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DEPARTMENT OF ENERGY

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[EERE–2017–BT–STD–0021] RIN 1904–AD90

Energy Conservation Program: Energy Conservation Standards for Unfired Hot Water Storage Tanks

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

ACTION: Final determination.

SUMMARY: The Energy Policy and Conservation Act, as amended (''EPCA''), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including unfired hot water storage tanks (''UFHWSTs''). EPCA also requires the U.S. Department of Energy (''DOE'' or ''the Department'') to periodically determine whether more-stringent, amended standards would be technologically feasible and economically justified, and would result in significant additional energy savings. In this final determination, DOE determines that the energy conservation standards for UFHWSTs do not need to be amended. DOE has determined that it lacks clear and convincing evidence that more-stringent standards for UFHWSTs would save a significant additional amount of energy and would be economically justified.

DATES: The effective date of this final determination is July 25, 2022.

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

The docket web page can be found at *www.regulations.gov/docket?D=EERE-2017-BT-STD-0021.* The docket web page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

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I. Synopsis of the Final Determination

Title III, Part C[1] of EPCA,[2] established the Energy Conservation Program for Certain Industrial Equipment. (42 U.S.C. 6311–6317) This equipment includes UFHWSTs, the subject of this rulemaking. (42 U.S.C. 6311(1)(K))

Pursuant to EPCA, DOE is triggered to consider amending the energy efficiency standards for certain types of commercial and industrial equipment, including the equipment at issue in this document, whenever the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (''ASHRAE'') amends the standard levels or design requirements prescribed in ASHRAE Standard 90.1, ''Energy Standard for Buildings Except Low-Rise Residential Buildings,'' (''ASHRAE Standard 90.1''). Under a separate provision of EPCA, DOE is required to review the existing energy conservation standards for those types of covered equipment subject to ASHRAE Standard 90.1 every 6 years to determine whether those standards need to be amended. (42 U.S.C. 6313(a)(6)(A)–(C)) DOE is publishing this final determination regarding the energy conservation standards for UFHWSTs under EPCA's 6-year-lookback authority. (42 U.S.C. 6313(a)(6)(C))

For this final determination, DOE analyzed UFHWSTs subject to standards as specified in the Code of Federal Regulations (''CFR'') at 10 CFR 431.110. DOE first analyzed the technological feasibility of more-efficient UFHWSTs. For those UFHWSTs for which DOE determined higher standards to be technologically feasible, DOE estimated energy savings that would result from potential amended energy conservation standards. DOE also considered whether potential energy conservation standards would be economically justified. As discussed in the following sections, DOE has determined that it lacks clear and convincing evidence that amended energy conservation standards for UFHWSTs would result in significant additional conservation of energy or be economically justified.

Based on the results of these analyses, summarized in section V of this document, DOE has determined that current energy conservation standards for UFHWSTs do not need to be amended.

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

[2] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflects the last statutory amendments that impact Parts A and A–1 of EPCA.

II. Introduction

The following section briefly discusses the statutory authority underlying this final determination, as well as some of the relevant historical background related to the establishment of energy conservation standards for UFHWSTs.

A. Authority

EPCA, Public Law 94–163 (42 U.S.C. 6291–6317, as codified), among other things, authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part C of EPCA, added by Public Law 95–619, Title IV, section 441(a) (42 U.S.C. 6311–6317, as codified), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes UFHWSTs, the subject of this rulemaking. (42 U.S.C. 6311(1)(K))

The energy conservation program under EPCA consists essentially of four parts: (1) Testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6311), energy conservation standards (42 U.S.C. 6313), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), and the authority to require information and reports from manufacturers (42 U.S.C. 6316).

Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and 42 U.S.C. 6316(b); 42 U.S.C. 6297) DOE may, however, grant waivers of Federal preemption in limited circumstances for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. (42 U.S.C. 6297(d); 42 U.S.C. 6316(a); 42 U.S.C. 6316(b)(2)(D))

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of covered equipment. (42 U.S.C. 6314) Specifically, EPCA requires that if a test procedure referenced in ASHRAE Standard 90.1 is updated, DOE must update its test procedure to be consistent with the amended test procedure in ASHRAE Standard 90.1, unless DOE determines, by rule, published in the **Federal Register** and supported by clear and convincing evidence, that the amended test procedure is not reasonably designed to produce test results that reflect the energy efficiency, energy use, or estimated operating costs of the covered ASHRAE equipment during a representative average use cycle. In addition, DOE must determine that the amended test procedure is not unduly burdensome to conduct. (42 U.S.C. 6314(a)(2) and (4)) In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures in the **Federal Register** and offer the public an opportunity (of not less than 45 days duration) to present oral and written comments on them. (42 U.S.C. 6314(b)) In contrast, if DOE determines that test procedure revisions are not appropriate, DOE must publish in the **Federal Register** its determination not to amend the test procedures. (42 U.S.C. 6314(a)(1)(A)(ii))

Manufacturers of covered equipment must use the Federal test procedures as the basis for: (1) Certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(b); 42 U.S.C. 6296), and (2) making representations about the energy use or efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE uses these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. It is noted that DOE does not prescribe a test procedure for UFHWSTs, as the current Federal standard is an insulation design requirement of a minimum R-value of R–12.5. 10 CFR 431.110.

EPCA contains mandatory energy conservation standards for commercial heating, air-conditioning, and water heating equipment. (42 U.S.C. 6313(a)) Specifically, the statute sets standards for small, large, and very large commercial package air conditioning and heating equipment, packaged terminal air conditioners and packaged terminal heat pumps, warm-air furnaces, packaged boilers, storage water heaters, instantaneous water heaters, and UFHWSTs. *Id.* In doing so, EPCA established Federal energy conservation standards that generally corresponded to the levels in the ASHRAE Standard 90.1 in effect on October 24, 1992 (*i.e.,* ASHRAE Standard 90.1–1989).

If ASHRAE Standard 90.1 is amended with respect to the standard levels or design requirements applicable under that standard for certain commercial equipment, including UFHWSTs, not later than 180 days after the amendment of the standard, DOE must publish in the **Federal Register** for public comment an analysis of the energy savings potential of amended energy efficiency standards. (42 U.S.C. 6313(a)(6)(A)(i)) DOE must adopt amended energy conservation standards at the new efficiency level in ASHRAE Standard 90.1, unless clear and convincing evidence supports a determination that adoption of a more-stringent efficiency level as a national standard would produce significant additional energy savings and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii))

To determine whether a standard is economically justified, EPCA requires that DOE determine whether the benefits of the standard exceed its burdens by considering, to the greatest extent practicable, the following seven factors:

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

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

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

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

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

(6) The need for national energy conservation; and

(7) Other factors the Secretary of Energy considers relevant.

(42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII) and (C)(i); 42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(i))

If DOE adopts as a national standard the efficiency levels specified in the amended ASHRAE Standard 90.1, DOE must establish such a standard not later than 18 months after publication of the amended industry standard. (42 U.S.C. 6313(a)(6)(A)(ii)(I)) If DOE determines that a more-stringent standard is appropriate under the statutory criteria, DOE must establish the more-stringent standard not later than 30 months after publication of the revised ASHRAE Standard 90.1. (42 U.S.C. 6313(a)(6)(B)(i))

EPCA also requires that every 6 years DOE shall evaluate the energy conservation standards for each class of certain covered commercial equipment, including UFHWSTs, and publish either a notice of determination that the standards do not need to be amended, or a notice of proposed rulemaking (''NOPR'') that includes new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6313(a)(6)(C)(i)) EPCA further provides that, not later than 3 years after the issuance of a final determination not to amend standards, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6313(a)(6)(C)(iii)(II)) DOE must make the analysis on which the determination is based publicly available and provide an opportunity for written comment. (42 U.S.C. 6313(a)(6)(C)(ii)) Further, a determination that more-stringent standards would: (1) Result in significant additional conservation of energy and (2) be both technologically feasible and economically justified must be supported by clear and convincing evidence. (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(A)) DOE is publishing this final determination in satisfaction of the 6-year-lookback review requirement in EPCA, having determined that DOE lacks clear and convincing evidence that amended standards for UFHWSTs would result in significant additional conservation of energy and be economically justified.

B. Background

1. Current Standards

The initial Federal standards for UFHWSTs, established by EPCA, corresponded to the efficiency levels contained in ASHRAE Standard 90.1–1989. On January 12, 2001, DOE amended the standards for UFHWSTs to be equivalent to the efficiency level in ASHRAE Standard 90.1 as revised in October 1999. 66 FR 3336 (''January 2001 final rule''). The January 2001 final rule established an insulation design requirement of a minimum R-value of R–12.5 for all UFHWSTs. 66 FR 3336, 3356 (Jan. 12, 2001). This remains the current Federal standard (and the standard level specified in the most recent version of ASHRAE Standard 90.1). The current standard is codified at 10 CFR 431.110.

2. History of Standards Rulemaking for UFHWSTs

As noted previously, the standards for UFHWSTs were most recently amended in the January 2001 final rule. EPCA requires DOE to evaluate the applicable energy conservation standard for UFHWSTs every 6 years to determine whether it needs to be amended. (42 U.S.C. 6313(a)(6)(C)(i)) Thus, DOE published a request for information (''RFI'') in the **Federal Register** on August 9, 2019, which identified various issues and sought to collect data and information to inform its determination, consistent with its obligations under EPCA, as to whether the UFHWST standards need to be amended (the ''August 2019 RFI''). 84 FR 39220. DOE subsequently published a notice of proposed determination (''NOPD'') in the **Federal Register** on June 10, 2021 (''June 2021 NOPD''), wherein DOE tentatively determined that the energy conservation standards for UFHWSTs do not need to be amended.

DOE received six comments in response to the June 2021 NOPD from the interested parties listed in Table II.1.

TABLE II.1—INTERESTED PARTIES PROVIDING WRITTEN COMMENTS ON THE JUNE 2021 UFHWSTS NOPD

Commenter(s)	Abbreviation	Commenter type
Aarin King	King	Individual.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Northwest Energy Efficiency Alliance.	Joint Commenters	Efficiency Organizations.
Bradford White Corporation	BWC	Manufacturer.
Rheem Manufacturing Company	Rheem	Manufacturer.
A.O. Smith Corporation	A.O. Smith	Manufacturer.
Pacific Gas and Electric Company (''PG&E''), San Diego Gas and Electric (''SDG&E''), Southern California Edison (''SCE'').	CA IOUs	Investor-Owned Utilities.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[3]

III. General Discussion

DOE developed this final determination after a review of the UFHWST market, including product literature and product listings in the DOE Compliance Certification Database (''CCD'').[4] DOE also considered oral and written comments, data, and information from interested parties that represent a variety of interests. The following discussion addresses issues raised by these commenters. BWC, Rheem, and A.O. Smith all expressed support for DOE's proposed determination that energy conservation standards for UFHWSTs do not need to be amended. (BWC, No. 14 at p. 1; Rheem, No. 15 at p. 1; A.O. Smith, No. 16 at p. 1) However, as discussed in section III.B of this document, the CA IOUs and the Joint Commenters encouraged DOE to consider a performance-based test procedure for UFHWSTs to address standby loss before proceeding with this standards rulemaking. (CA IOUs, No. 17 at p. 2; Joint Commenters, No. 13 at p. 1)

A. Product Classes and Scope of Coverage

When evaluating and establishing energy conservation standards, DOE typically divides covered equipment into equipment classes by the type of energy used or by capacity or other performance-related features that justify differing standards. For UFHWSTs, the current standard at 10 CFR 431.110 is applicable to a single equipment class covering all UFHWSTs, which is consistent with the standard and structure in ASHRAE Standard 90.1. DOE's regulations define ''unfired hot water storage tank'' as a tank used to store water that is heated externally, and that is industrial equipment. 10 CFR 431.102. The scope of coverage is discussed in further detail in section IV.A.1 of this final determination.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6314(a)) As a general matter, manufacturers of covered ASHRAE equipment must use these test procedures to certify to DOE that their equipment complies with energy conservation standards and to quantify the efficiency of their equipment. (42 U.S.C. 6316(b); 42 U.S.C. 6296) DOE's current energy conservation standards for UFHWSTs are expressed in terms of a minimum R-value for tank insulation. (*See* 10 CFR 431.110.)

