2.) In accordance with 42 U.S.C. 6313(a)(6)(C), the effective date of any new energy efficiency standard for commercial unitary air conditioners and heat pumps that is established by rule and that is more stringent than the amended ASHRAE/IESNA Standard 90.1, is four years after the final rule is published in the **Federal Register**. Consistent with its published regulatory agenda, the Department assumed that the final rule would be issued in 2004 and that, therefore, the new standards would take effect in 2008 and used these dates in the ANOPR analyses. For the NOPR analyses, the Department will adjust these dates to accurately reflect then-current expectations for the timing of the issuance of a final rule. The Department calculated the LCC for customers as if each new commercial unitary air conditioner or heat pump purchase occurs in the year the standard takes effect. For purposes of conducting the analyses for this ANOPR, it based the cost of the equipment on year 2008; however, because the Department collected manufacturing cost data for the ANOPR engineering analysis in 2001, it expresses all dollar values as year 2001 dollars. Also, the effective date of a standard is addressed in subsection 8.2.3.7 of the ANOPR TSD.

2. Inputs to the Payback Period Analysis

The data inputs to the PBP analysis 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 analysis uses the same inputs as the LCC analysis, except that the PBP analysis does not need electricity price trends and discount rates. Because the PBP is a ''simple'' payback, the required electricity rate is only for the year in which a new standard is to take effect, in the case of this ANOPR the year 2008. The electricity rate that DOE used in the PBP calculation was the price projected for that year. For more detail on payback period inputs, refer to section 8.3 of the ANOPR TSD.

3. Preliminary Results

The preliminary results of the LCC and PBP analyses are based on: (1) A sample of commercial buildings that represent all unitary air conditioner users; (2) output from the engineering, building simulation, and equipment price analyses; and (3) on current electric utility tariffs.

a. Life-Cycle Cost Results

This section presents LCC results for the efficiency-improvement levels specified in the engineering analysis. It provides only the LCC results from the tariff-based approach because the national average tariff-based and hourly based marginal electricity prices are so similar (refer to Table II.9). The hourly based approach provides important information because today's electric utility tariffs reflect, to some extent, the prices an electricity provider might charge a commercial customer for supplying electricity to operate a unitary air conditioner under an hourly based pricing structure. However, the hourly based prices are still an estimate and are not the actual electricity prices that commercial customers pay. As a result, the Department is designating the tariff-based approach as the primary analysis approach because it is based on electricity prices that commercial customers must actually pay for operating air conditioning equipment. The Department will use the hourly based approach as supplemental information that indicates what electricity pricing might be like under an hourly regime. The hourly based LCC results are very similar to the results from the tariff-based LCC analysis. For more detail on the results of the tariff-based and hourly based approaches to electricity prices, refer to sections 8.4 and 8.5 of the ANOPR TSD.

Most of the inputs to the LCC analysis are uncertain and are therefore represented by a distribution of values rather than a single-point value. As a result, the LCC analysis generates a distribution of results to represent the LCC for any given efficiency level.

The Department's first step in developing LCC results was to establish the baseline LCC for each of the two commercial air conditioner equipment classes. As noted earlier, DOE selected the ASHRAE/IESNA Standard 90.1–1999 levels as the baseline efficiency levels for the present rulemaking. Table II.11 summarizes the baseline distributions by showing the mean, median, minimum, and maximum LCCs.

TABLE II.11.—BASELINE LCC

Equipment class	Minimum	Median	Mean	Maximum
≥65,000 to <135,000 Btu/h	$6,667	$18,605	$20,514	$93,747
≥135,000 to <240,000 Btu/h	11,395	34,876	39,044	197,535

The Department presents the differences in the LCC of standard-level equipment relative to the baseline commercial unitary air conditioner design. The LCC differences are depicted as a distribution of values. Tables II.12 and II.13 show the mean and the percent of units with LCC savings for each standard level.

TABLE II.12.—SUMMARY OF LCC RESULTS FOR ≥65,000 TO <135,000 BTU/H COMMERCIAL UNITARY AIR CONDITIONERS

EER	Mean decrease in LCC from baseline (10.1 EER) (2001$)	Percent of units with LCC savings
10.5	$290	98
11.0	533	93
11.5	598	81
12.0	399	59

TABLE II.13.—SUMMARY OF LCC RESULTS FOR ≥135,000 TO <240,000 BTU/H COMMERCIAL UNITARY AIR CONDITIONERS

EER	Mean decrease in LCC from baseline (9.5 EER) (2001$)	Percent of units with LCC savings
10.0	$959	100
10.5	1,704	99
11.0	2,199	97
11.5	2,359	91
12.0	2,027	77

b. Payback Period Results

This section presents PBP results based on annual operating costs calculated from tariff-based electricity prices. Similar to the LCC differences, the Department depicts PBP results as a distribution of values. Tables II.14 and II.15 summarize the PBP results for each of the two commercial unitary air conditioner equipment classes.

TABLE II.14.—SUMMARY OF PBP RESULTS IN YEARS FOR ≥65,000 TO <135,000 BTU/H COMMERCIAL UNITARY AIR CONDITIONERS

EER	Median	Mean
10.5	2.3	2.6
11.0	3.1	3.5
11.5	4.3	5.1
12.0	6.4	8.1

TABLE II.15.—SUMMARY OF PBP RESULTS IN YEARS FOR ≥135,000 TO <240,000 BTU/H COMMERCIAL UNITARY AIR CONDITIONERS

EER	Median	Mean
10.0	1.5	1.6
10.5	1.8	2.0
11.0	2.4	2.7
11.5	3.2	3.7
12.0	4.5	5.5

G. National Impact Analysis

The national impacts analysis assesses the NPV of total customer LCC and NES. Assuming an effective date of 2008, the Department determined both the NPV and NES for all of the energy efficiency levels considered for the two equipment classes of commercial unitary air conditioners. ARI requested a quick adoption of the ASHRAE/IESNA Standard 90.1–1999 energy efficiency levels. (ARI, No. 14 at p. 3). The Department defined quick adoption to mean an effective date of 2004, instead of 2008. In this way, the Department can evaluate the national benefits of adopting more stringent standards at a later effective date compared to adopting the ASHRAE/IESNA 90.1–1999 standard levels almost immediately.

To make the analysis more accessible and transparent to all stakeholders, the Department prepared a user-friendly NES Spreadsheet Model in Microsoft Excel to forecast energy savings and the national economic costs and savings resulting from new standards. Consequently, a stakeholder can change certain input quantities to assess any impacts of possible new standards on the NES and NPV. Unlike the LCC Analysis, the NES Spreadsheet Model does not use probability distributions for inputs or outputs. To assess the impact of input uncertainty on the NES and NPV results, the DOE can conduct sensitivity analyses as needed for future analyses by running scenarios on input variables that are of interest to stakeholders. The Department conducted a preliminary assessment of the aggregate impacts at the national level for this ANOPR. For more detail on the NES and NPV, refer to Chapter 10 of the ANOPR TSD.

Table II.16 summarizes the inputs used to calculate the NES and NPV of the various energy efficiency levels. Chapter 10 of the ANOPR TSD provides a more detailed discussion of these inputs.

TABLE II.16.—SUMMARY OF NES AND NPV INPUTS

Parameter	Data description
Annual Energy Consumption per Unit	Annual weighted-average values are a function of efficiency level (established from the Building Simulation Analysis, section II.C) and efficiency trend (base case and standards case efficiencies as noted below).
Base Case Efficiencies	Annual shipment-weighted efficiencies are based on historical residential central air conditioner shipment-weighted efficiency trends and limited commercial air conditioner shipment-weighted efficiencies. Before 1993: Efficiency trend growth rate equivalent to 1982–1991 residential equipment efficiency trend. 1993–1994: Efficiency jump equivalent to 1991 to 1992 residential equipment efficiency jump. 1994–1998: Efficiency trend growth rate equivalent to 1992–1999 residential equipment efficiency trend. 1999–2001: Actual shipment-weighted efficiencies from ARI. 2002–2035: Efficiency trend growth rate equivalent to ½ of 1992–1999 residential equipment efficiency trend.
Standards Case Efficiencies (2008–2035)	Annual shipment-weighted efficiencies are based on a roll-up efficiency scenario and parallel growth trend.
Shipments	Annual shipments from shipments model (see details in section II.G.3).
Equipment Stock	Number of air conditioning units of each vintage (age). Based on annual shipments and the age of the equipment. The age of the equipment is characterized with a retirement function with an average lifetime of 15.4 years.
National Energy Consumption	Product of the annual energy consumption per unit and the stock (*i.e.*, the number of air conditioning units of each vintage.
Electricity Site-to-Source Conversion Factors	Conversion varies yearly and is generated by DOE/EIA's National Energy Modeling System (NEMS) program (a time series conversion factor; includes electric generation, transmission, and distribution losses).
Total Annual Installed Cost	Annual per unit weighted-average values are a function of efficiency level (established from the Life-Cycle Cost Analysis, section II.F). Total annual costs are the per unit cost multiplied by the shipments forecasted.
Total Annual Operating Cost Savings	Annual per unit savings consist of the per unit electricity cost savings, the per unit repair costs, and the per unit maintenance costs (as noted below). Total annual costs are the per unit cost multiplied by the shipments forecasted.
Annual Electricity Cost Savings	Annual per unit weighted-average values are a function of the annual energy consumption, electricity prices (established from the Life-Cycle Cost Analysis, section II.F), and electricity price trends. Only expenses based on tariff-based electricity prices are used in the NES spreadsheet model.
Electricity Price Trends	2003 EIA Annual Energy Outlook forecasts (to 2025) and extrapolation for 2025 and beyond (see the Life-Cycle Cost Analysis, section II.F).
Annual Repair Costs	Annual per unit weighted-average values are a function of efficiency level (established from the Life-Cycle Cost Analysis, section II.F).
Annual Maintenance Costs	Annual per unit weighted-average value equals $200 (established from the Life-Cycle Cost Analysis, section II.F).
Discount Factor	Based on both a 3 percent and 7 percent real discount rate and the year in which the present value of costs and savings are being determined.
Present Value of Costs	Annual total installed cost in each year discounted to the present using the discount rate.
Present Value of Savings	Annual operating cost savings in each year discounted to the present using the discount rate.
Present Year	Future expenses are discounted to year 2001.
Effective Date of Standard	2008 (2004 for ASHRAE/IESNA 90.1–1999 efficiency levels).

