CHAPTER 1. INTRODUCTION

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1.1 PURPOSE OF DOCUMENT

This technical support document (TSD) is a "stand-alone" report that provides the technical analyses and results in support of the information presented in the Advance Notice of Proposed Rulemaking (ANOPR) for commercial unitary air conditioners and heat pumps.

1.2 OVERVIEW OF COMMERCIAL EQUIPMENT STANDARDS

Part B of Title III of the Energy Policy and Conservation Act of 1975, Public Law 94-163, as amended by the National Energy Conservation Policy Act of 1978 (NECPA), Public Law 95-619; the National Appliance Energy Conservation Act of 1987 (NAECA), Public Law 100-12; the National Appliance Energy Conservation Amendments of 1988 (NAECA 1988), Public Law 100-357; and the Energy Policy Act of 1992 (EPAct), Public Law 102-486 (the Act or EPCA), established the Energy Conservation Program for Consumer Products other than Automobiles. (42 U.S.C. 6291-6309) Part 3 of Title IV of NECPA amended EPCA to add Certain Industrial Equipment, which includes air-conditioning equipment. (42 U.S.C. 6311(1)(B)) EPAct also amended EPCA with respect to air-conditioning equipment, providing definitions in section 122(a), test procedures in section 122(b), labeling provisions in section 122(c), energy-efficiency standards in section 122(d), and enforcement requirements in section 122(e). (42 U.S.C. 6311, 6313-15) These amendments expanded the Department's energy conservation program to include commercial unitary air conditioners and heat pumps, the focus of this document.

The EPCA, as amended by EPAct, established efficiency requirements that correspond to the levels in American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IESNA) Standard 90.1 as in effect on October 24, 1992. The statute further provides that if the efficiency levels in ASHRAE/IESNA Standard 90.1 are amended after that date for any of the covered products, including commercial unitary air conditioners and heat pumps, the Secretary of Energy (Secretary) must establish an amended uniform national standard for such equipment at the new minimum level for each effective date specified in ASHRAE/IESNA Standard 90.1, unless the Secretary 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, it must consider, to the greatest extent practicable, the economic impact of the standard on the manufacturers and consumers of the affected products; the savings in operating costs throughout the estimated average life of the product compared to any increases in the initial cost, or maintenance expense; the total projected amount of energy savings likely to result directly from the imposition of the standard; any lessening of the utility or the performance of the products likely to result from the imposition of

the standard; 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; the need for national energy conservation; and other factors the Secretary considers relevant. (42 U.S.C. 6313(a)(6)(B)(I)) Other statutory requirements are set forth in 42 U.S.C. 6313(a)(6)(B)(ii) and (C).

In order to guide DOE in the consideration and promulgation of new or revised appliance efficiency standards under EPCA, the Department established "Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products" (Process Rule) on July 15, 1996. 61 FR 36974. The Process Rule greatly enhanced opportunities for public input, improved analytic approaches, and encouraged adoption of consensus-based standards. The Process Rule provides policies and guidelines for early public review and consultation with interested parties as to identifying and screening design options, selecting a proposed standard, and establishing the final standard. The factors for screening design options include: (1) technological feasibility; (2) practicability to manufacture, install and service; (3) adverse impacts on product utility or product availability; and (4) adverse impacts on health or safety. Process Rule at 4(a)(4). The Process Rule requires the evaluation of uncertainty and variability by calling for scenario or probability analysis, and provides for review by experts and interested parties of the analyses used, including: (1) qualitative and quantitative analytical methods; (2) economic, engineering and life-cycle cost analyses; and (3) impacts on manufacturers and consumers, National energy savings, the economy and the environment. In addition, the DOE established an Advisory Committee on Appliance Energy Efficiency Standards, consisting of a representative group of these interested parties (61 FR 36979) to make recommendations to the Secretary regarding the implementation of the Process Rule. Although the Process Rule specifically applies only to the development of energy-efficiency standards for consumer products, DOE has decided to apply its procedures to the development of energy conservation standards for commercial and industrial equipment as well. Thus, the Process Rule is applicable to this rulemaking to develop energy-efficiency standards for commercial unitary central air conditioners and heat pumps. See appendix A to subpart C of Title 10 Code of Federal Regulations Part 430 (10 CFR Part 430).