DOE does not prescribe a test procedure for UFHWSTs; however, DOE's regulations define ''R-value'' as the thermal resistance of insulating material as determined using either ASTM International (''ASTM'') C177–13, ''Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus,'' or ASTM C518–15, ''Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus'' and expressed in degrees-square feet-hours per British thermal units (''°F ft^2 h/Btu''). 10 CFR 431.102.

In response to the June 2021 NOPD, the CA IOUs and the Joint Commenters encouraged DOE to consider a performance-based test procedure for UFHWSTs to address standby loss before proceeding with this energy conservation standards rulemaking. (CA IOUs, No. 17 at p. 2; Joint Commenters, No. 13 at p. 1) The CA IOUs stated that performance-based standards are preferable to prescriptive standards because performance-based standards present a clearer assessment of product energy performance, allow purchasers to directly compare product efficiencies, and would encourage innovation in terms of new methods to reduce heat loss. (CA IOUs, No. 17 at pp. 1–2) Additionally, the Joint Commenters stated that the current standard, in terms of thermal resistance, does not guarantee that all tank surfaces are sufficiently insulated. They suggested that performance-based standards would provide a better understanding of actual energy consumption and would likely encourage improved methods to reduce heat loss. (Joint Commenters, No. 13 at p. 1) In contrast, Rheem recommended that the current prescriptive design requirement (*i.e.,* the minimum insulation requirement of R–12.5) be retained for UFHWSTs. (Rheem, No. 15 at p. 1)

As discussed in section II.A of this document, DOE is publishing this final determination in satisfaction of the 6-year-lookback review requirement in EPCA, which requires DOE to evaluate the energy conservation standards for certain commercial equipment, including UFHWSTs. Under that provision, DOE must publish either a notice of determination that the standards do not need to be amended, or a NOPR that includes proposed amendments to the energy conservation standards (proceeding to a final rule, as appropriate) every 6 years. (42 U.S.C. 6313(a)(6)(C)(i)) Because a Federal test procedure for evaluating standby loss of UFHWSTs has not been established, DOE has only considered potential amended standards based on updating the prescriptive design requirement for insulation R-value. DOE will consider the merits and feasibility of a performance test in its next test procedure rulemaking for UFHWSTs.

Additionally, in response to the June 2021 NOPD, the CA IOUs suggested that DOE clarify the amount of tank surface area that is required to be insulated. (CA IOUs, No. 17 at p. 4) Aarin King stated that heat travels upward, and, therefore, insulation placement requirements should be at the greatest heat loss zones, such as the relief valve and fittings on the head of the tank. (King, No. 12 at p. 1)[5]

As stated, the energy conservation standard for UFHWSTs specifies a minimum insulation rating. The energy conservation standard does not further specify the manner in which insulation is applied to a UFHWST. There are a wide variety of tank configurations (including the number, shape, and location of ports and other fittings) in equipment currently on the market, and the relative amount of tank surface area that is practical to insulate to R–12.5 varies between tanks. Further, DOE is not aware of an industry standard that would allow for evaluation of insulation uniformity at this time. Therefore, DOE is not imposing an insulation placement requirement at this time but will continue to consider the issue in the future.

Additionally, in response to the June 2021 NOPD, Rheem suggested that focusing on insulation of field-installed plumbing may provide more significant energy savings than added tank insulation. The commenter stated that there are diminishing returns from increasing insulation thicknesses, and consequently, fittings and piping contribute to a significantly greater portion of the overall standby losses as tank insulation is increased. (Rheem, No. 15 at p. 2) In response to Rheem, DOE notes that it does not have authority to regulate field-installed plumbing insulation and did not

[3] The parenthetical reference provides a reference for information located in the docket (Docket No. EERE–2017–BT–STD–0021, which is maintained at *www.regulations.gov*). The references are arranged as follows: (Commenter name, comment docket ID number, page of that document).

[4] The CCD is available at *www.regulations.doe.gov/certification-data.*

[5] Commenter also provided additional comments regarding heat transfer in tanks not applicable to this rulemaking.

consider such approach for this analysis.

C. Technological Feasibility

1. General

In evaluating potential amendments to energy conservation standards, DOE conducts a screening analysis based on information gathered through a market and technology assessment of all current technology options and working prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. In general, DOE considers technologies incorporated in commercially-available products or in working prototypes to be technologically feasible. *See generally* 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, section 6(b)(3)(i) and 7(b)(1).

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) Practicability to manufacture, install, and service; (2) adverse impacts on equipment utility or availability; (3) adverse impacts on health or safety and (4) unique-pathway proprietary technologies. *See generally* 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5). Section IV.B of this document discusses the results of the screening analysis for UFHWSTs, particularly the designs DOE considered, those it screened out, and those that are the basis for the standards considered in this rulemaking.

2. Maximum Technologically Feasible Levels

As when DOE proposes to adopt an amended standard for a type or class of covered equipment, the Department determines the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such equipment. Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for UFHWSTs, using the design parameters for the most efficient equipment available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C of this final determination.

D. Energy Savings

1. Determination of Savings

For each efficiency level (''EL'') evaluated, DOE projected energy savings from application of the efficiency level to UFHWSTs purchased in the 30-year period that begins in the assumed year of compliance with potential amended standards (2025–2054). The savings are measured over the entire lifetime of UFHWSTs purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each efficiency level as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for the subject equipment would likely evolve in the absence of amended energy conservation standards.

DOE used a simplified national impact analysis (''NIA'') spreadsheet model to estimate national energy savings (''NES'') from potential amended standards for UFHWSTs. The simplified NIA for this analysis quantifies the potential energy savings from potential efficiency improvements for UFHWSTs; however, it does not estimate the net present value (''NPV'') to the Nation of these savings that is typically performed as part of the NIA. The simplified NIA spreadsheet model (described in section IV.G of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by equipment at the locations where it is used. DOE also calculates NES in terms of full-fuel-cycle (''FFC'') energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy conservation standards.[6] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.G.1 of this document.

2. Significance of Savings

In determining whether amended standards are needed for covered equipment addressed by ASHRAE Standard 90.1, DOE must determine whether such action would result in significant additional conservation of energy. (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(A)(ii)(II))

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking. For example, the United States has now rejoined the Paris Agreement on February 19, 2021. As part of that agreement, the United States has committed to reducing GHG emissions in order to limit the rise in mean global temperature.[7] Additionally, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand.

Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis. DOE has estimated the potential full-fuel cycle energy savings from an amended energy conservation standard for UFHWSTs at max-tech to be 0.058 quadrillion British thermal units (''quads'') over a 30-year analysis period (2025–2054). However, as explained in section V.B.2 of this document, DOE has encountered significant uncertainties related to its assessment of the energy savings potential of more-stringent amended energy conservation standards for UFHWSTs.

E. Economic Justification

As noted previously, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (*See* 42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

1. Economic Impact on Manufacturers and Consumers

In determining the impacts of potential amended standards on manufacturers, DOE typically conducts a manufacturer impact analysis (''MIA''). In conducting an MIA, DOE uses an annual cash-flow approach to determine the quantitative impacts between the no-new-standards and the potential amended standards cases. The industry-wide impacts analyzed typically include: (1) Industry net present value (''INPV''), which values the industry on the basis of expected

[6] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51281 (August 18, 2011), as amended at 77 FR 49701 (August 17, 2012).

[7] *See* Executive Order 14008, ''Tackling the Climate Crisis at Home and Abroad,'' 86 FR 7619 (Feb. 1, 2021).

future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. DOE has determined that the energy conservation standard for UFHWSTs does not need to be amended, and, therefore, this final determination has no cash-flow impacts on manufacturers. Accordingly, DOE did not conduct an MIA for this final determination.

For individual consumers, measures of economic impact include the changes in life-cycle cost (''LCC'') and payback period (''PBP'') associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national net present value of the consumer costs and benefits expected to result from particular standards. DOE also evaluates the impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a standard. However, as discussed in more detail in section IV.E of this document, due to significant uncertainties regarding the costs of alterations to doorways and mechanical rooms (which may be required in certain replacement installations in order to get an UFHWST to its installation destination if additional insulation thickness makes the UFHWST too large for existing structures to accommodate) and the lack of data indicating the likelihood and cost of such alterations when required, any analysis conducted by DOE regarding the LCC or PBP would have a high degree of uncertainty in terms of the inputs to those analyses. Comments received regarding the potential installation cost impacts of UFHWSTs due to larger tank dimensions in pursuit of increased efficiency for replacement equipment are discussed in section IV.E.1 of this document, and the rationale for not conducting the LCC or PBP is discussed in more detail in section IV.E.2 of this document. The consumer economic impacts which are normally calculated as part of the LCC are inputs to DOE's National NPV estimates, but since the Department did not conduct an LCC analysis in the present case, DOE was unable to estimate the NPV for this final determination.

2. Savings in Operating Costs Compared to Increase in Price (LCC and PBP)

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6313(a)(6)(B)(ii)(II))) DOE typically conducts this comparison in its LCC and PBP analysis.

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

The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of more-efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect. This type of calculation is known as a ''simple'' payback period because it does not take into account changes in operating expenses over time or the time value of money (*i.e.,* the calculation is done at an effective discount rate of zero percent). Payback periods greater than the life of the equipment indicate that the increased total installed cost is not recovered by the reduced operating expenses.

For its LCC and PBP analysis, DOE assumes that consumers will purchase the equipment in the first year of compliance with new or amended standards. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. As discussed in section IV.E of this document, DOE did not conduct an LCC and PBP analysis for this final determination because the lack of data and high degree of uncertainty of the inputs to those analyses meant that the outputs would be of little value.

3. Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6313(a)(6)(B)(ii)(III)) As discussed in section IV.G of this document, DOE uses the NIA spreadsheet models to project national energy savings.

4. Lessening of Utility or Performance of Equipment

In establishing equipment classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered equipment. (42 U.S.C. 6313(a)(6)(B)(ii)(IV)) Because DOE is not amending standards for UFHWSTs, the Department has concluded that this final determination will not reduce the utility or performance of UFHWSTs.

5. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a standard. (42 U.S.C. 6313(a)(6)(B)(ii)(V)) Because DOE did not propose amended standards for UFHWSTs, DOE did not transmit a copy of its proposed determination to the Attorney General for anti-competitive review.