1. National Energy Savings (NES)

The Department calculated the national energy consumption by multiplying the number or stock of commercial unitary air conditioners (by vintage) by the unit energy consumption (also by vintage). Vintage is the age of the equipment (varying from one to about 30 years). The Department calculated annual NES from the difference between national energy consumption in the base case (without new standards) and each standards case (with standards). Cumulative energy savings are the undiscounted sum of the annual NES that DOE determined over specified time periods. The NES analysis which will accompany the NOPR will include both discounted and undiscounted values for future energy savings to account for their timing. For more detail on NES and consumer impacts, refer to Chapter 10 of the ANOPR TSD.

The stock of commercial unitary air conditioning equipment is dependent on annual shipments and the lifetime of the equipment. The Department developed shipments projections under a base case and standards cases for a variety of possible equipment efficiency scenarios and equipment efficiency trends. It determined that shipment projections under the standards cases were lower than those from the base case projection, due to the higher installed cost of the more efficient equipment. Higher installed costs caused some customers to forego equipment purchases. As a result, the Department used the standards case shipments projection and, in turn, the standards case stock to determine the NES and to avoid the inclusion of savings due to displaced shipments.

a. National Energy Savings Inputs

As summarized in Table II.16 above, the inputs for the determination of NES are: (1) Annual energy consumption per unit, (2) shipments, (3) equipment stock, (4) national energy consumption, and (5) electricity site-to-source conversion factors.

(1) Annual Energy Consumption per Unit

The annual energy consumption per unit is the energy consumed by a commercial unitary air conditioning unit per year. The annual energy consumption is directly tied to the efficiency of the unit. Thus, knowing the efficiency of a commercial unitary air conditioning unit allows for the determination of the corresponding annual energy consumption. As described below, the Department determined annual historical and forecasted shipment-weighted average equipment efficiencies which, in turn, allowed for the determination of shipment-weighted, annual, energy-consumption values.

The Department based historical, shipment-weighted, average efficiency trends for commercial air conditioners on a combination of commercial air conditioner efficiency data from 1999 through 2001 and residential central air conditioner efficiency trends. Once DOE established historical efficiency trends, it established future trends of equipment efficiency and, in turn, annual energy consumption by extrapolating it from the historical trend. The Department forecasted future trends of equipment efficiency for a base case and for standards cases. The difference in equipment efficiency between the base and standards cases was the basis for determining the reduction in per-unit annual energy consumption due to new standards. For more detail on annual energy consumption per unit, refer to subsection 10.2.2.1 of the ANOPR TSD.

The Department chose a growth rate for its forecasted, base-case efficiency trends of one-half the observed growth rate of the historical residential air conditioner efficiency trend during the 1990s. The Department made this decision based on observed trends in the historical commercial air conditioner efficiency data. The three years of commercial air conditioner efficiency data revealed a significant shift to higher equipment efficiencies from the year 2000 to 2001. Although the ASHRAE/IESNA 90.1–1999 standards are not mandatory, it appears that their effect has been to move the commercial air conditioner market to higher equipment efficiencies. Historical efficiency trends for residential central air conditioners indicate that the most significant effect of ASHRAE/IESNA 90.1–1999 standards on transforming the market is in the short term. In the case of residential central air conditioners, for years immediately after a new minimum standard became effective the shipment-weighted efficiencies grew at an annual rate of less than one percent. Therefore, if historical efficiency trends for related products and equipment are any indication, the growth rate of the commercial unitary air conditioner efficiency trend in the long term (*i.e.*, for years after 2001) should be much lower than the shift in equipment efficiencies observed between 2000 and 2001.

The Department based its standards case forecasts (*i.e.*, forecasts of efficiency trends after standards take effect) on a roll-up efficiency scenario and parallel growth trend. The roll-up scenario moves or rolls-up all equipment efficiency levels from below a prospective standard to the minimum efficiency level allowed under the new standard. The distribution of equipment at efficiency levels above the prospective standards is unaffected (*i.e.*, this equipment remains at its pre-standard efficiency levels). The roll-up efficiency scenario dictates how DOE determined efficiency distributions in the first year a new standard takes effect, but does not define future distribution of equipment efficiencies. Under the parallel growth trend, the Department assumes that the standards case efficiency trend parallels the base case efficiency trend. In other words, the initial jump in shipment-weighted efficiency that occurs when the standard first becomes effective carries on throughout the forecast.

The 11.5 EER and 12.0 EER standards-case efficiency trends are notable exceptions to the use of the parallel growth trend for the entire time span of the forecast (*i.e.*, through 2035). Because the maximum technologically feasible design is 12.0 EER, the maximum shipment-weighted efficiency for any given year is 12.0 EER. As a result, because the efficiency trend for the 11.5 EER standards case achieves a shipment-weighted efficiency of 12.0 EER in the year 2023, the forecasted efficiency trend remains flat from the year 2023 through 2035. In the case of the 12.0 EER standards case, there is a shipment-weighted efficiency of 12.0 EER immediately after the standard becomes effective. Thus, the efficiency trend is flat (*i.e.*, stays fixed at 12.0 EER) throughout the entire forecast.

(2) Shipments

The Department forecasted shipments for the base case and all standards cases. Forecasted shipments are addressed in subsection 10.2.2.2 of the TSD ANOPR. The Shipments Model is discussed in more detail in section II.G.3 of this ANOPR.

(3) Equipment Stock

The commercial unitary air conditioner stock is the number of unitary air conditioners purchased or shipped in a particular year that survive in a later year. The NES Spreadsheet Model keeps track of the number of commercial unitary air conditioners shipped each year. The Department assumes that commercial unitary air conditioners have an increasing probability of retiring as they age. The probability of survival, as a function of years after purchase, is the survival function. Commercial unitary air conditioner lifetimes, otherwise called the vintage, range from one to about 30 years, with an average value of 15.4 years. Note that the resulting stock of commercial unitary air conditioners under all standards cases is less than that under the base case due to the smaller number of shipments forecasted for the standards cases. For more detail on equipment stock, refer to subsection 10.2.2.3 of the ANOPR TSD.

(4) National Annual Energy Consumption

The national annual energy consumption is the annual energy consumption per commercial unitary air conditioner multiplied by the number of commercial unitary air conditioners of each vintage. This approach accounts for differences in unit energy consumption from year to year.

In determining national annual energy consumption, DOE initially calculated the annual energy consumption at the site (*i.e.*, electricity in kWh consumed by the commercial unitary air conditioning unit inside the building it is serving). The Department then calculated primary energy consumption from site energy consumption by applying a conversion factor to account for losses, such as those losses associated with the generation, transmission, and distribution of electricity. For more detail on national annual energy consumption, refer to subsection 10.2.2.4 of the ANOPR TSD.

(5) Electricity Site-to-Source Conversion Factors

To transform site energy savings into source energy savings, DOE uses electricity site-to-source energy conversion factors that vary from year to year. The Department based the annual source conversion factors used for the analysis conducted for this ANOPR on U.S. average values from the commercial sector, calculated from the *AEO 2003*. For analyses conducted in the future, the Department plans to use marginal conversion factors specific to the type of generation sources (*i.e.*, power plants) displaced from decreases in national energy consumption resulting from the use of more efficient commercial unitary air conditioners. The resulting conversion factors will change over time. For more information on electricity site-to-source conversion factors, refer to subsection 10.2.2.5 of the ANOPR TSD.