Therefore, before the Department determines whether to adopt a proposed energy conservation standard, it must first solicit comments on the proposed standard. (42 U.S.C. 6313(a)(6)(B)(I)) Any new or amended standard must be designed so as to achieve significant additional conservation of energy and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)) To determine whether economic justification exists, the Department must review comments on the proposal and determine that the benefits of the proposed standard exceed its burdens to the greatest extent practicable, weighing the following seven factors:

1. the economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard;

2. the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the imposition of the standard;

3. the total projected amount of energy savings likely to result from the imposition of the standard;

4. any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard;

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

6. the need for national energy conservation; and

7. other factors the Secretary considers relevant.

(42 U.S.C. 6313(a)(6)(B)(I))

1.3 OVERVIEW OF COMMERCIAL UNITARY AIR CONDITIONER AND HEAT PUMP STANDARDS

On October 29, 1999, ASHRAE/IESNA adopted the energy-efficiency standards found in ASHRAE/IESNA Standard 90.1-1999 for certain commercial heating and air-conditioning equipment, including commercial unitary air conditioners and heat pumps. 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. On January 12, 2001, the Department published a final rule adopting the ASHRAE/IESNA Standard 90.1-1999 level for 18 product categories and made a decision to further evaluate other products. 66 FR 3336. In the final rule, DOE determined that further analysis was warranted for commercial unitary air conditioners and heat pumps. This conclusion was based on DOE's screening analysis.

Today's TSD marks the next step in analyzing technical and economic data to determine whether to adopt ASHRAE/IESNA Standard 90.1-1999 or amend the energy conservation standards for commercial unitary air conditioners and heat pumps covered by the statute. As the analysis under this rulemaking proceeds, DOE intends to make its findings available to the ASHRAE/IESNA Standard Project Committee 90.1 and other stakeholders under the ASHRAE/IESNA continuous maintenance process. Furthermore, the DOE may choose to propose an addendum to ASHRAE/IESNA Standard 90.1-1999, or proceed with adopting ASHRAE/IESNA Standard 90.1-1999 energy-efficiency levels for this equipment if DOE concludes that the EPCA criteria for a more stringent standard are not likely to be satisfied. This

could occur either as a result of further analysis by the Department during the rulemaking process or as a result of ASHRAE's adopting a new addendum to ASHRAE/IESNA Standard 90.1-1999, for which a more stringent alternative is not justified.

In June 2001, the Department published a *Framework Document for Commercial Air Conditioner and Heat Pump Standards Rulemaking*, describing the procedural and analytical approaches the Department anticipates using to evaluate the establishment of energy conservation standards for commercial unitary air conditioners and heat pumps. This document is available at http://www.eren.doe.gov/buildings/codes_standards/applbrf/coml_air_conditioner.html. The Department held a workshop on October 1, 2001, to discuss procedural and analytical approaches to 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 life-cycle cost (LCC) and payback, the methods proposed for conducting them, and the relationships among the various analyses. See Table 1.3.1.

Table 1.3.1 Commercial Unitary Air Conditioner and Heat Pump Analyses under 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	
Energy use and end-use load characterization	Utility impact analysis	
Markups for equipment price determination	Environmental assessment	
Life-cycle cost and payback period analyses	Employment impact analysis	
Shipments analysis	Regulatory impact analysis	
National impact analysis		

*The Process Rule's complete title is: *Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products.* 61 FR 36974.

During the October 1, 2001, workshop, stakeholders raised concerns about the application of the Process Rule to the commercial unitary air conditioner and heat pump rulemaking relative to: (1) the appropriateness of immediately adopting the applicable energy-efficiency standards in ASHRAE/IESNA Standard 90.1-1999; (2) inclusion of efficiency ratings to address both full-load and part-load performance; (3) appropriate approaches to conducting the engineering analysis; (4) how non-regulatory issues, such as the phase-out of hydrofluorochlorocarbon (HCFC) refrigerants, might affect the effective date of any new standards; (5) methods for developing customer equipment prices; (6) methods for developing

discount rates to evaluate future energy cost savings realized from new equipment standards; and (7) estimation of future electricity prices and possible impacts of electric utility deregulation.

In response to these concerns and related comments by stakeholders at the October 1, 2001, workshop, the Department performed the engineering analysis along two approaches: first, an energy-efficiency-level approach to establish a manufacturer cost-versus-efficiency curve; and second, a design-option approach to simulate equipment performance at higher efficiency levels for purposes of validating the cost-versus-efficiency curve.

In developing the cost-versus-efficiency curve, the Department conducted tear-down analyses of actual commercial unitary air-conditioning equipment in order to itemize the cost of specific design options. Thereafter, under the Process Rule, the Department met several times with members of the Air-Conditioning & Refrigeration Institute (ARI) Unitary Equipment Regulatory Committee and presented its preliminary findings. During this time, individual manufacturers submitted production cost data to DOE in order to help DOE to refine cost estimates generated through the efficiency-level approach. Both the efficiency-level and design-option approaches are discussed in detail in Chapter 5, entitled Engineering Analysis.