6. Need for National Energy Conservation

DOE also considers the need for national energy conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6313(a)(6)(B)(ii)(VI)) Because DOE has concluded that it lacks clear and convincing evidence that amended standards for UFHWSTs would result in significant additional conservation of energy and be technologically feasible and economically justified, DOE did not conduct a utility impact analysis or emissions analysis for this final determination.

7. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6313(a)(6)(B)(ii)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described previously, DOE could consider such information under ''other factors.''

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this final determination with regard to UFHWSTs. Separate subsections address each component of the factors for DOE's consideration, as well as corresponding analyses to the extent conducted. DOE used a spreadsheet tool to estimate the impact of potential energy conservation standards. This spreadsheet uses inputs from the energy use analysis and shipments projections and calculates a simplified NES expected to result from potential energy conservation standards.

A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, manufacturers, market characteristics, and technologies used in the equipment. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. DOE also had structured, detailed interviews conducted with representative manufacturers. During these interviews, engineering, manufacturing, procurement, and financial topics were discussed to validate assumptions used in DOE's analyses, and to identify key issues or concerns. These interviews were conducted under non-disclosure agreements (''NDAs''), so DOE does not document these discussions in the same way that it does public comments in the comment summaries and DOE's responses throughout the rest of this document.

The subjects addressed in the market and technology assessment for this rulemaking include: (1) A determination of the scope of the rulemaking and equipment classes; (2) manufacturers and industry structure; (3) shipments information; (4) market and industry trends, and (5) technologies or design options that could improve the energy efficiency of UFHWSTs. The key findings of DOE's market assessment are summarized in the following subsections.

1. Scope of Coverage and Equipment Classes

In this analysis, DOE relied on the definition of UFHWSTs in 10 CFR 431.102, which defines an UFHWST as a tank used to store water that is heated externally, and that is industrial equipment. Any equipment meeting the definition of an UFHWST is included in DOE's scope of coverage. UFHWSTs are not currently divided into equipment classes (*i.e.,* there is a single equipment class covering all UFHWSTs).

In the June 2021 NOPD, DOE did not propose to amend the definition of UFHWSTs or to divide UFHWSTs into separate equipment classes, stating that there was no indication the definition would benefit from an amendment or that further delineation of equipment classes was justified. 86 FR 30796, 30802 (June 10, 2021). In response to the June 2021 NOPD, the CA IOUs recommend that DOE explore whether separate product classes would remove technical and market barriers to the setting of more stringent standards and if it would be feasible to set different standards. Similarly, the CA IOUs requested that DOE investigate different markets and applications for these different types of equipment, stating that rated capacity, along with other performance-related features, may justify the recognition of subgroups of UFHWSTs as separate equipment classes with differing standards. (CA IOUs, No. 17 at p. 2)

In response, DOE notes that for consumer products, EPCA provides that DOE shall specify a level of energy use or efficiency higher or lower than that which applies (or would apply) for such type (or class) for any group of covered products which have the same function or intended use, if the Secretary determines that covered products within such group consume a different kind of energy or have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard from that which applies (or will apply) to other products within such type (or class). (42 U.S.C. 6295(q)(1)) However, there is no companion provision to 42 U.S.C. 6295(q)(1) for ASHRAE equipment. In addition, DOE continues to find that changes to the definition of UFHWST are unnecessary.

Therefore, in this Final Determination, DOE maintains the definition of UFWST and is not dividing UFHWSTs into separate equipment classes.

2. Technology Options

In the June 2021 NOPD, DOE identified several technology options that would be expected to improve the efficiency of UFHWSTs. 86 FR 30796, 30802 (June 10, 2021). These technology options were based on manufacturer equipment literature and publicly-available technical literature. Specifically, the technologies identified in the June 2021 NOPD included the following:

- Improved insulation R-value
  - Increased insulation thickness
  - Foam insulation
  - Advanced insulation types
    - Aerogel
    - Vacuum panels
    - Inert gas-filled panels
- Pipe and fitting insulation
- Greater coverage of tank surface area with foam insulation (*e.g.,* tank bottom)

In response to the June 2021 NOPD, Rheem commented that some foam systems can provide higher R-values but noted that there are variations with in-place foam properties such as densities within the cavity from the top to the bottom of the tank that will impact insulation performance. (Rheem, No. 15 at p. 2)

In the analysis for this final determination, DOE maintained the same set of technology options, which include foam insulation as suggested by Rheem.

B. Screening Analysis

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

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

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

(3) *Impacts on equipment utility or equipment availability.* If it is determined that a technology would have significant adverse impact on the utility of the equipment to significant subgroups of consumers or would result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time, it will not be considered further.

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

(5) *Unique-Pathway Proprietary Technologies.* If a design option utilizes proprietary technology that represents a unique pathway to achieving a given efficiency level, that technology will not be considered further due to the potential for monopolistic concerns.

10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3) and 7(b). In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed five criteria, it will be excluded from further consideration in the engineering analysis. The reasons for eliminating any technology are discussed in the following sections.

1. Screened-Out Technologies

In the June 2021 NOPD, DOE did not consider any advanced insulation types as a technology option to increase the insulation R-value for UFHWSTs. Based on feedback from manufacturers, DOE tentatively determined that use of advanced insulation types (such as vacuum panels or aerogels) could necessitate an extremely difficult change to the UFHWST manufacturing process due to the rigid nature of these materials and the high degree of customization and ports on UFHWSTs. Additionally, DOE is not aware of any UFHWST equipment on the market that incorporate aerogels, vacuum panels, or inert gas-filled panels. DOE found that polyurethane foam is the most commonly used type of insulation for meeting the minimum insulation requirement, but fiberglass and/or Styrofoam are often used in specific regions (*e.g.,* tank tops or bottoms, or regions around ports) where applying polyurethane foam could limit access to ports or be impractical to manufacture. As discussed in the June 2021 NOPD, DOE included a minimum amount of insulation other than polyurethane foam around pipes and fittings in its analysis of baseline equipment, but it did not consider requiring different insulation materials in these regions. For similar reasons, DOE did not consider additional insulation coverage around pipes and fittings as a technology option for the analysis. 86 FR 30796, 30803 (June 10, 2021).

DOE did not receive any comments in response to the June 2021 NOPD suggesting any changes to the results of its screening analysis.

2. Remaining Technologies

In the June 2021 NOPD, DOE retained improved insulation R-value due to increased polyurethane foam thickness as a design option in the engineering analysis. DOE determined that this technology option is technologically feasible because it only involves an increase in thickness of the same insulation material that is currently used on UFHWSTs, and can be achieved with the same processes that are currently being used in commercially-available equipment or working prototypes (*e.g.,* fabricating jackets or foaming). 86 FR 30796, 30803 (June 10, 2021). DOE did not receive any comments opposing the use of this design option, and considered it for the engineering analysis for this final determination.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of UFHWSTs at different levels of reduced heat loss (''efficiency levels'').[8] There are typically two elements to consider in the engineering analysis; the selection of efficiency levels to analyze (*i.e.,* the ''efficiency analysis'') and the determination of equipment cost at each efficiency level (*i.e.,* the ''cost analysis''). In determining the performance of higher-efficiency equipment, DOE considers technologies and design option combinations not eliminated by the screening analysis. DOE then typically estimates the baseline cost, as well as the incremental cost for the equipment at efficiency levels above the baseline, up to the max-tech efficiency level for each equipment class. The typical output of the engineering analysis is a set of cost-efficiency ''curves'' that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA). However, for the reasons discussed in section IV.C.3 of this document, the cost analysis was not performed for this final determination.

1. Efficiency Analysis

DOE typically uses one of two approaches to develop energy efficiency levels for the engineering analysis: (1) Relying on observed efficiency levels in the market (*i.e.,* the efficiency-level approach), or (2) determining the incremental efficiency improvements associated with incorporating specific design options to a baseline model (*i.e.,* the design-option approach). Using the efficiency-level approach, the efficiency levels established for the analysis are determined based on the market distribution of existing equipment (in other words, based on the range of efficiencies and efficiency level ''clusters'' that already exist on the market, without regard to the specific design options used to achieve those levels). Using the design option approach, the efficiency levels established for the analysis are determined through detailed engineering calculations and/or computer simulations of the efficiency improvements from implementing specific design options that have been identified in the technology assessment. DOE may also rely on a combination of these two approaches.

In the June 2021 NOPD, DOE adopted a design-option approach. DOE identified very few models of UFHWSTs on the market that are marketed with higher insulation levels than the current baseline requirement of R–12.5. However, as discussed later in this section, in the interim since the publication of the June 2021 NOPD, UFHWSTs have been certified in DOE's CCD with R-values up to R–30. Therefore, for the current analysis, DOE is using the efficiency-level approach to determine the ''max-tech'' efficiency level as the maximum efficiency level available on the market. However, DOE is retaining the design-option approach for setting intermediate efficiency levels because of the limited range of R-values among UFHWSTs on the market between the baseline and max-tech.

In response to the June 2021 NOPD, BWC commented that it is concerned about foam consistency and quality at thicknesses approaching or exceeding 3 inches. BWC stated that it is difficult to ensure that the foam would evenly flow circumferentially, as well as vertically, on the tank given the size and many features on tanks. BWC asserted that this could ultimately compromise perceived efficiency improvements from increased foam thicknesses. (BWC, No. 14 at p. 1) Similarly, Rheem recognized that some foam systems can provide higher R-values, but the commenter pointed out that there are variations with in-place foam properties, such as densities within the cavity from the top to the bottom of the tank, that will impact insulation performance. (Rheem, No. 15 at p. 2) Rheem suggested that applying more than 3 inches of polyurethane foam insulation to a jacketed tank is challenging and can lead to larger variation with in-place density and foam, which it stated would impact insulation quality and contributes to a decrease in R-values. Rheem also stated that R-values of 6.25 per inch of insulation can be achieved with larger cavities but said that this is impractical and costly to manufacture, especially with the highly customized tanks and relatively small market production quantities for UFHWSTs. (Rheem, No. 15 at pp. 1–2)

Rheem further stated that there are diminishing returns from increasing insulation thicknesses due to the increased surface area and heat transfer rate. (Rheem, No. 15 at p. 2). Similarly,

[8] While the UFHWSTs standard addresses heat loss through establishing a minimum level of insulation, for the purpose of this analysis, the levels of improvement are referred to generally as ''efficiency levels.''

A.O. Smith stated that in its experience, polyurethane foam insulation collapses when expanding in a cavity greater than 3 inches (which in turn leads to increased heat loss). The commenter stated that it did experience greater reliability when exceeding 3 inches of thickness for polyurethane foam insulation by sequentially adding several layers of insulation but added that this process came at significant cost, including increased curing time, longer manufacturing times, as well as increased capital and labor. (A.O. Smith, No. 16 at p. 2) A.O. Smith also recommended that the Department engage with the U.S. Environmental Protection Agency (''EPA'') and industry moving forward regarding the efficacy of polyurethane foam properties, given evolving chemical regulations. (A.O. Smith, No. 16 at p. 2)

Rheem and A.O. Smith also stated that they support the insulation thickness levels (up to 3 inches) as well as the R-value per inch (6.25) used in DOE's analysis. (Rheem, No. 15 at p. 2; A.O. Smith, No. 16 at p. 2)

For each equipment class, DOE generally selects a baseline model as a reference point for each class, and measures changes resulting from potential energy conservation standards against the baseline. The baseline model in each equipment class represents the characteristics of equipment typical of that class (*e.g.,* capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market.