2. National Net Present Value

The NPV is the sum over time of discounted net savings. The national NPV of each candidate standards level is the difference between the base case national average LCC and the national average LCC in the standards case. For more detail on national net present value, refer to section 10.3 of the ANOPR TSD.

a. National Net Present Value Calculations

The Department calculated net savings each year as the difference between total operating cost savings (including electricity, repair, and maintenance cost savings) and increases in total installed costs (including equipment price and installation cost). The Department calculated savings over the life of the equipment, which accounts for the differences in yearly energy rates. The Department calculated the NPV as the difference between the present value of operating cost savings and the present value of increased total installed costs. It discounted future costs and savings to the present with a discount factor. The Department calculated the discount factor from the discount rate and the number of years between 2001 (the year to which DOE discounted the sum) and the year in which the costs and savings occur. An NPV greater than zero shows net savings (*i.e.*, the energy efficiency standard reduces customer expenditures in the standards case relative to the base case). An NPV that is less than zero indicates that the energy efficiency standard incurs net costs.

The elements of the NPV can be expressed in another form, as the benefit/cost ratio. The benefit is the savings in decreased operating cost (including electricity, repair, and maintenance), while the cost is the increase in the total installed cost (including equipment price and installation cost) due to standards, relative to the base case. When the NPV is greater than zero, the benefit/cost ratio is greater than one.

In the determination of the NPV, the Department calculated costs as the product of the difference in the total installed cost between the base case and standards case, and the annual sales volume or number of shipments in the standards case. Because costs of the more efficient equipment purchased in the standards case are higher than those of equipment purchased in the base case, price increases appear as negative values in the NPV.

The Department depicted monetary savings as decreases in operating costs associated with the higher energy efficiency of equipment purchased in the standards case compared to the base case. Total operating cost savings are the product of savings per unit and the number of units of each vintage surviving in a particular year. Savings appear as positive values in the NPV.

As noted earlier, the Department determined that shipment projections under the standards cases were lower than those from the base case projection, due to the higher installed cost of the more efficient equipment. As a result, DOE used the standards case shipments projection and, in turn, the standards case stock, to determine the NPV, to avoid the inclusion of operating cost savings and increased total installed costs due to displaced shipments.

b. Net Present Value Inputs

The inputs for the determination of NPV are: (1) Total annual installed cost, (2) total annual operating cost savings, (3) discount factor, (4) present value of costs, and (5) present value of savings. Net present value inputs are discussed below. Also, for more detail on net present value inputs, refer to subsection 10.3.2 of the ANOPR TSD.

(1) Total Annual Installed Cost

An increase in the total annual installed cost to the Nation is the annual change in the per-unit total installed cost (the difference between the base case and the standards case) multiplied by the shipments forecasted in the standards case. As noted earlier concerning the national energy savings, DOE used the standards case shipments forecast to avoid miscounting the reduction in shipments as a reduction in total installed costs.

The total installed cost includes both the equipment cost and the installation price, and is a function of equipment efficiency. The equipment cost includes the distribution markups (as determined in section II.E of this ANOPR) that are applied to the manufacturer costs estimated in the engineering analysis (section II.C of this ANOPR). The resultant equipment prices increase with equipment efficiency. The Department based average per-unit equipment costs on average manufacturer prices, multiplied by average overall markup values. With regard to installation prices, the Department varies installation prices in direct proportion to the weight of the equipment (section II.F.1.a of this ANOPR). The Department developed linear relationships of operating weight as a function of equipment efficiency for 7.5-ton and 15-ton commercial unitary air conditioners and assumed the installation price increased in the same proportion. It based average per-unit installation prices on nationally representative values for each of the two commercial unitary air conditioner equipment classes. Because DOE calculated the total installed cost as a function of equipment efficiency, it could determine historical and forecasted total installed costs based on the annual shipment-weighted efficiency levels specified in the base case and standards case efficiency trends.

(2) Total Annual Operating Cost Savings

The annual operating cost savings to the Nation is the annual change in the per-unit annual operating costs (the difference between base case and standards case) multiplied by the shipments forecasted in the standards case. As just noted earlier concerning the total annual installed cost, DOE used the standards case forecast to avoid miscounting the reduction in shipments as an operating cost savings. The annual operating cost includes the electricity, repair, and maintenance costs.

As described in the discussion of the LCC Analysis, the Department calculated annual electricity expenses based on two approaches: A tariff-based approach and an hourly based approach. The hourly based approach resulted in annual energy expenses which were, on average, less than one percent different from those in the tariff-based analysis. As discussed in section II.F.3.b. (LCC results), because the resulting national customer economic impacts from the two approaches would not be significantly different, the Department designated the tariff-based analysis as the primary analysis approach. Thus, the NPV calculations are based only on the results from the tariff-based approach.

The Department determined weighted-average per-unit annual energy expenses as a function of equipment efficiency. As discussed in the Building Simulation Analysis, Chapter 6 of the ANOPR TSD, DOE conducted whole-building simulations on a representative sample of commercial buildings that use commercial unitary air conditioning equipment. The Department assigned tariff-based electricity rates to each building to determine the annual energy expense for air conditioning in that building. Using the representative set of buildings, DOE performed a weighted-average calculation to arrive at the net present values as a function of equipment efficiency. The Department based the weighting not only on the representativeness of the building, but also on the representativeness of the electric utility to which the building was assigned, as well as the number of air conditioning units that were required to meet the simulated cooling load.

As discussed in the LCC Analysis, Chapter 8 of the ANOPR TSD, the Department based the average annual repair costs on the weight of the equipment, and in turn, the equipment efficiency, while it determined average annual maintenance costs to be $200 regardless of cooling capacity or efficiency level. Thus, annual maintenance costs did not factor into the determination of the total operating cost savings.

Because the Department calculated the annual energy expense and repair costs as a function of equipment efficiency, it could determine historical and forecasted annual energy expenses and repair costs based on the annual shipment-weighted efficiency levels specified in the base case and standards case efficiency trends. Further, the Department characterized each standards case with three efficiency scenarios and three growth trends, and from them it developed annual energy expense and repair cost trends for a total of nine standards cases for each possible new standard.

(3) Discount Factor

The discount factor is the factor by which DOE multiplied monetary values in one year to determine the present value in a different year. The discount factor is a function of the discount rate, the year of the monetary value, and the year in which the present value is being determined. For example, assuming a discount rate of seven percent, to discount monetary values in the year 2010 to values in the year 2001, DOE would use a discount factor of $1/(1.07)^9$ or 0.544.

The ACEEE commented that long-term social discount rates are appropriate for assessing the national impacts of standards. (Public Workshop Tr., No. 2EE at p. 201) Consistent with the Process Rule, the Department estimated national impacts with both a three-percent and a seven-percent real discount rate as the average real rate of return on private investment in the U.S. economy. These discount rates are used in accordance with the Office of Management and Budget's (OMB) guidelines on Regulatory Analysis. (OMB Circular A–4, section E, September 17, 2003) See Chapter 10 of the TSD for more details on national impacts based on three-percent and seven-percent discount rates. The Department defines the present year as 2001 for consistency with the year in which the Department collected manufacturer cost data.

(4) Present Value of Costs

The present value of increased total installed costs is the total installed cost increase (i.e., the difference between the standards case and base case) discounted to the present, and summed over the time period for which DOE evaluated the impact of standards (i.e., from the effective date of standards for this ANOPR in year 2008 to the year 2035).

Costs are increases in total installed cost (including both equipment cost and installation price) associated with the higher energy efficiency of commercial unitary air conditioners purchased in the standards case compared to the base case. The Department calculated total equipment costs as the difference in total installed cost for new equipment purchased each year, multiplied by the shipments in the standards case.

(5) Present Value of Savings

The present value of operating cost savings is the annual operating cost savings (i.e., the difference between the base case and standards case) discounted to the present, and summed.

Savings are decreases in operating costs (including electricity, repair, and maintenance) associated with the higher energy efficiency of commercial unitary air conditioners purchased in the standards case compared to the base case. Total operating cost savings are the savings per unit multiplied by the number of units of each vintage surviving in a particular year. Equipment consumes energy over its entire lifetime, and for units purchased in 2035 the present value of savings includes energy expenses incurred until the unit is retired from service.

3. Shipments Model

The Department chose an accounting model to prepare shipment scenarios for the baseline and the various standard levels considered for commercial unitary air conditioners. The model tracks the stocks (inventory of installed equipment) and purchases of equipment in the two equipment classes of commercial unitary air conditioners. Events and customer decisions influence how the stock and supply of commercial air conditioners flow from one category to another. The Department modeled decisions that are influenced by economic parameters (*i.e.,* total installed cost, operating cost, and income) with a logit probability model. The logit probability model is described later in this section.