In addition to gathering and presenting manufacturer cost data, the Department met with members of the ARI Unitary Equipment Regulatory Committee and presented data necessary for conducting the building simulation, LCC, and payback period analyses. In turn, ARI committee members provided comments on how to improve the quality of the data used in the analyses. Thereafter, the Department met with the ARI committee members and presented the preliminary LCC analysis. The building simulation analysis is discussed in detail in Chapter 6, and the LCC and payback period analyses are discussed in Chapter 8.

The Department conducted the LCC and payback period analyses along two approaches: a monthly approach and an hourly approach. The monthly approach establishes an annual energy expense using 2002 electric utility tariffs and derived electricity prices. Under this approach, LCC results are based on the assumption that commercial building customers in the future will face electricity charges very similar to those that exist in today's electricity markets. The hourly approach establishes an annual energy expense using electricity prices that may exist assuming all electricity markets are deregulated. Under this approach, LCC results are based on the assumption that commercial building customers will face electricity charges under fully deregulated electricity markets.

The Department developed new spreadsheets for the LCC, payback period, and national impact analyses in an effort to meet the objectives of the Process Rule. The Department developed two spreadsheets for the LCC and payback period analyses, one based on the monthly approach and the other based on the hourly approach. Both spreadsheets are essentially identical except for the methods used to determine annual energy expenses. A spreadsheet tool that demonstrates the calculation of annual energy expenses based on monthly electric utility tariffs (i.e., the monthly approach) accompanies the monthly based LCC spreadsheet. The Department developed a national impact analysis spreadsheet that calculates the national energy savings

(NES) and national net present values (NPV) at various energy-efficiency levels. This spreadsheet includes a model that forecasts the impacts of energy-efficiency standards at various levels on commercial unitary air conditioner shipments. These spreadsheets appear on the Department's web site.[a] The Department wants to receive notice of any significant errors in the spreadsheet tools for correction. Any other comments may be submitted during the 75-day period following publication of the ANOPR.

The Department has reviewed the recommendations made on April 21, 1998, by the Advisory Committee on Appliance Energy Efficiency Standards. (Advisory Committee, No. 96)[b] These recommendations relate to: (1) using the full range of consumer marginal energy rates (CMER) in the LCC Analysis (replacing the use of national average energy prices), (2) defining a range of energy price futures for each fuel used in the economic analyses, and (3) defining a range of primary energy conversion factors and associated emission reductions based on the generation of energy and emissions that would be displaced by energy-efficiency standards for each rulemaking. As discussed above, DOE conducted the LCC analysis with electricity prices based on both electric utility tariffs and hourly prices to capture the full range of CMERs. Thus, the Department incorporated the use of consumer marginal energy rates into the analysis for this ANOPR. Also, the Department incorporated a range of future energy prices for ANOPR analysis, and plans to incorporate the recommendations concerning energy conversion factors in future analyses for the Notice of Proposed Rulemaking (NOPR).

Although this rulemaking covers both commercial unitary air conditioners and heat pumps, the analysis detailed in this ANOPR TSD covers only unitary air conditioners. The Department in its ANOPR requests comments on the need for conducting analyses specific to commercial heat pumps.

The ANOPR TSD outlines the analytical approaches used in this rulemaking and solicits comments from stakeholders on them. The DOE will modify or refine these analytical approaches, or explore alternative approaches if stakeholders demonstrate a need for such changes.

1.4 STRUCTURE OF THE DOCUMENT

This ANOPR TSD consists of fourteen chapters, nineteen appendices, an environmental assessment, and a regulatory impact analysis.

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[a] See http://www.eere.energy.gov/buildings/appliance_standards/commercial/ac_hp.html

[b] Advisory Committee, No. 96 refers to the recommendations of the Advisory Committee on Energy Efficiency Standards and is available for inspection at the U.S. Department of Energy, Forrestal Building, Room 1J-018 (Resource Room of the Building Technologies Program) in the file under "Energy Conservation Program for Consumer Products: Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products," RIN [1904–AA83], as document number 96.

Chapter 1 Introduction: provides an overview of the appliance standards program and how it applies to the commercial unitary and heat pump rulemaking, and outlines the structure of the document.

Chapter 2 Analytical Framework: describes the rulemaking process step-by-step.