Based on its review of publicly-available equipment information and feedback from manufacturers, DOE found that 2 inches of polyurethane foam insulation provides a level of insulation that meets the current insulation requirement, and DOE, therefore, considered this insulation thickness as the baseline. As discussed in section IV.B.2 of this document, increased polyurethane foam insulation thickness was the only technology option that was not screened-out for this analysis, and thus, DOE considered more-stringent efficiency levels (*i.e.,* increased R-value) based on varying levels of increased polyurethane foam thickness. As discussed in the June 2021 NOPD, based on feedback from manufacturers and its own review of the UFHWST market, improvement in R-value as insulation thickness increases beyond 3 inches for jacketed tanks is unclear due to the lack of models on the market with thicker insulation and manufacturers' feedback that increasing thickness beyond 3 inches is impractical. Therefore, DOE limited its analysis in the June 2021 NOPD to considering only up to 1 additional inch of insulation thickness above the baseline insulation level of 2 inches (*i.e.,* 3 inches of foam insulation was considered the max-tech efficiency level for UFHWSTs). 86 FR 30796, 30804 (June 10, 2021).

As noted, UFHWSTs are currently certified in DOE's CCD with insulation R-values up to R–30. From a review of product literature,[9] DOE found that these products are insulated with polyurethane foam and have a stated insulation thickness of 5 inches. Based on the presence of these UFHWSTs on the market and their represented R-value, DOE updated its analysis from the June 2021 NOPR to use R–30 as the max-tech level, as this level of insulation has now been demonstrated to be technologically feasible.

In response to manufacturer concerns that insulation levels beyond 3 inches would be difficult or impossible to achieve, DOE notes that such products are now on the market, demonstrating that they are feasible to manufacture. Therefore, DOE has concluded that the R–30 level is appropriate for consideration in this analysis. The conversion costs to produce higher levels of insulation would typically be accounted for in the MIA. However, as discussed in section III.E.1 of this document, DOE did not complete an MIA for this analysis because DOE is not amending standards for UFHWSTs. Similarly, in response to A.O. Smith's suggestion that DOE engage with the EPA and industry moving forward regarding the efficacy of polyurethane foam properties given ever evolving chemical regulations, DOE notes that it is not amending standards for UFHWSTs in this final determination but will consider the impact of chemical regulations of foam efficacy in future rulemakings.

For the evaluated insulation at a thickness less than the R–30 max-tech level, DOE estimated an R-value per inch of 6.25 because UFHWSTs are typically capable of achieving R–12.5 using 2 inches of insulation. For the max-tech level, DOE estimated an R-value per inch of 6.00 based on the certified R-value and the insulation thickness specified in manufacturer literature, which represents the insulation properties demonstrated in the current tanks. The reduction in R-value per inch of insulation seen in units with increased insulation thickness illustrates the uncertainty associated with improvements in R-value as jacket thickness increases. This reduction in R-value at higher thicknesses of insulation is also consistent with feedback from manufacturers that the R-value per inch of polyurethane foam insulation would be uncertain at thicknesses greater than 3 inches. (*See* discussion of comments received earlier in this section.)

DOE included this updated max-tech efficiency level in its analysis in addition to the two efficiency levels considered in the June 2021 NOPD: R–15.625 and R–18.75, which correspond to 2.5 and 3 inches of polyurethane foam insulation, respectively. DOE did not receive any comments in response to the June 2021 NOPD suggesting that the efficiency levels previously analyzed should be adjusted, and did not identify any information that would support adjusting the insulation thickness or the assumed R-value per inch at those levels. The efficiency levels used in the analysis for this final determination are shown in Table IV.1.

TABLE IV.1—EFFICIENCY LEVELS FOR REPRESENTATIVE UFHWSTS BASED ON INCREASED INSULATION

Efficiency level	Insulation thickness (polyurethane foam)	R-value per inch of insulation	R-value of insulation
Baseline—EL0	2 inches	6.25	R–12.5.
EL1	2.5 inches	6.25	R–15.625.
EL2	3 inches	6.25	R–18.75.
EL3	5 inches	6.0	R–30.

[9] See: *www.hotwater.com/water-heaters/commercial/storage-tanks/jacketed---hpwh-optimized/* (Last accessed Feb. 21, 2022).

2. Representative Equipment for Analysis

For the engineering analysis, DOE analyzed the publicly-available details, including storage volumes and other critical features, of UFHWST models available on the market to determine appropriate representative equipment to analyze. DOE also discussed the appropriate representative characteristics with UFHWST manufacturers during interviews. For the June 2021 NOPD, DOE determined the dimensions in Table IV.2 to be representative of the UFHWST market.

TABLE IV.2—REPRESENTATIVE TANK CHARACTERISTICS USED IN THE JUNE 2021 NOPD

Volume range	Representative volume *(gal.)*	Representative dimensions	
		Height *(in.)*	Diameter *(in.)*
0 to 100	50	47	22
101 to 250	175	65	28
251 to 500	375	72	42
501 to 1000	750	141	42
1,001 to 2,000	1,500	124	60
2,001 to 5,000	3,500	168	84
>5,000	5,000	180	96

In response to the June 2021 NOPD, A.O. Smith suggested alternative dimensions for several representative tank sizes. Specifically, it recommended a height of 34 inches and a diameter of 24 inches for a 50-gallon tank, a height of 87 inches and a diameter of 36 inches for a 375-gallon tank, a height of 100 inches and a diameter of 48 inches for a 750-gallon tank, a height of 204 inches and a diameter of 72 inches for a 3,500-gallon tank, and a height of 283 inches and a diameter of 72 inches for a 5,000-gallon tank. A.O. Smith also suggested that tanks of 3,500 and 5,000 gallons should be installed horizontally. (A.O. Smith, No. 16 at p. 3)

Rheem recommended that an 80-gallon tank be used instead of a 50-gallon tank to represent tanks in the 0 to 100 gallon volume range, because this volume would better represent commercial applications as the predominant installation size. Rheem suggested that 50 gallons is more representative of light commercial and some residential applications. (Rheem, No. 15 at p. 2) After further reviewing UFHWSTs on the market between 0 and 100 gallons, DOE agrees with this comment and changed the representative size for this volume range to 80 gallons in the analysis for this final determination.

Rheem also suggested that the diameter and height for an 80-gallon tank should be 24 inches and 58 inches, respectively, and suggested that the dimensions of the 175-gallon tank should be 67 inches in height and 32 inches in diameter. (Rheem, No. 15 at p. 2) Based on a review of manufacturer specification sheets for 80-gallon models on the market, DOE agrees that Rheem's suggested dimensions for the 80-gallon tank are appropriate and has updated its representative dimensions for this final determination accordingly. However, based on review of the manufacturer specification sheets for other sizes of UFHWSTs on the market, DOE did not conclude that the representative dimensions used for other volumes of tanks should be changed. These dimensions were determined based on DOE's review of the entire market, as well as feedback from manufacturers during manufacturer interviews.

In the June 2021 NOPD, DOE acknowledged comments regarding the customized and variable nature of the UFHWST market. 86 FR 30796, 30804 (June 10, 2021). To account for the wide range of UFHWSTs on the market, DOE chose several representative baseline units for analysis. DOE also included several ambient temperature conditions in its energy use analysis to reflect typical installation locations (*i.e.,* indoors in mechanical rooms or outdoors in ''Very Hot'' and ''Hot'' regions). DOE also noted that UFHWSTs can be installed in either a vertical or horizontal orientation. As discussed in section IV.D.1.b of this document, for the energy use analysis, DOE employed a conservative assumption that a tank would always be full of hot water and, therefore, did not consider stratification of water temperature inside the tank. Under this assumption, installation orientation would not have a significant impact on its energy use analysis results. As such, DOE included only vertically-oriented units (which are the most common) in the representative equipment analyzed. In light of these considerations, the characteristics of the representative units evaluated (including the change to an 80 gallon unit for the 0–100 gallon range) are listed in Table IV.3.

TABLE IV.3—REPRESENTATIVE TANK CHARACTERISTICS USED IN THE FINAL DETERMINATION

Volume range	Representative volume (*gal.*)	Representative dimensions	
		Height (*in.*)	Diameter (*in.*)
0 to 100	80	58	20
101 to 250	175	65	28
251 to 500	375	72	42
501 to 1,000	750	141	42
1,001 to 2,000	1,500	124	60
2,001 to 5,000	3,500	168	84
>5,000	5,000	180	96

3. Cost Analysis

The cost analysis portion of the engineering analysis is conducted using one or a combination of cost approaches. The selection of cost approach depends on a suite of factors, including the availability and reliability of public information, characteristics of the regulated equipment, the availability and timeliness of purchasing the equipment on the market. The cost approaches are summarized as follows:

• *Physical teardowns:* Under this approach, DOE physically dismantles commercially-available equipment, component-by-component, to develop a detailed bill of materials for the equipment.

• *Catalog teardowns:* In lieu of physically deconstructing equipment, DOE identifies each component using parts diagrams (available from sources such as manufacturer websites or appliance repair websites) to develop the bill of materials for the equipment.

• *Price surveys:* If neither a physical nor catalog teardown is feasible (*e.g.,* for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable), cost-prohibitive, or otherwise impractical (*e.g.,* large commercial boilers), DOE conducts price surveys using publicly-available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.

As discussed in section IV.E of this document, DOE did not conduct a cost analysis because DOE did not have the requisite inputs to develop its LCC model with a degree of certainty that would meet the statute's ''clear and convincing'' evidentiary threshold. Accordingly, DOE did not generate a cost-efficiency curve, as it would not be necessary without an LCC model to feed into.

D. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of UFHWSTs at different efficiencies in representative U.S. commercial buildings and industrial facilities, and to assess the energy savings potential of increased UFHWST efficiency. The energy use analysis estimates the range of energy use of UFHWSTs in the field (*i.e.,* as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessment of the energy savings that could result from adoption of amended or new standards.

As discussed, UFHWSTs store hot water and do not directly consume fuel or electricity for the purpose of heating water, so any potential amendments to the standard would reduce standby loss of heat from the stored water. Further, DOE currently only prescribes a minimum insulation requirement (as opposed to a minimum efficiency requirement) for UFHWSTs. Accordingly, the energy use analysis determines the annual energy consumption of paired water heaters and boilers due to standby loss of the UFHWSTs and assesses the energy savings potential of increasing the stringency of the required insulation for UFHWSTs.

1. Tank Thermal Loss Model

As discussed in the June 2021 NOPD, for this determination, DOE adapted the thermal loss model described in the technical support document (''TSD'') for the commercial water heating (''CWH'') energy conservation standards (''ECS'') NOPR published in the **Federal Register** on May 31, 2016 (81 FR 34440; ''May 2016 CWH ECS NOPR''), with some modifications to how the tank surface areas are defined.[10] 86 FR 30796, 30806 (June 10, 2021). These modifications were introduced to capture equipment performance that results from differences in surface insulation thickness over different areas of the tank (*i.e.,* insulation around fittings and access ports). These differences are described in section IV.D.1.a of this document.