The Department organized the model into three classes of elements: Stocks, events, and decisions. It divided stocks of commercial unitary air conditioners into ownership categories, and units are assigned to age categories. Events are things that happen to stocks independent of economic conditions, *i.e.*, breakdowns requiring repair or replacement. Decisions are customer reactions to market conditions, *e.g.*, whether to repair or replace equipment, or purchase an air conditioner for a building which does not have one. The model characterizes customer purchase decisions by market segments. The model uses decision trees to describe customer choices for purchases and repairs. A logit probability model simulates customer purchase decisions that are based on equipment price, operating costs, and business income level. A logit model allows a person to pinpoint variables that affect the probability of purchase. For more detail on the shipments model, refer to Chapter 9 of the ANOPR TSD.

a. Ownership Categories

The Department first divided buildings into commercial air conditioner markets, then further divided the two markets into four different ownership categories, including: (1) New buildings; (2) existing buildings with a commercial unitary air conditioner; (3) buildings without a commercial unitary air conditioner; and (4) buildings with an extended-life commercial unitary air conditioner (*i.e.*, equipment repaired to extend its life). The Department refers to the population of commercial unitary air conditioner units in each ownership category as the stock of commercial unitary air conditioner units of that category. Accounting equations relate annual changes in stocks to activities in the various market segments.

b. Market Segments

The Department divided commercial unitary air conditioner purchases into four market segments:

• *Net New Building Market:* Net increases in the building stock that force the purchase of new commercial unitary air conditioners.
• *Regular Replacement Market:* Most commercial unitary air conditioner purchases are to replace an existing system that has broken down after completion of its useful life.
• *Extra Repair Market:* Because replacement of commercial unitary air conditioners is costly, a few customers will rebuild or repair a malfunctioning system (thus extending its lifetime), rather than purchasing a new system. Eventually, even extended-life commercial unitary air conditioners are replaced.
• *Buildings Without a Commercial Air Conditioner:* Owners of some buildings without a commercial air conditioner will purchase and become new users of commercial unitary air conditioners.

The Department modeled events and decisions (*e.g.*, the probability that an existing commercial unitary air conditioner has a problem and the customer's course of action) separately for each market segment.

Trane stated that large increases in energy efficiency standards levels for commercial unitary air conditioners will cause users to repair their equipment rather than replace it, thereby decreasing shipments. (Public Workshop Tr., No. 2EE at p. 226) As noted above, the Department explicitly accounts for those customers that choose to repair their equipment rather than purchase a new system. Due to the increased equipment purchase price from higher efficiency standards, the shipments model estimates that some existing commercial unitary air conditioner customers, when faced with a replacement decision, will forego the purchase of a new piece of equipment and, instead, extend its normal life by repairing it. As a result, DOE estimated shipment projections under any standards case to be lower than those from the base case projection. Also, the shipments model forecasted that a greater number of existing customers would defer the purchase of a new system and extend the life of their equipment as the purchase price increased due to higher minimum efficiency standards.

c. Logit Probability Model

The Department used the logit probability-of-purchase model to estimate the impact of standards-induced price and features changes on customer decisions. The model accounts for customer responsiveness to total installed cost, operating costs, and business income to capture the effect of these three variables on future shipments. The Department developed a coefficient of elasticity for the responsiveness to these three factors for each of the market segments. The elasticity was established by calibrating equipment forecasts to historical shipments. This ensured that estimates were consistent with the recent history of commercial unitary air conditioner shipments, market structure, and customer preferences.

However, the Department understands that there are certain drawbacks to this method which include: (1) The need to forecast saturation of units in new and stock buildings; (2) the need to forecast building starts (although the AEO does provide readily available forecasts); and (3) the need to make assumptions concerning the lifetime of a unit to determine its retirement date. Concerning equipment saturation, the Department estimates that a maximum of ten percent of the total commercial floor space is eligible to receive equipment of the type covered by this rulemaking. Concerning building starts, the Department believes that unitary air conditioners would continue to be installed in the same types of buildings in which they are currently being used, and future equipment installations of commercial unitary air conditioners would not be preferentially installed in particular building types (*e.g.*, retail or office). Although the Department believes its estimates for equipment saturations and building starts are reasonable, the Department invites comments from interested parties on the reasonableness of these estimates. The equipment saturation and building start issues are addressed as Issues 12 and 13 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

Table II.17 summarizes the various inputs and sources of the commercial unitary air conditioner shipments model.

TABLE II.17.—SUMMARY OF SHIPMENTS MODEL INPUTS

Parameter	Data description
New Commercial Building Starts	DOE-Energy Information Administration, Annual Energy Outlook 2003.
Historical Commercial Building Starts	U.S. Census Bureau, Statistical Abstract of the United States: 2002.
Regular Replacement Market	Based on a survival function constructed from a Weibull distribution function normalized to produce a 15-year median lifetime. DOE based the 15-year median lifetime on data from the 1999 ASHRAE HVAC Applications Handbook.
Extra Repair Market	Same survival function as used for regular replacement market but with a six-year extended life.
Buildings Without an Air Conditioner	This is a function of shipments going to new commercial buildings and existing floor space.
Business Income	Building Owners and Managers Association (BOMA) International, Historical Experience Exchange Reports.

TABLE II.17.—SUMMARY OF SHIPMENTS MODEL INPUTS—Continued

Parameter	Data description
Total Installed Cost	Average values from LCC and PBP Analysis.
Operating Cost	Average values from LCC and PBP Analysis.
Elasticities	Developed by calibrating logit probability model to historical shipments.
Historical Shipments	U.S. Census Bureau, Current Industrial Reports, Refrigeration, Air Conditioning and Warm Air Heating Equipment (MA333M series 1970 through 2000).

Unlike the LCC Analysis, the shipments model does not use probability distributions of values for inputs. As noted in the above discussion of the NES spreadsheet model, the shipments model uses the same basic input data as the LCC model for energy use and cost of equipment, but uses shipment-weighted average values instead of probability distributions.

4. Preliminary Results

Tables II.18 and II.19 show the forecasted NES for the two primary equipment classes at each of the candidate standard levels. Note that in the case of both equipment classes, although the ASHRAE/IESNA Standard 90.1–1999 energy efficiency levels allow for four additional years of energy savings over the other standards cases, the amount is not great enough to offset the additional energy savings realized from adopting more stringent standards.

TABLE II.18.—SUMMARY OF CUMULATIVE NES IMPACTS (QUADS) THROUGH THE YEAR 2035 FOR ≥65,000 TO <135,000 BTU/H COMMERCIAL AIR CONDITIONERS

Candidate standard level	Effective date of standard	NES (quads)
ASHRAE 90.1—1999	2004	0.31
10.5 EER	2008	0.39
11.0 EER	2008	0.70
11.5 EER	2008	0.98
12.0 EER	2008	1.08

TABLE II.19.—SUMMARY OF CUMULATIVE NES IMPACTS (QUADS) THROUGH THE YEAR 2035 FOR ≥135,000 TO <240,000 BTU/H COMMERCIAL AIR CONDITIONERS

Candidate standard level	Effective date of standard	NES (quads)
ASHRAE 90.1—1999	2004	0.20
10.0 EER	2008	0.31
10.5 EER	2008	0.53
11.0 EER	2008	0.79
11.5 EER	2008	1.02
12.0 EER	2008	1.09

Tables II.20 and II.21 show the national NPVs for the two primary equipment classes for each of the candidate standard levels evaluated at discount rates of three-percent and seven-percent real per OMB's guidelines contained in *Circular A–4, Regulatory Analysis,* September 17, 2003. Based on the use of a seven-percent real discount rate, note that the NPV increases with the stringency of the standard level until the 12.0 EER standards case. Although the 12.0 EER standards case provides additional operating cost savings, the higher equipment purchase costs incurred under the standard result in an NPV that is lower than that realized under the 11.5 EER standards case. Use of a three-percent discount rate, as called for by OMB guidelines, increases both future equipment purchase costs and operating cost savings. But because future annual operating cost savings in latter years grow at a faster rate than annual equipment purchase costs, use of a three-percent discount rate dramatically increases the NPV at all standard levels for both equipment classes. For example, in the 11.5 EER standard level scenario for the ≥65,000 Btu/h to <135,000 Btu/h commercial unitary air conditioning equipment class, the $1.08 billion NPV based on a seven-percent discount rate becomes $3.06 billion under a three-percent discount rate. Chapter 10 of the ANOPR TSD also provides the full set of NPV results.