Chapter 3 Market and Technology Assessment: characterizes the commercial unitary air conditioner and heat pump market and the technologies available for increasing equipment efficiency.

Chapter 4 Screening Analysis: determines which technology options are viable for consideration in the Engineering Analysis.

Chapter 5 Engineering Analysis: discusses the methods used for developing the relationship between increased manufacturer price and increased efficiency.

Chapter 6 Building Energy Use and End-Use Load Characterization: discusses the process used for generating energy use estimates and end-use load shapes for commercial cooling equipment in a variety of building types and climate locations.

Chapter 7 Markups for Equipment Price Determination: discusses the methods used for establishing markups for converting manufacturer prices to customer equipment prices.

Chapter 8 Life-Cycle Cost and Payback Period Analysis: discusses the effects of standards on individual customers and users of the equipment and compares the life-cycle cost and payback period of equipment with and without higher efficiency standards.

Chapter 9 Shipments Analysis: discusses the methods used for forecasting shipments with and without higher efficiency standards including how equipment purchase decisions are economically influenced and modeled with econometric equations.

Chapter 10 National Impact Analysis: discusses the methods used for forecasting national energy consumption and national economic impacts based on estimates of future equipment efficiency, commercial building starts, and annual equipment sales in the absence and presence of higher efficiency standards.

Chapter 11 Life-Cycle Cost Sub-Group Analysis: describes the methodology for estimating the life-cycle cost impacts on sub-groups of commercial air conditioner customers.

Chapter 12 Manufacturer Impact Analysis: describes the methodology for determining the financial impact of increased efficiency standards on manufactures.

Chapter 13 Utility Impact Analysis: describes the methodology for determining the decrease in installed generation capacity due to higher efficiency standards.

Chapter 14 Employment Impact Analysis: describes the methodology for determining the impact of higher efficiency standards on the national employment.

Environmental Assessment for Commercial Unitary Air Conditioners and Heat Pumps: describes the methodology for determining the reduction in air-borne emissions due to higher efficiency standards.

Regulatory Impact Analysis for Commercial Unitary Air Conditioners and Heat Pumps: describes the methodology for analyzing the impact of non-regulatory alternatives to efficiency standards.

Appendix A Commercial Technologies That Are Not Considered in the Engineering Analysis: accompanies Chapter 5, Engineering Analysis

Appendix B Technical Description of the Cost Estimation Methodology: accompanies Chapter 5, Engineering Analysis

Appendix C Design Option Analysis - Supporting Documentation: accompanies Chapter 5, Engineering Analysis

Appendix D PARM File Contents: accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix E Frequency of Occurrence of Buildings Type by Aspect Ratio Bin for Each of the Six Principal Building Activities (PBAs): accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix F Aspect Ratio Calculations for Buildings with Courtyards: accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix G Lights, Plug Load and Occupancy Schedules: accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix H Number of CBECS Buildings Assigned to Each TMY2 City: accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix I Typical Meteorological Year (TMY) Assignments: accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix J Sample BLAST Input File: accompanies Chapter 6, Building Energy Use and End-Use Load Characterization

Appendix K Detailed Data for Equipment Price Markups: accompanies Chapter 7, Markups for Equipment Price Determination

Appendix L Uncertainty and Variability: accompanies Chapter 8, Life-Cycle Cost and Payback Period Analysis

Appendix M Sample Utilities: accompanies Chapter 8, Life-Cycle Cost and Payback Period Analysis

Appendix N Historical and Modeled Data by Subdivision: accompanies Chapter 8, Life-Cycle Cost and Payback Period Analysis

Appendix O Modeling Typical Meteorological Year (TMY) Prices: accompanies Chapter 8, Life-Cycle Cost and Payback Period Analysis

Appendix P User Instructions for Life-Cycle Cost (LCC) and Payback Period (PBP) Spreadsheets: accompanies Chapter 8, Life-Cycle Cost and Payback Period Analysis

Appendix Q Life-Cycle Cost (LCC) and Payback Period (PBP) Results: accompanies Chapter 8, Life-Cycle Cost and Payback Period Analysis

Appendix R User Instructions for National Energy Savings (NES) and Net Present Value (NPV) Spreadsheet: accompanies Chapter 10, National Impact Analysis

Appendix S National Equipment and Operating Costs: accompanies Chapter 10, National Impact Analysis

Appendix T Base Case and Standards Case Efficiency Trends: accompanies Chapter 10, National Impact Analysis

Appendix U Alternative "Max Tech" Scenario and Its Impact on National Energy Savings and Net Present Value: accompanies Chapter 10, National Impact Analysis