DOE received comment from both the CA IOUs and Rheem on its energy use analysis. The CA IOUs suggested that DOE should find alternative methods to analyze the energy consumption of UFHWSTs or solicit assistance from stakeholders because, they stated that the challenges of evaluating the impacts and feasibility of energy efficiency standards for UFHWSTs should not prompt DOE to forego updating those standards. (CA IOUs, No. 17 at p. 4) In contrast, Rheem stated that the Tank Thermal Loss Model was appropriate for this analysis. (Rheem, No. 15 at p. 3) DOE did not receive any further specific input or information from stakeholders on its Tank Thermal Loss Model. After again considering the available information, DOE did not identify alternative models appropriate for the analysis conducted for this determination. Accordingly, DOE has elected to maintain its modeling approach for this final determination.

[10] Available at: *www.regulations.gov/document?D=EERE-2014-BT-STD-0042=0016,* section 5.5.3 (Last accessed: April 8, 2020).

$$Q_{hr,j} = \sum_{i=1}^{6} \frac{A_{i,j} \times (T_i - T_{amb,z})}{R_{i,j}}$$

Where:

$Q_{hr,j}$ = The hourly heat loss for the UFHWST for each efficiency level j (Btu/hr).

i = The surface area of the cylindrical tank is divided into different zones each indexed i.

$A_{i,j}$ = The area of each zone i at each efficiency level j (ft^2).

T_i = The constant internal water temperature for each tank zone i (°F).

$T_{amb,z}$ = The ambient air temperature for each climate zone z (°F).

$R_{i,j}$ = The net R-value of the insulation for each zone i at each efficiency level j (°F · ft^2 · hr/Btu).

a. Tank Surface Area (Ai, j)

DOE maintained the approach it used in the June 2021 NOPD for this final determination, where DOE used a conservative assumption in its energy use analysis that water temperature would remain uniformly at 140 °F and did not consider stratification of water temperatures inside the tank. 86 FR 30796, 30806 (June 10, 2021). Therefore, although tanks can be installed horizontally or vertically, there is no difference in thermal losses between these configurations, and DOE only used vertical tanks in its analysis. The UFHWST's total external surface area was divided into separate zones, where i is the index for each zone. Zones represent the different areas of an UFHWST that would have unique insulative values.

$A_{TankTop}$ = When the UFHWST is oriented vertically, this represents the tank's top surface.

$A_{Fittings}$ = Is the sum of all uninsulated areas of the tank's surface devoted to fittings.

$A_{FittingInsulation}$ = Is the sum of all insulated areas of the tank's surface surrounding the (uninsulated) fittings.

$A_{AccessPort}$ = Is the sum of all insulated areas of the tank's surface devoted to the tank's clean-out hand hole port or manhole.

$A_{TankWall}$ = When the UFHWST is oriented vertically, this represents the tank's walls.

$A_{TankBottom}$ = When the UFHWST is oriented vertically, this represents the tank's bottom surface.

In response to the June 2021 NOPD, A.O. Smith stated that it has not conducted any tests to validate DOE's Tank Thermal Loss Model but recommended that any tests conducted to validate the Tank Thermal Loss Model must include an uninsulated temperature and pressure relief valve installed in a fitting in the top 6 inches of the tank. The commenter stated that a temperature and pressure relief valve is a mandatory safety device that will be installed on each UFHWST and is not permitted by most applicable safety codes to be covered. (A.O. Smith, No. 16 at p. 4) In response and as discussed in this section, DOE's Tank Thermal Loss Model accounts for small areas of uninsulated tank to reflect losses through adjoining pipes or fittings at each of several ports. DOE maintained the quantity of uninsulated ports that were discussed in the June 2021 NOPD, which specifically included reference to a temperature and pressure relief valve. 86 FR 30796, 30805 (June 10, 2021).

b. Tank Internal Water Temperature (Ti)

For the June 2021 NOPD analysis, DOE assumed that the water inside the UFHWSTs is at a constant uniform temperature of 140 °F, which is the average water temperature required by the current Federal test procedures for storage-type CWH equipment during standby loss testing. 86 FR 30796, 30806 (June 10, 2021). (*See generally* 10 CFR 431.106; 10 CFR part 431, subpart G, appendix A, section 6; 10 CFR part 431, subpart G, appendix B, section 5.) Because UFHWSTs serve the same function as storage-type CWH equipment in standby mode, DOE reasoned that similar conditions would be appropriate for UFHWSTs as for storage-type CWH equipment in standby mode. *Id.* DOE used a conservative assumption that internal water temperatures would remain indefinitely at 140 °F. In reality, the rate of heat loss from a UFHWST would decrease slowly as the temperature difference between the internal stored water and the ambient air decreased. However, because this effect would be minimal, DOE did not consider stratification of water temperatures inside the tank and assumed that a tank would always be full of hot water. Therefore, DOE held the temperature *T* constant across all tank zones *i. Id.*

DOE received comments from a number of stakeholders regarding the assumed constant internal water temperature of 140 °F. The CA IOUs commented that many common commercial hot water applications require temperatures higher than 140 °F and stated that the Centers for Disease Control and Prevention notes in its Environmental Infection Control Guidelines that a temperature of 160 °F is recommended for clothes washing in healthcare facilities. (CA IOUs, No. 17 at p. 2)

Rheem stated that typical storage water temperatures are between 120 °F and 180 °F for food service, laundry, and commercial building applications or between 120 °F and 130 °F for commercial buildings not requiring sanitation. Rheem stated that a constant internal tank temperature of 140 °F is an appropriate estimate for the purposes of DOE's analysis. (Rheem, No. 15 at p. 2) A.O. Smith stated that it agrees with DOE's use of 140 °F as a constant internal water temperature. (A.O. Smith, No. 16 at p. 3)

Given the wide range of temperatures provided by stakeholders above and below DOE's assumed internal temperature, DOE finds the 140 °F to be reasonably representative of UFHWST use in the field. The 140 °F is within the range of temperatures suggested by commenters. The data sources examined by DOE (*i.e.,* recent versions of the Commercial Building Energy Consumption Survey (''CBECS'')),[11 12] while containing information on primary business activity, do not contain information from which to infer an average internal tank water temperature. Additionally, commenters did not provide data in terms of percentage of applications at which the various internal temperatures are realized. As such, DOE maintained its use of 140 °F for this final determination.

c. Tank Ambient Temperature (Tamb, z)

For the June 2021 NOPD, DOE assumed that all tanks that are installed indoors would have a constant ambient temperature of 75 °F, which is the average air temperature specified by the current Federal test procedure for storage-type CWH equipment during standby loss testing. 86 FR 30796, 30806 (June 10, 2021). *See generally* 10 CFR 431.106; 10 CFR part 431, subpart G, appendix A, section 6; 10 CFR part 431, subpart G, appendix B, section 5.

Both Rheem and A.O. Smith commented on DOE's assumed use of 75 °F as the constant average ambient temperature. Rheem supported the ambient temperature of 75 °F used as a representative value for indoor installations. (Rheem, No. 15 at p. 3) In contrast, A.O. Smith suggested that 78 °F would be more accurate for indoor ambient temperatures. (A.O. Smith, No. 16 at p. 3)

In response, DOE understands that indoor ambient temperatures seen in the field will be a distribution of values depending on the location of the UFHWST within the building and that this location may be conditioned to a temperature other than 75 °F, or not conditioned at all. As discussed, UFHWSTs serve the same function as storage-type CWH equipment in standby mode, and DOE expects that similar conditions would be appropriate for UFHWSTs as for storage-type CWH equipment in standby mode. For the purpose of this simplified energy savings estimate for this final determination, DOE finds that the use of the 75 °F applicable under the CWH test procedure is appropriately representative for UFHWSTs.

DOE notes that A.O. Smith did not provide a basis for its suggestion to test at 78 °F, which would increase the ambient air temperature as compared to the current DOE test procedure. Increasing the ambient temperature would lower the temperature differential between the UFHWST's internal and ambient temperature, thereby reducing the projected potential energy savings. Given the unsubstantiated nature of A.O. Smith's comment and for the reasons discussed, DOE maintained its use of 75 °F as the indoor constant ambient temperature for this final determination.

As stated in the June 2021 NOPD, based on feedback from manufacturers during interviews conducted under NDA, DOE assumed that 90 percent of UFHWSTs would be installed indoors and that the remaining 10 percent would be installed outdoors. 86 FR 30796, 30806 (June 10, 2021).

Rheem agreed with DOE's assumption that 10 percent of all UFHWSTs are installed outdoors. (Rheem, No. 15 at p. 3) A.O. Smith suggested that the Department's assumption that 10 percent of all UFHWSTs are installed outdoors may be overstated. (A.O. Smith, No. 16 at p. 3) However, A.O. Smith did not provide a basis for its assertion and did not provide an alternate percentage to consider. Absent additional support for a different value, for this final determination, DOE maintained its assumption that 10 percent of UFWHSTs are installed outdoors.

A.O. Smith stated that outdoor tanks tend to be taller and have larger volumes than indoor tanks, but R-values are generally consistent with indoor tanks. (A.O. Smith, No. 16 at p. 3) Rheem stated that typical capacities used for outdoor applications include 235, 335, 499, 534-gallon sizes; smaller tanks not specifically intended for outdoor installation may also be placed outside with applied weatherization; and outdoor models can have 2.5 to 3 inches of spray foam insulation and be

[11] Presently, the 2018 edition of CBECs is the most recent version. Energy Information Administration (EIA), 2018 Commercial Building Energy Consumption Survey (CBECS) (Available at: *www.eia.gov/consumption/commercial/*) (Last accessed Feb. 10, 2021).

[12] Energy Information Administration (EIA), 2012 Commercial Building Energy Consumption Survey (CBECS) (Available at: *https://www.eia.gov/consumption/commercial/*) (Last accessed April 4, 2019).

rated as high as R–16. (Rheem, No. 15 at p. 3)

Furthermore, Rheem stated that in addition to climate zones 1A, 2A, and 2B, UFHWSTs are installed in some areas of climate zones 3 and 4. Rheem also stated that given indoor space constraints and rising construction costs, installation outdoors in colder climate zones with added pipe and fittings insulation and freeze protection is becoming more viable. (Rheem, No. 15 at p. 3)

For this final determination, for the fraction of UFHWSTs modeled as installed in outdoor spaces, or in non-conditioned spaces, DOE expanded the applicable climate zones (*z*) and calculated the monthly average temperatures from Typical Meteorological Year 3 (''TMY3'')[13] data for the Building America climate regions 1A, 2A, 2B, 3A, 3B, 3C, 4A, 4B, and 4C.[14] [15] The temperatures for each region are represented by the cities in Table IV.4. The monthly regional averages were then weighted using the regional city populations based on 2018 Census data.[16] Additionally, DOE revised its capacity weighting assumptions for outdoor installed tanks to account for the larger capacities described by both A.O. Smith and Rheem; these capacity weights are shown in Table IV.5.

TABLE IV.4—CLIMATE ZONES AND REPRESENTATIVE CITIES

Climate zone	Population	Representative city	TMY location #
1A	6,208,359	Miami	722020
2A	38,418,718	Houston	722430
2B	6,869,283	Phoenix	722780
3A	43,230,951	Atlanta	722190
3B—CA	29,951,605	Los Angeles	722950
3B—Non CA	5,546,151	Las Vegas	723677
3C	8,596,694	San Francisco	724940
4A	69,154,015	Baltimore	724060
4B	2,245,023	Albuquerque	723650
4C	9,696,610	Seattle	727930
5A	70,727,419	Chicago	725300
5B	13,119,013	Boulder	724699
6A	17,705,715	Minneapolis	726580
6B	2,650,907	Helena	727720
7	2,625,239	Duluth	727450
8	170,286	Fairbanks	702610

TABLE IV.5—CAPACITY WEIGHTING OF INDOOR VERSUS OUTDOOR UFHWSTS

Capacity range (*gal*)	Indoor weighting factor	Outdoor weighting factor
60 to 100	0.05	0
101 to 250	0.2	0.21
251 to 500	0.3	0.32
501 to 1000	0.2	0.21
1001 to 2000	0.15	0.16
2001 to 5000	0.09	0.09
>5000	0.01	0.01

Table IV.6 provides the monthly average ambient temperature values, $T_{amb,\ z}$, for each of the Climate Zones considered in this final determination.