TABLE II.20.—SUMMARY OF CUMULATIVE NET PRESENT VALUE IMPACTS (IN BILLION 2001 DOLLARS) FOR ≥65,000 TO <135,000 BTU/H COMMERCIAL AIR CONDITIONERS CALCULATED WITH A SEVEN-PERCENT AND THREE-PERCENT REAL DISCOUNT RATE

Candidate standard level	Effective date of standard	NPV (billion 2001$)	
		7% discount rate	3% discount rate
ASHRAE 90.1–1999	2004	0.52	1.25
10.5 EER	2008	0.57	1.52
11.0 EER	2008	0.93	2.53
11.5 EER	2008	1.08	3.06
12.0 EER	2008	1.02	3.05

TABLE II.21.—SUMMARY OF CUMULATIVE NET PRESENT VALUE IMPACTS (IN BILLION 2001 DOLLARS) FOR ≥135,000 TO <240,000 BTU/H COMMERCIAL AIR CONDITIONERS CALCULATED WITH A SEVEN-PERCENT AND THREE-PERCENT REAL DISCOUNT RATE

Candidate standard level	Effective date of standard	NPV (billion 2001$)	
		7% discount rate	3% discount rate
ASHRAE 90.1–1999	2004	0.38	0.90
10.0 EER	2008	0.51	1.33
10.5 EER	2008	0.83	2.19
11.0 EER	2008	1.12	3.02
11.5 EER	2008	1.24	3.44
12.0 EER	2008	1.20	3.44

The engineering analysis, section II.C of the ANOPR, established a maximum technologically feasible (*i.e.*, ''max tech'') efficiency level of 12.0 EER. However, the engineering analysis also described a process (to be used for the NOPR) to ascertain whether the max tech level is actually greater than 12 EER. In anticipation that a greater max tech level could exist beyond 12.0 EER, the Department ran a sensitivity analysis to determine the effect on NES and NPV of a max tech efficiency level greater than 12.0 EER. For purposes of conducting the sensitivity analysis, the Department assumed that the max tech efficiency level would be 2 EER rating points beyond a given candidate standard level. This means that under the ASHRAE/IESNA Standard 90.1–1999 and 10.0 EER standards cases, the max tech level remains unchanged at 12.0 EER. But for all other standards cases, the max tech level is greater than 12.0 EER (*i.e.*, 12.5 EER for the 10.5 EER standards case, 13.0 EER for the 11.0 EER standards case, 13.5 EER for the 11.5 EER standards case, and 14.0 EER for the 12.0 EER standards case). Although under these standards cases the max tech level is allowed to go beyond 12.0 EER, equipment with efficiencies equal to the max tech level are assumed to be gradually phased in over time. As a result, the forecasted efficiency trends for these candidate standards are not very different from those developed with a max tech level of 12.0 EER. As a result, only the NES and NPV results for the 11.5 EER and 12.0 EER standards cases are significantly different from those results based on a max tech level of 12.0 EER. For more details on the NES and NPV results for the max tech sensitivity analysis, refer to subsection 10.4.5 of the ANOPR TSD.

H. LCC Sub-Group Analysis

The LCC sub-group analysis evaluates impacts on identifiable groups of customers, such as customers of different business types, who may be disproportionately affected by any national energy efficiency standard level. The Department will accomplish this, in part, by analyzing the LCC and PBPs for those customers that fall into those identifiable groups.

Also, the Department plans to evaluate variations in energy prices and variations in energy use that might affect the NPV of a standard to customer sub-populations. To the extent possible, the Department will get estimates of the variability of each input parameter and consider this variability in its calculation of customer impacts. Variations in energy use for a particular equipment type depend on factors such as climate, building type, and type of business. The Department plans to perform sensitivity analyses to consider how differences in energy use will affect sub-groups of customers.

The Department will then determine the effect on customer sub-groups using the LCC spreadsheet model. The standard LCC analysis includes various commercial building types that use unitary air conditioners. Where different data points are input to the spreadsheet model, the Department can analyze the LCC for any sub-group, such as office buildings in the U.S., by sampling only that sub-group. For more detail on the LCC sub-group analysis, refer to Chapter 11 of the ANOPR TSD.

The Department will be especially sensitive to purchase price increases (''first cost'' increases) to avoid negative impacts on identifiable population groups such as small businesses (*i.e.*, those with low annual revenues) which may not be able to afford a significant increase in the price of commercial unitary air conditioning equipment. Increased first costs to commercial customers which result from standards are especially important to smaller businesses because this group is most sensitive to price increases. For these types of customers, an increase in first cost for a piece of unitary air conditioning equipment might preclude the purchase of a new model of that equipment. As a result, some commercial customers may keep a unitary air conditioner past its anticipated useful life. An older unitary air conditioner is generally less efficient than a new one and its efficiency may further deteriorate if it keeps operating beyond that useful life. Further, an increase in first cost might altogether preclude the purchase and use of new equipment and potentially result in a great loss of utility.

Although the Department does not know the actual business income and annual revenues for the buildings analyzed in the LCC analysis, the Department will attempt to identify a building characteristic that correlates to annual income (*e.g.*, floor space). If a characteristic can be found, the Department will be able to perform sub-group analyses on smaller businesses. If the Department cannot identify a building characteristic that correlates with income, then the Department may not be able to perform sub-group analyses on smaller businesses. The issue of business income and how it might relate to a particular building characteristic is addressed as Issue 14 under ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.

The ACEEE stated that a sub-group analysis is unnecessary, stating that analyzing customer sub-groups will lead to an analytical quagmire. (ACEEE, No. 10 at p. 11) The Department understands ACEEE's concerns because the LCC analysis of numerous sub-groups could require an inordinate amount of time and resources. However, as long as there are valid reasons for analyzing certain sub-groups, such as those businesses that may be affected more severely than the general population by increases in purchase price, the Department will analyze the LCC impacts on those sub-groups.

I. Manufacturer Impact Analysis

The purpose of the manufacturer analysis is to identify the likely impacts of efficiency standards on manufacturers. Consistent with the policies outlined in the Department's Process Rule, 10 CFR Part 430, Subpart C, Appendix A, the Department will analyze the impact of standards on manufacturers with substantial input from manufacturers and other interested parties. The use of quantitative models will be supplemented by qualitative assessments by industry experts.

The Department intends to conduct the manufacturer impact analysis in three phases, and further tailor the analytical framework based on stakeholder comments. In Phase I, an industry profile is created to characterize the industry, and identify important issues that require consideration. In Phase II, an industry cash flow model and an interview questionnaire are prepared to guide subsequent discussions. In Phase III, manufacturers are interviewed, and the impacts of standards are assessed both quantitatively and qualitatively. First, industry and sub-group cash flow and net present value are assessed through use of the government regulatory impact model (GRIM). Second, impacts on competition, manufacturing capacity, employment, and regulatory burden are assessed based on manufacturer interview feedback and discussions. For more detail on the manufacturer impact analysis, refer to Chapter 12 of the ANOPR TSD.

1. Sources of Information for the Manufacturer Impact Analysis

Many of the analyses described above provide important information concerning the manufacturer impact analysis. Such information includes manufacturing costs (section II.C), shipments forecasts (section II.G.3), and price forecasts (section II.E). The Department supplemented this information with information gathered during interviews with manufacturers. The interview process has a key role in the manufacturer impact analysis because it allows interested parties to privately express their views on important issues, and allows DOE to consider confidential or sensitive information in the rulemaking decision.

The Department intends to conduct detailed interviews with as many manufacturers as necessary to gain insight into the range of potential impacts of standards. Typically during the interviews, DOE 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. The Department intends to schedule interviews well in advance to provide every opportunity for key individuals to be available for comment. Although a written response to a questionnaire would otherwise be acceptable, DOE prefers an interactive interview process because it helps clarify responses and identify additional issues.

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

The Department will ask interview participants to give, either in writing or orally, notice of any confidential information that is being provided. The Department will consider all relevant information in its decision-making process. However, DOE will not 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 and whether they want it to be presented with, or without, attribution.

The Department will review the results of the interviews and prepare a summary of the major issues and outcomes. For more detail on the methodology used in the manufacturer impact analysis, refer to section 12.2 of the ANOPR TSD.

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.

The GRIM analysis uses several factors to determine annual cash flows beginning with the first public announcement of a new standard and for the several years after its implementation: Annual expected revenues; manufacturer costs such as costs of sales, selling, and general administration costs; taxes; and capital expenditures related to depreciation, new standards, and maintenance. The Department compares the results against baseline 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. For more information on the industry cash flow analysis, refer to subsection 12.2.2.1 of the ANOPR TSD.

3. Manufacturer Sub-Group Analysis

Industry cost estimates are not adequate to assess differential effects among sub-groups of manufacturers. For example, there could be greater negative effects on smaller manufacturers, niche players, or manufacturers exhibiting a cost structure that differs largely from the industry average. Ideally, the Department would consider the impact on every firm individually; however, it typically uses the results of the industry characterization to group manufacturers exhibiting similar characteristics.

During the interview process, DOE will discuss the potential sub-groups and sub-group members that it has identified for the analysis. The Department will encourage the manufacturers to suggest what sub-groups or characteristics are most appropriate for the analysis. For more detail on the manufacturer sub-group analysis, refer to subsection 12.2.3 the ANOPR TSD.

4. Competitive Impacts Assessment

The Department must examine whether any lessening of competition is likely to result if a standard is set above the levels established in the ASHRAE/IESNA Standard 90.1–1999 and the Attorney General must determine the impacts, if any, of any lessening of competition. (42 U.S.C. 6313(6)(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 manufacturers. The Department 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 asymmetrical 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 the Department's Process Rule, 10 CFR Part 430, Subpart C, Appendix A, sections 4(d)(7)(ii) and (vi), and 5(e)(3)(i)(B).

The Department understands that the phaseout in 2010 of R–22 refrigerant may occur shortly after the effective date of any new standards for commercial unitary air-conditioning equipment. Two refrigerants, R–410a and R–407c, are currently under consideration as substitutes for R–22. In either case, the Department understands that there may be additional capital conversion and production conversion costs associated with the phaseout. The firms that manufacture the commercial equipment, for the most part, also manufacture residential central air conditioners and will face that conversion expense in 2010.

J. Utility Impact Analysis

To estimate the effects of candidate commercial unitary air conditioner standard levels on the electric utility industry, the Department intends to use a variant of DOE/EIA's National Energy Modeling System (NEMS).[3] The DOE/EIA used this model to produce the Annual *Energy Outlook.* The Department will use a variant known as NEMS-Building Technologies (BT) to provide key inputs to the analysis. The utility impact analysis is a comparison between model results for the base case and candidate standards cases. The analysis will consist of forecasted differences between the base and standards cases for electricity generation, installed capacity, sales, and prices. Because the Department attempts to use a variant of the latest version of NEMS, the NOPR analyses will use the most recently available version of NEMS, which in all likelihood will be the version used to generate the *AEO 2004.*

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. This model 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 for each trial standard level, as well as changes in electricity sales to the commercial sector.

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

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 the AEO. The AEO reference case projects that the U.S. economy, as measured by gross domestic product (GDP), will grow at an average rate of three percent from 2001 to 2025. The high economic 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.

This model provides reference case load shapes for several end uses by census division, including commercial space cooling. The Department uses predicted growth in demand for each end use to project the total electric system load growth for each region, which in turn DOE uses to predict the necessary additions to capacity. The NEMS–BT model accounts for the implementation of efficiency standards by decreasing the value of certain variables in the appropriate reference case load shape. The Department determines the amount of decrease in a variable by using data for the per-unit energy savings developed in the LCC and PBP analyses and the shipments forecast developed for the NES analysis. For more detail on the utility impact analysis, refer to Chapter 13 of the ANOPR TSD.

The Southern Company stated that in conducting the utility analysis, it is important to consider the effect on utilities from changes that affect load factor and peak demand. (Public Workshop Tr., No. 2EE at p. 246) The Department recognizes the Southern Company's concerns, and because the predicted reduction in capacity additions is very sensitive to the peak load impacts of the standard, the Department will also use the hourly load data from the building simulations to provide an independent estimate of the total system load reduction that results from a given trial standard level.

Because the current AEO (*AEO 2003*) version of NEMS forecasts only to the year 2025, DOE must extrapolate results to 2035. The Department will use the approach which the EIA uses to forecast fuel prices for the Federal Energy Management Program (FEMP).[4] The Federal Energy Management Program uses these prices to estimate LCC of federal equipment procurements. For petroleum products, FEMP uses the average growth rate for the world oil price over the years 2010 to 2025, in combination with the refinery and distribution markups from the year 2025, to determine the regional price forecasts. Similarly, FEMP derives natural gas prices from an average growth rate figure in combination with regional price margins from the year 2025.

Results of the analysis will include changes in commercial electricity sales, and installed capacity and generation by fuel type, for each trial standard level, in five-year forecasted increments extrapolated to the year 2035. The Natural Resources Defense Council stated that increases in the commercial unitary air conditioner standards will protect lives by reducing electricity blackouts. (NRDC, No. 6 at p. 5) Although the Department recognizes the possibility that a reduction in installed capacity could reduce the likelihood of blackouts, the Department does not intend to correlate reductions in installed capacity to possible reductions in electricity outages.

K. Environmental Assessment

The Department will conduct an assessment of the impacts of candidate commercial unitary air conditioner standard levels on certain environmental indicators using NEMS–BT to provide key inputs to the analysis. Results of the environmental assessment are similar to those provided in the AEO. Because the Department attempts to use a variant of the latest version of NEMS, the analyses conducted for the NOPR will use the most recently available version of NEMS, which in all likelihood will be the version used to generate the AEO 2004.

[3] For more information on NEMS, 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 program that performs this work).

[4] Memorandum from the Office of Integrated Analysis and Forecasting, Energy Information Administration, to the Federal Energy Management Program Office, dated January 23, 2003, ''Energy Price Projections for Federal Life Cycle Cost Analysis.''

The Department intends the environmental assessment to provide emissions results to policymakers and stakeholders, and to fulfill relevant legal requirements concerning the evaluation of environmental effects of new rules. The environmental assessment considers only two pollutants, sulfur dioxide (SO_2) and nitrogen oxides (NO_X), and one emission, carbon. The only form of carbon NEMS–BT tracks is carbon dioxide (CO_2), so the carbon discussed in this report is only in the form of CO_2. For each of the standard levels, DOE will calculate total undiscounted and discounted emissions using NEMS–BT and will use 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. The Southern Company stated that the environmental impacts calculated from a standards increase must consider other factors that may also be affecting power plant emissions. (Public Workshop Tr., No. 2EE at p. 254) 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.

The NEMS–BT model tracks carbon emissions using a detailed carbon module. This gives 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.

The NEMS–BT model 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. The NEMS–BT model 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. The Department reports the outcome of the analysis for each trial standard level as a deviation from the AEO reference cases. The Natural Resources Defense Council stated that increases in the commercial unitary air conditioner standards will protect lives by reducing airborne emissions. (NRDC, No. 6 at p. 5) Although the Department recognizes the possibility that a reduction in airborne emissions could result in improved health benefits, the Department has not correlated reductions in installed capacity to possible improvements in public health for appliance standards rulemakings. The Department requests data from stakeholders that identify specific health benefits from reductions in installed generation capacity. For more detail on the environmental assessment, refer to the environmental assessment report in Chapter 14 of the ANOPR TSD. Also, see ''Issues on Which DOE Seeks Comment'' in section IV.E of this ANOPR.''

L. Employment Impact Analysis

The Process Rule includes employment impacts among the factors to be considered in selecting a proposed standard. The Department usually would not issue any proposed standard level that would cause significant plant closures or losses of domestic employment. See the Department's Process Rule, 10 CFR Part 430, Subpart C, Appendix A, sections 4.(d)(7)(ii) and (vi), and 10.

The Department estimates the impacts of standards on employment for equipment manufacturers, relevant service industries, energy suppliers, and the economy in general. The estimates cover both the indirect and direct effects on employment. 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. The discussion of the manufacturer sub-group analysis in section II.I.3 of this ANOPR covers estimates of the direct effects on employment.

Indirect impacts are impacts on the national economy other than in the manufacturing sector being regulated. Indirect impacts may result both from expenditures shifting among goods (substitution effect) and changes in income which lead to a change in overall expenditure levels (income effect). The Department 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.

The Department expects new commercial unitary air conditioner standards to increase the total installed cost of equipment (customer purchase price plus sales tax, and installation). It expects the new standards to decrease energy consumption, and therefore to reduce customer expenditures for energy. Over time, the energy savings will pay back the increased total installed cost. Customers that benefit from the savings in energy expenditures may spend those savings on new commercial investments 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 impact on jobs. The Department will estimate national impacts for major sectors of the U.S. economy in the NOPR. Public and commercially available data sources and software will be used to estimate employment impacts. The Department will make all methods and documentation available for review.

In recent energy efficiency standards rulemakings, the Department has used the Impact of Building Energy Efficiency Programs (IMBUILD) spreadsheet model to analyze indirect employment impacts. The Department's Building Technologies program office developed

IMBUILD, which is a special-purpose version of the Impact Analysis for Planning (IMPLAN) national input/output model. IMPLAN specifically estimates the employment and income effects of building energy technologies. The IMBUILD model 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 using data from the Bureau of Labor Statistics (BLS). The IMBUILD model estimates changes in employment, industry output, and wage income in the overall U.S. economy resulting from changes in expenditures in the various sectors of the economy. Changes in expenditures due to commercial air conditioning standards are modeled by IMBUILD as changes to economic flows (*e.g.*, increased equipment prices and increased commercial sector investment). The economic flow changes provide IMBUILD with the means to estimate the net national effect on employment by sector.

While ACEEE generally supports the inclusion of a net national employment impacts analysis, it stated that any model or tool used to estimate employment impacts must be robust and sensitive enough to reveal effects as small as those that can be foreseen. ACEEE commented that DOE must show that any direct employment impacts differ significantly from productivity-related employment changes. (ACEEE, No. 10 at p. 15) The IMBUILD model estimates standards-induced impacts on the economy while holding constant all other economic factors that can affect national employment (such as recessions, government stimulus packages, and government budget deficits). While this approach to estimating employment impacts cannot determine the impacts due to small changes (such as productivity gains) on any particular industry, it does provide an approximation of the impact that equipment standards have on employment, barring any significant changes to the U.S. economy. Nevertheless, increases or decreases in the net demand for labor in the economy estimated by the input/output model due to commercial unitary air conditioners and heat pump standards are likely to be very small relative to total national employment. For the following reasons, it is doubtful that even modest changes in employment will be predicted in the NOPR.