TABLE IV.6—AVERAGE MONTHLY AMBIENT TEMPERATURES

Climate zone	Location weight	Average temperature for month (° F)											
		1	2	3	4	5	6	7	8	9	10	11	12
1A	0.028	67.0	69.6	70.8	75.4	79.5	81.8	82.6	82.4	81.5	79.4	74.5	68.5
2A	0.175	50.9	55.0	61.2	68.9	75.3	80.6	82.9	82.8	79.6	68.6	62.8	54.6
2B	0.031	55.4	60.2	63.2	74.6	81.1	93.2	96.0	92.9	86.7	76.7	64.3	53.1
3A	0.197	39.1	46.3	56.8	63.0	69.5	76.6	78.9	79.8	72.5	60.8	53.5	45.9
3B—CA	0.136	56.7	57.6	58.2	60.4	62.6	64.7	67.8	68.1	67.7	64.7	61.2	57.8
3B—Non CA	0.025	37.6	37.6	40.6	53.4	58.9	65.1	68.6	66.0	63.6	50.5	40.3	34.5

[13] The TMY data sets hold hourly values of solar radiation and meteorological elements for a 1-year period. Their intended use is for computer simulations of solar energy conversion systems and building systems to facilitate performance comparisons of different system types, configurations, and locations in the United States and its territories. Because they represent typical rather than extreme conditions, they are not suited for designing systems to meet the worst-case conditions occurring at a location.

[14] Wilcox, S. and W. Marion, 2008 User's Manual for TMY3 Data Sets, NREL/TP–581–43156 (April 2008) (Available at: *www.nrel.gov/docs/fy08osti/43156.pdf*) (Last accessed November 2021).

[15] Building America Best Practices Series, Volume 7.3, Guide to determining climate regions by county 2015 (Available at: *www.energy.gov/sites/prod/files/2015/10/f27/ba_climate_region_guide_7.3.pdf*).

[16] U.S. Census Population Estimates by County, as of 2018 (Available at: *www.census.gov/data/tables/time-series/demo/popest/2010s-counties-total.html#par_textimage*) (Last accessed April 1, 2022).

TABLE IV.6—AVERAGE MONTHLY AMBIENT TEMPERATURES—Continued

Climate zone	Location weight	Average temperature for month (°F)											
		1	2	3	4	5	6	7	8	9	10	11	12
3C	0.039	49.3	52.3	54.8	56.6	59.0	59.6	60.7	61.9	62.1	59.2	55.0	51.2
4A	0.314	31.1	36.0	46.4	55.7	65.0	73.3	77.6	75.7	68.8	54.8	48.0	35.7
4B	0.010	36.7	39.7	47.8	57.0	64.1	73.8	78.1	75.3	68.9	56.7	44.5	35.7
4C	0.044	40.1	42.5	47.0	51.5	55.4	60.1	63.8	65.8	59.2	52.6	46.5	41.8
Indoor	0.90	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0

d. R-Value of Insulation (Ri, j)

The R-value of each zone *i* of the UFHWST is defined for each efficiency level *j* in the engineering analysis in Table IV.1 and Table IV.3 of section IV.C of this document.

2. Annual Energy Use Due to UFHWST Losses

To calculate the energy used by the boiler attributable to the heat losses of the UFHWSTs, DOE maintained the approach from the June 2021 NOPD and used the following equation for each efficiency level listed in Table IV.1:

$$EBoil_j = Q_{hr,j} \times 8760 \times \frac{1}{Boiler_{\eta,yr}}$$

Where:

eBoil$_j$ = The energy by the boiler required to maintain the water temperature in the UFHWST at the temperature T_i at each efficiency level *j,* (Btu/yr),

$Q_{hr,\ j}$ = hourly heat loss for the UFHWST at each efficiency level *j* (see section IV.D.1, of this document) (Btu/hr), and

*Boiler*η = average boiler efficiency (%) in year *yr* (defined in section IV.G.4 of this document).

Table IV.7 presents the energy used by the boiler attributable to the heat losses of the UFHWST at the baseline (EL 0) and each efficiency level by tank capacity. Table IV.8 presents the resulting energy savings at each efficiency level above baseline. The representative storage volumes used in this analysis are discussed in section IV.C.2 of this document.

DOE did not receive any comment regarding annual energy use due to UFHWST losses and maintained its approach from the June 2021 NOPD for this final determination.

TABLE IV.7—BOILER ENERGY USE DUE TO UFHWST HEAT LOSSES IN 2025

[MMBtu/yr] [17]

EL	UFHWST capacity (*gal*)						
	80	175	375	750	1,500	3,500	5,000
0	2.28	3.42	5.56	9.79	12.82	22.53	27.48
1	2.00	2.94	4.70	8.35	10.80	18.67	22.68
2	1.82	2.63	4.13	7.39	9.46	16.10	19.48
3	1.48	2.03	3.01	5.49	6.81	10.99	13.10

TABLE IV—8 SAVINGS IN BOILER ENERGY USE DUE TO REDUCED UFHWST HEAT LOSSES IN 2025

[MMBtu/yr]

EL	UFHWST capacity (*gal*)						
	80	175	375	750	1,500	3,500	5,000
1	0.28	0.47	0.86	1.45	2.01	3.85	4.80
2	0.46	0.79	1.43	2.41	3.35	6.42	8.00
3	0.81	1.39	2.54	4.30	6.01	11.53	14.38

3. Additional Sources of Uncertainty

As discussed in section IV.C.2 of this document, the inputs to DOE's Tank Thermal Loss Model were primarily based on publicly-available information, DOE's previous knowledge of UFHWSTs, and feedback from manufacturers received during interviews conducted under NDAs. To validate the model, DOE compared the results produced by the model to results of testing previously conducted to evaluate the performance-based test procedure proposed for UFHWSTs in the May 2016 CWH TP NOPR, which was largely based on the standby loss test procedure for commercial storage water heaters. The proposed test procedure included a standby loss test that would be conducted as the mean tank water temperatures decay from 142 °F to 138 °F at a nominal ambient temperature of 75 °F. 81 FR 28588, 28603 (May 9, 2016). Standby loss tests were conducted on 17 UFHWSTs with an advertised insulation level of R–12.5

[17] The projected value for Boiler Efficiency (*Boiler*$_\eta$) is 0.922 in 2027. See section IV.G.4 of this document for more details.

and storage volumes of 40, 80, or 120 gallons in order to gather data on whether measured standby losses were consistent with what would be expected from tanks insulated to their rated and/or advertised insulation levels, to assess the repeatability and sensitivity of the proposed test procedure, and to gather data on the potential burden in conducting the testing.

DOE used the same analytical model described in this section to calculate the expected losses from each of these tanks, using their measured dimensions and actual number of ports. As discussed, the internal water temperature (140 °F) and ambient air temperature (75 °F) used for the analytical model were the same as the average temperatures seen during the physical testing. The same assumptions about insulation details (*e.g.,* R-values for different materials and the use of fiberglass around ports) were used as were used for the baseline (R–12.5) units in DOE's Tank Thermal Loss Model. The average predicted rate of standby losses for these tanks was 73 percent of the measured standby losses and ranged from as low as 58 percent of the measured losses up to 90 percent of the measured losses. Because the estimated standby losses are significantly lower than the measured losses, this suggests that DOE's Tank Thermal Loss Model undercounts the actual standby losses that would occur in the field. Furthermore, the wide range in calculated standby losses as compared to measured standby losses indicates that the accuracy of the thermal loss calculations in predicting the standby losses of a particular model will be somewhat unpredictable, thereby adding additional uncertainty.

Furthermore, when DOE conducted standby loss tests of UFHWSTs, it found that tanks with identical storage volumes, dimensions, number of ports, and nominal insulation levels differed by up to 8.5 percent, whereas DOE's model would predict the same level of standby losses for these tanks. This finding suggests that there may be variations in the extent of R–12.5 coverage between units, even between units from the same manufacturer. As discussed in section IV.C.2 of this document, it may not be practical to insulate all surfaces of UFHWSTs with polyurethane foam due to the nature of the insulation application process or the need to retain access to certain ports. Differences in manufacturers' tank designs, manufacturing processes, or their interpretations of the R–12.5 insulation requirement could lead to variations in the amount of tank surface area that is actually insulated with R–12.5. Therefore, tanks that appear to have the same attributes and insulation may have different levels of standby losses in the field. This source of potential variation in standby losses further supports DOE's conclusion that there may be additional sources of thermal losses that vary between tanks and that are not adequately captured in its current Tank Thermal Loss Model. This variation also makes it very difficult for DOE to characterize the representative performance of a "baseline" UFHWST, or the expected performance at any potential amended standard level, with a high degree of confidence since there is significant variation in thermal energy losses at a given efficiency level (R-value) that cannot be readily predicted or otherwise accounted for in the analysis. Due to these potential variations in insulation coverage and because DOE has not been able to verify its Tank Thermal Loss Model against its physical test results, there is significant uncertainty as to the validity of its energy use analysis.

E. Life-Cycle Cost and Payback Period Analysis

To determine whether a standard is economically justified, EPCA requires DOE to consider the economic impact of the standard on manufacturers and consumers, as well as the savings in operating costs throughout the estimated average life of the equipment compared to any increase in price, initial charges, or maintenance expenses of the equipment likely to result from the standard. (42 U.S.C. 6313(a)(6)(B)(ii)(I)–(II)) The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. To evaluate the economic impacts of potential energy conservation standards on consumers, in order to determine whether amended standards would be economically justified, DOE used the following two metrics to measure consumer impacts:

- The LCC is the total consumer expense of an appliance or equipment over the life of that equipment, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the equipment.
- The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of more-efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

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

1. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. In the June 2021 NOPD, DOE qualitatively examined certain factors that can impact the installation costs of UFHWST. 86 FR 80796, 80809–80810 (June 10, 2021). DOE acknowledged that that increasing installation costs can reduce, or even eliminate, the future economic consumer benefits from a potential new standard. *Id.* at 86 FR 80810. DOE tentatively agreed with the commenters that a small increase in tank dimensions, a change driven by the need to comply with a potential new standard case, could potentially disproportionately increase the installation costs for a fraction of consumers of replacement equipment. *Id.* DOE stated that while the fraction of impacted consumers is uncertain, DOE is certain that there will be some consumers who will experience these higher installation costs. *Id.* DOE further stated that these higher installation costs for replacement equipment create uncertainty regarding the positive economic benefits for a potentially significant fraction of consumers from an amended standard for UFHWSTs. *Id.*