• Although unemployment has increased over the past few years, it is still at a relatively low rate. If unemployment remains low during the period when amended energy efficiency standards go into effect, it is unlikely that the efficiency standards alone would cause any change in national employment levels;
• Neither the 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 might be offset if job quality and pay also change; and
• The net benefits or losses from potential employment changes are a result of the estimated net present value of benefits or losses that are likely to result from amended commercial unitary air conditioner and heat pump energy efficiency standards. It may not be appropriate to separately identify and consider any employment impacts beyond the calculation of NPV.

Taking into consideration these legitimate concerns regarding the interpretation and use of the employment impact analysis, the Department expects that any energy efficiency standards for commercial unitary air conditioners and heat pumps are likely to produce employment benefits that are sufficient to offset fully any adverse impacts on employment in the commercial air conditioning equipment or energy industries. Employment impact analyses for products that have recently gone through a standards rulemaking for energy efficiency, such as residential water heaters and clothes washers, have demonstrated that losses in the appliance and energy industries have been offset by gains in other sectors of the economy.

Although the Department intends on using IMBUILD for its analysis of employment impacts, the Department welcomes any input on tools that might be better than IMBUILD. For more information on the net national employment impacts analysis, refer to Chapter 14 of the ANOPR TSD.

M. Regulatory Impact Analysis

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

As part of the regulatory analysis, the Department will identify and seek to mitigate the overlapping effects on manufacturers of 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 commercial unitary air conditioners (*e.g.*, HCFC refrigerant phaseout) and other equipment (*e.g.*, non-unitary commercial air conditioners). Northeast Energy Efficiency Partnerships (NEEP) stated that existing incentive programs have demonstrated that commercial consumers need modest incentives to select equipment with efficiencies that are greater than the minimum standard requirements in ASHRAE Standard 90.1–1999. (NEEP, No. 8 at p. 3) The Department takes note of NEEP's comment and intends to address its concerns in the regulatory impact analysis discussion. The Department also seeks input from other stakeholders regarding other regulations that it should consider.

The NOPR will include a complete quantitative analysis of alternatives to the proposed energy 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 conservation standards. For more information on the regulatory impact analysis, refer to the regulatory impact analysis report in Chapter 16 of the ANOPR TSD.

III. Candidate Energy Conservation Standards Levels

The Process Rule requires 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). These candidate levels appear in Tables II.18 through II.21 of today's ANOPR. The Department intends to review the public comments received during the public comment period following the ANOPR public meeting and to update the analyses appropriately for each equipment class, before issuing the NOPR.

Also, the Department requests comments from interested parties about the phaseout of R–22 refrigerant, and has identified it as Issue 15 under ''Issues on Which DOE Seeks Comment'' in section IV.E. of this ANOPR.

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. The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 1E–245, 1000 Independence Avenue, SW., Washington, DC, 20585. Those stakeholders who want to attend the public meeting should notify Ms. Brenda Edwards-Jones at (202) 586–2945. Foreign nationals visiting DOE Headquarters are subject to advance security screening procedures, requiring a 30-day advance notice. A foreign national who wishes to participate in the meeting, must tell DOE of this fact as soon as possible by contacting Ms. Brenda Edwards-Jones to initiate the necessary procedures.

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. 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 be submitted by mail or e-mail 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 persons who cannot supply an advance copy of their 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 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 the 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: *commercialairconditioner.anopr@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–01–375, 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 particularly interested in receiving comments (including data) concerning:

1. Approaches to Analyses for Split Systems, Heat Pumps, and Niche Equipment

The Department assumes that the cost/efficiency relationship for commercial single-package unitary air-conditioning equipment in the ANOPR is similar to that of commercial split air-conditioning systems. Is this a reasonable assumption for the DOE to make in its approach to developing the cost/efficiency curves? (*See* section II.C.1 of this ANOPR for details.)

This ANOPR and the analyses detailed in the accompanying TSD address only commercial unitary air conditioning equipment. The Department proposes to address energy efficiency standards for commercial unitary heat pump equipment in a way that is consistent with the ASHRAE methodology used to set the ASHRAE/IESNA Standard 90.1–1999 levels for unitary air conditioning systems with heat pump heating. The Department requests comments on this proposed approach. (*See* section II.C.1 of this ANOPR for details.)

The Department did not consider any niche equipment classes in the engineering analysis. Should the Department consider any niche classes of commercial unitary air conditioning equipment (*e.g.*, portable units and explosion-proof/hazardous-duty units) that would fall under the definitions of either small unitary air conditioner, large unitary air conditioner, small unitary heat pump, or large unitary heat pump, in section I.C.3. of this ANOPR, apart from these general classes of commercial unitary air-conditioning equipment?

2. Alternative Refrigerant Analysis

The Department based its alternative refrigerant analysis on the use of R–410a refrigerant. The Department concluded that the incremental manufacturing cost and efficiency relationship derived for equipment using R–22 refrigerant would not be substantially different for equipment using R–410a. The Department requests data concerning the incremental cost/efficiency relationship associated with the use of R–410a in commercial unitary air conditioners. Also, the Department requests stakeholders to identify and provide similar information for any other alternative refrigerants DOE should consider. (*See* section II.C.5 of this ANOPR for details.)

3. Candidate Standards Levels

The Department has identified candidate energy efficiency standards levels ranging from 10.0 to 12.0 EER. The Department seeks comments on these efficiency standards levels and any other alternatives it should consider. (*See* sections III. and II.G.4 of this ANOPR for details.)

4. Design-Option Analysis and Maximum Energy Efficiency Levels

Because there were no commercial unitary air conditioners that had efficiencies beyond 11.5 EER when the Department conducted its engineering analysis for commercial unitary air conditioners rated ≥65,000 Btu/h through <240,000 Btu/h, the Department had to rely on its design-option analysis modeling to estimate the manufacturing cost and efficiency relationship beyond 11.5 EER. The Department requests comments from stakeholders on: (1) Whether the design options presented in the engineering analysis accurately estimate cost and efficiency trends beyond 11.5 EER, (2) whether the Department's assumptions for evaluating a maximum technologically feasible design were appropriate, and (3) what other design options should the Department consider in its analysis.

Since the Department completed its engineering analysis in late 2002, several new commercial unitary air conditioners, with rated efficiency levels greater than 12.0 EER, have become available on the market. The Department requests comments from stakeholders on any commercial unitary air-conditioning equipment with rated efficiency levels above 12.0 EER. (See sections II.C.1.a and II.C.4 of this ANOPR for details.)

5. Industrial Buildings

The Department's analysis relies on simulations of electric loads in commercial buildings to determine the relative impact of the standard. The analysis is also intended to cover equipment installed in light-manufacturing buildings. Light-manufacturing buildings are those engaged in the process of making, assembling, altering, converting, fabricating, finishing, processing or treatment of a manufactured product utilizing a relatively clean and quiet process which does not include or generate significant objectionable or hazardous elements such as smoke, odor, vibration, water pollution or dust. As such, commercial unitary air-conditioning equipment covered under this rulemaking could serve to provide space conditioning to light-manufacturing buildings. If the electric load shapes and magnitudes, and in particular the degree of correlation between the hour of the peak air conditioning load and the hour of the peak building load, are substantially different for light-manufacturing buildings, a separate analysis for these buildings might be necessary. The Department seeks comments about whether adding light-manufacturing buildings to its analysis is necessary and what, if any, impact it would have on the results. (See sections II.D.1 and II.F.1.b.(2)(a) of this ANOPR for details.)

6. Economizer Performance

In its building simulation analysis, the Department assumed that the economizers operated flawlessly where economizer presence was indicated by CBECS data. This might result in some underestimation of the actual cooling loads in the buildings. Should the Department revise this assumption, and if so, what assumptions are appropriate? (See section II.D.1 of this ANOPR for details.)

7. Fan Energy Consumption

The Department included fan energy consumption as part of the total energy consumption of the commercial unitary air-conditioning equipment in the ANOPR analysis. This analysis includes fan energy consumption that occurs whenever the fan is in operation (*i.e.*, during cooling, heating, and ventilation). Should the Department revise this approach in the NOPR analysis, and if so, what approach is appropriate? (See section II.D.1 of this ANOPR for details.)

8. Equipment Markups

For purposes of deriving customer prices for more efficient equipment, the Department differentiated between a baseline markup and an incremental markup for wholesalers, general contractors, and mechanical contractors. The incremental markup covers only those expenses associated with a change in the manufacturer price and is used to derive the incremental change in customer equipment price due to higher EER levels. Because the incremental markup covers fewer expenses, it has a lower value than its corresponding baseline markup. Nevertheless, it is essential to identify all expenses the incremental markup should cover. Therefore, the Department seeks comments on whether more or fewer expenses should be covered by the wholesale, general contractor, and mechanical contractor incremental markups. (See section II.E.2 of this ANOPR for details.)

9. Hourly Based Electricity Prices

The Department's hourly based electricity price analysis uses extensive data to develop estimates of generation and coincident peak load savings due to the standard for each building in the sample. The Department enters these savings estimates into a customer price model to compute annual energy bill savings as an input to the LCC. The Department's price model is based on the avoided-cost methodologies traditionally used to value demand reduction programs. Should the Department consider price models other than those based on avoided-cost methodologies? (See section II.F.1.b.(2)(b) of this ANOPR for details.)