In response to the June 2021 NOPD, DOE received comments regarding information related to costs resulting from building modifications due to increased equipment size. A.O. Smith stated that the primary consideration of the designing/specifying engineer when replacing a UFHWST is the required storage volume and frequency of hot water demand for the building/application. From there, an installation recommendation is made based upon constraints, including, but not limited to, doorways and passageways that can accommodate the installation of one or more new UFHWSTs. (A.O. Smith, No. 16 at p. 5) Rheem suggested that an increase in the overall dimensions, especially the diameter of UFHWST due to increased insulation thickness, could require modifications to existing doorways or mechanical rooms. Rheem stated that an increase in the overall dimensions of UFHWSTs would require additional space for installation, along with higher cost for transportation and handling of the tank until it reaches its final location. (Rheem, No. 16 at p. 3) Both A.O. Smith and Rheem agreed that the costs will vary substantially depending on the tank size, building type, and whether it is going to new construction or a replacement installation. Rheem commented that for new construction, the UFHWST installation can be better planned and located during the construction process, but future replacement will still present challenges. Rheem further commented that there are several requirements to consider in determining if restructuring a building is cost-effective or appropriate for a given installation and building, including compliance with building, mechanical, plumbing, and local codes and manufacturer's instructions. Rheem stated that installing floor tie downs, modifying fire-rated doorways and interior passage doors, and changing exit routes in a building are some examples of codes-related considerations. (Rheem, No. 15 at pp. 3–4; A.O. Smith, No. 16 at p. 4) Finally, A.O. Smith suggested that buildings associated with municipal, university, school, and hospital (''MUSH'') facilities will typically have equipment/mechanical rooms, and access thereto, that can accommodate the installation of UFHWSTs of slightly different sizes, including ones with modest increases in dimensions. In the commenter's experience, the more challenging installations are ones associated with ''high-rise buildings'' and historic buildings, in both urban and rural areas; according to A.O. Smith, these buildings often have equipment/mechanical rooms in basements or on the rooftop, which present unique and challenging circumstances for replacing a UFHWST generally, let alone with one that may have slightly larger dimensions. (A.O. Smith, No 16 at p. 5)

In response, the comments from A.O. Smith and Rheem reaffirmed DOE's understanding that potential amended standards for UFHWSTs could potentially disproportionately increase the installation costs for a fraction of consumers of replacement equipment. Absent further information or data on typical installations costs for UFHWST to indicate the contrary, DOE maintains the conclusion arrived at in the June 2021 NOPD: There is considerable uncertainty regarding future consumer economic benefits from increasing the efficiency of UFHWSTs.

2. Annual Energy Consumption

DOE typically determines the annual energy consumption for equipment at different efficiency levels. DOE's approach to determining the annual energy consumption of UFHWSTs is described in section IV.D of this document.

As discussed in section V.A.1 of this document, DOE estimates that amended standards at the max-tech level would result in FFC energy savings of 0.058 quads over 30 years. However, as discussed in sections IV.D and IV.E of this document, even small adjustments to several critical inputs to the model could have a large impact on these results and could significantly alter the findings. For example, as explained previously, the inputs to the Tank Thermal Loss Model are primarily based on publicly available data and information gathered during manufacturer interviews, but as discussed earlier, the results from this model underestimate losses as compared to those observed during testing of UFHWSTs that was previously done to evaluate the test procedure proposed for UFHWSTs in the May 2016 CWH TP NOPR. As noted in the June 2021 NOPD, when DOE conducted standby loss tests of UFHWSTs, it found that tanks with identical storage volumes, dimensions, number of ports, and nominal insulation levels differed by up to 8.5 percent, whereas DOE's model would predict the same level of standby losses for tanks with the same attributes and insulation. This finding suggests that there are variations in the extent of R–12.5 coverage between units, even between units from the same manufacturer. 86 FR 30796, 30808 (June 10, 2021). The unpredictable results of DOE testing meant that DOE was unable to validate its thermal loss model to test data with a high degree of certainty. Without being able to verify expected levels of heat loss through testing, DOE is unable to conduct an LCC and PBP analysis for this final determination. DOE may continue to investigate this issue further in the future.

F. Shipments Analysis

DOE uses projections of annual equipment shipments to calculate the national impacts of potential amended or new energy conservation standards. The shipments model takes an accounting approach in tracking market shares of each equipment class and the vintage of units in the stock. Stock accounting uses equipment shipments as inputs to estimate the age distribution of in-service equipment stocks for all years.

To project shipments and equipment stocks for 2025 through the end of the 30-year analysis period (2054), DOE used a stock accounting model. Future shipments are calculated based on projections in *Annual Energy Outlook 2021* (*AEO 2021*) (see section IV.F.3 of this document for further details). The stock accounting model keeps track of shipments and calculates replacement shipments based on the expected service lifetime of UFHWSTs and a Weibull distribution that identifies a percentage of units still in existence from a prior year that will fail and need to be replaced in the current year.

DOE's approach begins with an estimate of the current stock of UFHWSTs. DOE uses an estimate of average UFHWST lifetime to derive the fraction of the stock that is replaced in each year. DOE then adds an estimate of new UFHWSTs installed in each year.

1. Stock Estimates

DOE investigated each sector that is presumed to operate UFHWSTs: Residential, commercial, and industrial. However, DOE was unable to find clear indicators of how many UFHWST are used by any of these sectors, so it developed sectoral stock estimates from publicly-available data, as discussed in the paragraphs that follow.

a. Residential Stock

As explained in detail in the June 2021 NOPD, to estimate the stock of UFHWSTs in the residential sector, DOE's search of the RECS database using these assumptions yielded a sample of zero buildings that had the potential to contain an UFHWST.[18] 86 FR 30796, 30811 (June 10, 2021). At that time, DOE assumed that UFHWST were not used in residential buildings. DOE did not receive any comments on residential installations of UFHWST. Accordingly, for this final determination, DOE concluded that the quantity of UFHWST installed in the residential sector is minimal, and consequently, it was not considered for the purpose of this final determination.

b. Commercial Stock

To estimate the stock of UFHWSTs in the commercial sector, DOE examined the CBECS databases. At the time of the publication of the June 2021 NOPD, the 2012 edition of CBECS (''CBECS 2012'') was the most recent edition. Since the

[18] U.S. Energy Information Administration, Residential Energy Consumption Survey 2015 (RECS), as published in 2018.

June 2021 NOPD was published in the **Federal Register**, the 2018 edition of CBECS (''CBECS 2018'') was made available.

CBECS 2018 introduced new building records that may contain UFHWST equipment, as they relate to technologies that are often connected to UFHWSTs which were absent from CBECS 2012. However, CBECS 2018 was also limited in its characterization of buildings that may contain an UFHWST when compared to CBECS 2012 and did not have the same fields from which to draw a customer sample. For this final determination, in addition to the sample based on CBECS 2012 which was presented in the June 2021 NOPD, DOE included the buildings from CBECS 2018 with the following characteristics in addition to the stock estimates presented in the June 2021 NOPD (*see* 86 FR 30796, 30811 (June 10, 2021)).

- Solar thermal used for water heating (SOWATR = 1), and
- Water loop heat pump for hot water distribution (WTLOOP_HW = 1).

As noted previously, for the June 2021 NOPD, DOE based its commercial stock estimates on data from CBECS 2012. Since DOE did not receive any comments suggesting alternate stock from the estimates, the Department has elected to maintain its use of these estimates for this final determination in addition to the new records from CBECS 2018. From CBEC 2012, DOE assumed that builds likely to contain an UFHWST would be characterized as follows:

- A building with water heating equipment (WTHTEQ = 1), and
- Where the main heating equipment is boilers inside (or adjacent to) the building that produce steam or hot water (MAINHT = 3).

The results of a search of the CBECS databases using these assumptions yielded a commercial sample of 325,089 buildings from CBECS 2012, plus an additional 11,134 buildings from CBECS 2018. From this sample DOE also found that 99.2 percent of these buildings use natural gas as their primary energy source for water heating, with the remaining 0.8 percent of buildings using district water heating,[19] electricity, heating oil, or other fuels. For purpose of analysis, DOE considered 100 percent of commercial buildings to use natural gas to heat water.

DOE notes that for this determination, the surveys from both CBECS 2012, and CBECS 2018 contain very course data regarding the quantity and type of water heating technologies for each record. DOE assumed one UFWHST per building—for *all* building records-regardless of building size from the CBECS results. This is likely to be an overestimation of UFHWST installed stock, as not all buildings matching the available criteria from CBECS will contain UFHWSTs, even if some of these building contain multiple units.

c. Industrial Stock

For this final determination DOE maintained its industrial stock approach and estimate of UFWHSTs that it used in the June 2021 NOPD. As described in the June 2021 NOPD, DOE examined the industrial data source listed in the August 2019 ECS RFI and was not able to determine an appropriate stock sample from the highly aggregated data available.[20 21] 86 FR 30796, 30811 (June 10, 2021). DOE maintains that UFHWSTs are used to store potable hot water for human consumption and washing, not for industrial process water. This assumption is supported by Rheem's comment that stated that their UFHWSTs are not intended for non-potable water storage. (Rheem, No.15 at p. 5)

DOE maintained its assumption that the volume of hot water storage needed would be similar across both commercial and manufacturing sectors on a per-person basis. To estimate the stock of industrial consumers, DOE used the number of manufacturing employees from the 2017 census.[22] DOE then determined the ratio of UFHWSTs per commercial employee. DOE then used the ratio of the employee count from the commercial sample described in section IV.F.1.b of this document over the total number of commercial employees to represent the number of UFHWSTs in the commercial sector on a per-employee basis. DOE then applied this ratio to the total number of manufacturing employees from the 2017 census to produce a National stock estimate for the industrial sector.

DOE received comments from Rheem and A.O. Smith indicating that the estimates industrial stock should be a smaller fraction of the UFHWST install base when compared to commercial installations. Rheem commented that most UFHWSTs are installed in the commercial sector; and A.O. Smith stated that the percentage of UFHWSTs used for industrial process hot water storage is relatively small, and that those UFHWSTs used for industrial processes are typically customized/engineered-to-order tanks. (Rheem, No.15 at p. 4; A.O. Smith, No. 16 at p. 6) Additionally, Rheem supported DOE's ''80/20'' split between commercial and industrial applications. (Rheem, No.15 at p. 4) DOE received no other comment on the industrial stock estimates. Given the supportive nature of these comments regarding DOE's industrial stock estimation, the Department maintained the approach from the June 2021 NOPD for this final determination.

Table IV.9 presents the estimated stock of UFHWSTs in each sector, in 2012 and 2018. Table IV.9 shows that even with the updated commercial inputs resulting from the additional buildings from CBEC 2018 that the approximate 80/20 split in the final determination weight between commercial and industrial sectors is maintained.

TABLE IV.9—ESTIMATED UFHWST STOCK (2012)

Sector	NOPD number of units (2012)	Final determination units (2012)	Final determination weight (%) (2018)
Residential	0	0	0
Commercial	315,360	325,269	82

[19] ''District heating'' is an underground infrastructure asset where thermal energy is provided to multiple buildings from a central energy plant or plants. In this context, it would be operated by local governments.

[20] Energy Information Administration (EIA), 2014 Manufacturing Energy Consumption Survey (MECS) (Available at: *https://www.eia.gov/consumption/manufacturing/data/2014/*) (Last accessed April 4, 2019).

[21] Northwest Energy Efficiency Alliance, 2014 Industrial Facilities Site Assessment: Report & Analytic Results, 2014 (Available at: *https://neea.org/img/documents/2014-industrial-facilities-stock-assessment-final-report.pdf*) (Last accessed May 3, 2021).