10. Forecasts of Electricity Prices

The Department has relied on EIA energy price forecasts, including the various EIA scenarios, to bound projected energy prices used in the standards analyses. The Department applied EIA's projected trend in national average electricity prices to each customer's marginal energy expenses. Although the Department believes the EIA forecasts are the most credible projections available, the Department is open to using other sources of credible information. Are there alternative electricity price forecasts that are credible and warrant consideration by the Department? (See section II.F.1.b.(3) of this ANOPR for details.)

11. Equipment Lifetime

The Department based its equipment lifetime assumption on data from the 1999 *ASHRAE HVAC Applications Handbook,* which gives a median lifetime of 15 years for commercial unitary air conditioners. The Department found no other data to indicate a different median or mean lifetime for commercial unitary air conditioning equipment. The Department seeks data concerning whether a 15-year median lifetime is appropriate for commercial unitary air conditioners and heat pumps. (See section II.F.1.b.(6) of this ANOPR for details.)

12. Maximum Market Share of Commercial Unitary Air Conditioning Equipment

The shipments model uses a logit decision model to represent the probability that a new building will have unitary air conditioning equipment installed. Even if all eligible commercial customers decided to acquire a unitary air conditioner, there is still only a finite fraction of floor space that would contain the particular equipment covered by the standard (due, for example, to the climate, the building size or type, etc.). The Department estimates that the maximum fraction of floor space that is eligible to receive the unitary air conditioning equipment covered by the standard is about 10 percent for each equipment category. The Department seeks data to determine whether it should revise its estimate. (See section II.G.3.c of this ANOPR for details.)

13. Future Building Types Using Commercial Unitary Equipment

Future shipments of unitary air conditioning equipment depend in part on the rate of growth of commercial floor space. The Department uses the average growth rate for all commercial buildings as provided by AEO. The shipments model should cover the effects of any commercial unitary air conditioning equipment that is preferentially installed in particular types of buildings (*e.g.*, retail or office) and any growth rate of floor space for these building types that is substantially different from the average. The Department seeks comments concerning whether to base floor space growth rate on specific building types rather than the average growth rate. (See section II.G.3.c. of this ANOPR for details.)

14. Customer Sub-Groups

The Department has identified smaller businesses, as measured by annual revenue, as a possible sub-group in which to conduct a separate LCC analysis. Although the Department does not know the annual revenues for the businesses in the buildings analyzed in the LCC analysis, the Department hopes to identify a building characteristic that is an indicator of annual revenues. The Department seeks comments from interested parties on whether there is any building characteristic that correlates to business income. (See section II.H. of this ANOPR for details.)

15. Effective Date of New Standards and Phaseout Date of R–22 Refrigerant

For purposes of conducting the shipments and manufacturer impact analyses, should the Department assume that manufacturers will change over to a new refrigerant (R–410a) at the same time new standards levels become effective? (See section III. of this ANOPR for details.)

16. Independent Expert Third-Party Reviews

ARI and Lennox raised the following issues: (a) Sample of buildings, (b) BLAST simulation and CBECS data, (c) supply fan energy use while ventilating, and (d) incremental markups. (ARI, Nos. 14, 17, 18, and 19; Lennox, No. 15; and Memo to the File: Meeting with ARI/Lennox, March 12, 2003, No. 16) The Department engaged independent third-party experts to review the approaches, assumptions, data, and analytical methods used for the ANOPR analyses for these four issues. The results of these third-party reviews are available to interested parties on the Department's website at *http://www.eere.doe.gov/buildings/appliance_standards/ac_hp.html.* The Department seeks comments about each of these issues and the third-party review of these issues. (See sections I.A.5, II.D.1 and II.E.2 of this ANOPR and below discussion for more details.)

a. Sample of Buildings

The Department's economic analysis examined energy-use estimates in a sample of buildings from the EIA's CBECS database. The sample represents a diversity of cooling loads where commercial unitary air conditioning equipment is installed in six building types: assembly, education, food services, office, retail, and warehouse (non-refrigerated). Because of the complexity of this analysis, the Department also obtained an independent third-party expert review to ensure that the sample of buildings represented the operating conditions associated with the population of commercial unitary air conditioning equipment with rated cooling capacities of ≥65,000 Btu/h to <240,000 Btu/h. The Department seeks comments from interested parties about this third-party review.

b. Building Loads and System Thermodynamics Simulation and Commercial Buildings Energy Consumption Survey Estimates of Energy Use

The Department simulated load shapes for each of the above-sampled buildings at various efficiency levels by using the Building Loads and System Thermodynamics (BLAST) software. In doing so, the Department found that cooling energy use intensity (EUI) predicted by BLAST is higher than the cooling EUI estimated by CBECS for buildings with commercial unitary air conditioning equipment, although both the BLAST and CBECS calculations of energy end uses for cooling and ventilation are derived from modeled data. In view of these findings, the Department used a third party to examine the differences between the BLAST simulation EUI and the CBECS estimated EUI. The Department seeks comments from interested parties about the third-party review of the BLAST simulation and CBECS estimates of energy use. (See section II.D.1 of this ANOPR for details.)

c. Supply Fan Energy Use While Ventilating

The Department's analysis examines the total energy impact of commercial unitary air conditioning equipment on building energy consumption and therefore includes both the energy use and savings associated with the supply fan during non-cooling hours. The Department presumes that the fan is an integral component of a commercial unitary air conditioner and operates continuously to provide fresh air and air circulation at established ASHRAE Standard 62–1989 air quality levels when the building is occupied. The Department seeks comments from interested parties about the third-party review of fan energy use in the Department's ANOPR analysis. (See section II.D.1 of this ANOPR for details.)

d. Incremental Markups

To determine customer prices for more efficient commercial unitary air conditioning equipment, the ANOPR analysis addresses both the manufacturer's baseline markup and incremental markups for wholesalers, general contractors, and mechanical contractors. It addresses those overhead expenses that may vary with an increase in equipment efficiency for each step of the distribution channel, and in particular those overhead expenses that can be attributed to higher EER levels. The Department seeks comments from interested parties about the third-party review of incremental markups in the ANOPR analysis. (See section II.E.2 of this ANOPR for details.)

17. Effect of Income Taxes on Life-Cycle Cost

The Department did not include the effect of income taxes in the LCC analysis for this ANOPR because it believes the net impact of taxes on the LCC analysis depends upon how a firm's accounting procedures expense the purchase cost of commercial equipment and measure profitability. The Department requests comments as to whether DOE should perform such an analysis. The Department also requests information from interested parties on the number of firms that purchase commercial unitary air conditioning equipment and actually pay taxes, and for those that pay taxes, how the purchase of such equipment is expensed and subsequently depreciated over time. (See section II.F.1 of this ANOPR for details.)

18. Technologies That Affect Full- or Part-Load Performance

The Department understands that there are other technologies that operate under full- or part-load conditions and that can improve the net annual energy performance of a system, but which generally reduce the EER of commercial unitary air-conditioning equipment, or, at best, have no effect on EER. Such technologies include, for example, multiple compressors, economizers, inverter-driven variable-speed fans, and exhaust air enthalpy recovery devices. The Department did not examine such technologies because EPCA requires the commercial unitary air conditioners that are under consideration in this rulemaking meet certain energy levels measured in terms of EER. Moreover, EPCA establishes minimum EER levels for these air-cooled commercial unitary air conditioners and any amended national standard for that equipment must be more stringent—in other words, have an increased EER. Nevertheless, the Department understands that part-load and seasonal performance of a commercial unitary air conditioner is important because of the impact on national energy consumption. Therefore, the Department seeks comments and recommendations from interested stakeholders on how best to analyze the effects of those technologies that can reduce EER or are EER-neutral, and the implications both on national energy savings and consumer life cycle costs. (See section II.B of this ANOPR for details.)

19. Environmental Assessment

The Department recognizes the possibility that a reduction in airborne emissions may result from energy efficient commercial unitary air conditioners and heat pumps which, in turn, could result in improved health benefits. The Department has not correlated reductions in installed generation capacity to possible improvements in public health for this ANOPR. Nevertheless, the Department requests data from stakeholders which identify specific health benefits from reductions airborne emissions. (See section II.K of this ANOPR for details.)

20. Rebound Effect

As part of the building energy use and end-use load characterization, the Department did not take into account a rebound effect in determining the reduction in cooling and fan energy consumption due to higher EER levels. The rebound effect occurs when a piece of equipment 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 on which to base the calculation of the rebound effect. (See section II.D.2 of this ANOPR for details.)

V. Regulatory Review and Procedural Requirements

This advance notice of proposed rulemaking was submitted for review to the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget under Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (October 4, 1993). If DOE later proposes amended energy conservation standards for certain air-cooled, electrically operated, unitary central air conditioners and heat pumps for commercial applications, 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 other 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.

[FR Doc. 04–16575 Filed 7–28–04; 8:45 am]

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