[22] U.S. Census Bureau, All Sectors: Summary Statistics for the U.S., States, and Selected Geographies: 2017, Table EC1700BASIC, 2017 (Available at: *https://data.census.gov/cedsci/table?q=31-33%3A%20Manufacturing&hidePreview=false&tid=ECNBASIC2017.EC1700BASIC&vintage=2017*) (Last accessed: March 27, 2020).

TABLE IV.9—ESTIMATED UFHWST STOCK (2012)—Continued

Sector	NOPD number of units (2012)	Final determination units (2012)	Final determination weight (%) (2018)
Industrial	71,361	71,361	18

2. Shipments for Replacement

For the reasons explained in the June 2021 NOPD, DOE based the replacement rate for UFHWSTs on an average equipment lifetime of 12 years, using the equipment lifetime developed for commercial water heaters. 86 FR 30796, 30811–30812 (June 10, 2021). In response to the June 2021 NOPD, DOE did not receive any comments regarding its derived annual rate of UFHWST replacement. Accordingly, for this final determination, DOE maintained its assumption of an 8 percent per year replacement rate for UFHWSTs.

3. Shipments for New Construction

To project shipments of UFHWSTs for new construction, DOE relied on the trends available from the *AEO 2021.* DOE used the Commercial Floorspace and Macro Indicators Employment Manufacturing trends to project new construction for the commercial and industrial sectors, respectively.[23 24] DOE estimated a saturation rate for each equipment type using building and equipment stock values. The saturation rate was applied in each year, yielding shipments to new buildings.

On this topic, Rheem stated that it expects to see growth in storage tank applications to support growth with commercial heat pump water heater systems for new a construction and replacement installations. (Rheem, No.15 at p. 5) The CA IOUs stated that they likewise expect future shipments of UFHWSTs to increase in response to the increased penetration of commercial heat pump water heaters. (Rheem, No.15 at p. 5, CA IOUs, No.17 at p. 1)

A.O. Smith commented that the *AEO* may be too broad of a ''scaler'' to use and recommended considering whether an organization like the American Institute of Architects (AIA) or ASHRAE may have a more defined data set. (A.O. Smith, No.16 at p. 6)

In response, DOE notes that there are insufficient publicly-available data to model the future shipments of UFHWSTs connected to heat pump water heaters. However, buildings with heat pump water heaters were included in CBECS 2018, and they were also included in this stock analysis (see section IV.F.1.b of this document). Additionally, DOE did search for data related to future UFHWST shipments (or an appropriate proxy) generated by either the AIA or ASHRAE, but the Department was unable to locate any such information. Therefore, for this final determination, DOE continued to use *AEO 2021* to project future UFHWST sales. The trend from *AEO* is publicly available, and DOE finds that it provides an accepted, credible projection of key performance indicators.

Rheem commented on instances of installation of a second tank that can serve to help meet the total hot water load or function as a backup. More specifically, Rheem stated that two tanks (under 500 gallons) are used in a growing number of applications, but the commenter did not provide data or information as to the extent of any such trend. (Rheem, No.15 at p. 4) A.O. Smith suggested that it is not uncommon for installations to have more than one UFHWST per building. A.O. Smith further stated that individual installations will have different/unique dimensional limitations depending on the doorways or elevators that must be used to get the tanks into place, as well as overhead clearances. A.O. Smith stated that these constraints may limit tank size and require multiple tanks to meet the intended application. A.O. Smith further stated that some installations require redundancy for critical components such as hot water supply systems and will have heaters and storage tanks connected in parallel such that one can be isolated for maintenance while the other remains in service. (A.O. Smith, No.16 at p. 6)

DOE understands that the installation of additional equipment could be driven by concerns related to limitations associated with individual installation circumstances, or the need for added redundancy of critical hot water systems, as suggested by commenters. However, DOE does not have data as to the extent to which multiple installations occur, and commenters did not provide information as to the extent of such installations in terms of either units installed or sectors where this would be most probable. Nonetheless, DOE notes that its initial stock estimate in section IV.F.1 of this document is very broad due to the categories available in CBECS 2012 and CBECS 2018, and, therefore, it likely estimates at the higher end of the potential range of installed UFHWSTs. For these reasons, DOE did not explicitly include a factor to increase shipments to account for redundant UFHWSTs.

4. Estimated Shipments

Table IV.10 presents the estimated UFHWST shipments in selected years.

TABLE IV.10—SHIPMENTS RESULTS FOR UFHWSTS (UNITS)

Year	Shipments (NOPD)	Shipments (final determination)
2025	38,119	39,407
2030	41,324	41,424
2040	45,474	45,694
2050	48,363	49,901

Table IV.11 presents the estimated distribution of UFHWST shipments by the storage volume ranges specified in section IV.C.2 of this document. DOE estimated these values through examination of capacity counts in existing trade literature and DOE's CCMS database, confidential interviews with manufactures under NDA, and stakeholder comments. DOE assumes that this distribution is static and does not change over time.

DOE received comments from A.O. Smith and Rheem regarding the distribution of shipments over equipment capacities. Both suggested that DOE's stock analysis may include too many large tanks and not enough smaller tanks. Rheem stated that the distribution of shipment estimates for the 0 to 100 and 101 to 250-gallon capacity ranges appears to be low, and the 1,001 to 2,000 and 2,001 to 5,000-gallon ranges are high. (A.O. Smith, No.16 at p. 5, Rheem, No.15 at p. 5) In

[23] U.S. Energy Information Administration, *Annual Energy Outlook (2021),* Table 22, Commercial Sector Energy Consumption, Floorspace, Equipment Efficiency, and Distributed Generation (Available at: *https://www.eia.gov/outlooks/aeo/data/browser/#/?id=32-AEO2021&cases=ref2021&sourcekey=0*) (Last accessed Feb. 21, 2022).

[24] U.S. Energy Information Administration, Annual Energy Outlook (2021), Table 23, Industrial Sector Macroeconomic Indicators (Available at: *https://www.eia.gov/outlooks/aeo/data/browser/#/?id=34-AEO2021&cases=ref2021&sourcekey=0*) (Last accessed Feb. 21, 2022).

response, for this final determination, DOE has redistributed the fraction of capacities based on the comments received. This redistribution is shown in Table IV.11.

TABLE IV.11—DISTRIBUTION OF SHIPMENTS BY UFHWST STORAGE VOLUME (GAL)

Capacity range	Market shares in NOPD (%)	Revied market shares (%)
0 to 100	3	15
101 to 250	11	20
251 to 500	23	23
501 to 1000	26	26
1001 to 2000	20	10
2001 to 5000	16	5
>5000	1	1

5. Additional Sources of Uncertainty

DOE recognizes that the market for UFHWSTs is a relatively highly customized and low-volume shipments market. DOE's review of publicly-available information indicates that annual shipments through 2030 will be below 20,000 units (see the previous section for additional details). In the June 2021 NOPD, DOE identified 48 UFHWST manufacturers, 37 of which are small domestic manufacturers. 86 FR 30796, 30812 (June 10, 2021). In response to the June 2021 NOPD, BWC stated that the number of manufacturers identified that produce UFHWSTs reinforces the point that the market is highly customized and contains a significant number of small, niche manufacturers. (BWC, No. 14 at p. 2)

Due to the niche nature of this marketplace, it is difficult to accurately predict how the market would respond to amended standards (*e.g.,* whether any manufacturers would face disproportionately high conversion costs, what changes may result to the distribution of tank sizes sold, if consumers would select different equipment to meet their water heating needs, or whether manufacturers might consolidate or exit the market). These uncertainties may substantially impact the findings if DOE were to complete a full economic impact analysis of amended standards for UFHWSTs or estimate the cost-effectiveness of a more-stringent standard.

G. National Impact Analysis

DOE conducted an NIA that assesses the NES in terms of total FFC energy savings that would be expected to result from new or amended standards at specific efficiency levels. DOE did not assess the net present value (''NPV'') of the total costs and benefits experienced by consumers as part of the NIA because of the lack of a cost analysis and LCC analysis, as previously discussed. DOE calculates the NES for the potential standard levels considered based on projections of annual equipment shipments, along with the annual energy consumption from the energy use analysis. For the present analysis, DOE projected the energy savings over the lifetime of UFHWSTs sold from 2025 through 2054.

1. National Energy Savings

The national energy savings (''NES'') analysis involves a comparison of national energy consumption of UFHWSTs between each potential standards case (for this final determination represented by efficiency level (''EL'')) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of equipment (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher-efficiency-standards case. DOE evaluates the effects of amended standards at the national level by comparing a case without such standards (referred to as the no-new-standards case) with standards-case projections that characterize the market for each UFHWST class if DOE were to adopt amended standards at the specified energy efficiency levels for that class. As discussed in the subsections that follow, this analysis requires an examination of both the efficiency of the UFHWST, as well as the efficiency of the appliance supplying heated water to that tank.

In 2011, in response to the recommendations in a report titled, ''Review of Site (Point-of-Use) and Full-Fuel-Cycle Measurement Approaches to DOE/EERE Building Appliance Energy-Efficiency Standards'' issued by a committee appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the NIA and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE subsequently published a statement of amended policy in the **Federal Register**, in which DOE explained its determination that EIA's National Energy Modeling System (''NEMS'') is the most appropriate tool for DOE's FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sectoral, partial equilibrium model of the U.S. energy sector [25] that EIA uses to prepare its *AEO.* The FFC factors incorporate losses in production, and delivery in the case of natural gas, (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants.

2. Product Lifetime

For this analysis, DOE maintained use of the average lifetime for commercial electric storage water heaters (*i.e.,* 12 years) as a proxy for UFHWST lifetime, as was done in the June 2021 NOPD. 86 FR 30796, 30812 (June 10, 2021).

DOE received several comments related to average UFHWST lifetimes. Both Rheem and A.O. Smith agreed with DOE's estimated 12-year tank lifetime. (Rheem, No.15 at p. 5 and A.O. Smith, No.16 at p. 6) BWC suggested that UFHWST lifetimes vary between 6 and 12 years, but the commenter opined that the actual lifetime is extremely dependent on product maintenance,

[25] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009) (October 2009) (Available at: *www.eia.gov/analysis/pdfpages/0581(2009)index.php*) (Last accessed March 25, 2022).

water quality, and product application. (BWC, No.14 at p. 1)

In response, DOE notes that in its analysis, a distribution of lifetimes is used (with an average lifetime of 12 years) to capture different factors that may contribute to lifetimes that are shorter or longer than the average. As BWC did not provide specific frequencies of UFHWST failures as would support modification of the distribution of lifetimes, DOE maintained the same assumptions used in its proposed determination for this final determination.

3. Energy Efficiency Distribution in the No-New-Standards Case

To estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE first considered the projected distribution (market shares) of product efficiencies under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards. In the June 2021 NOPD, DOE based its distribution of efficiencies in the no-new-standards case on the counts and R-values of the records in its CCD database. At that time, DOE found that there were a minimal number of designs that related to the R-value efficiency levels determined in the engineering analysis. 86 FR 30796, 30813 (June 10, 2021).

In commenting on the June 2021 NOPD, DOE received input from interested parties regarding the distribution of efficiencies in the no-new-standards case. Both A.O. Smith and BWC agreed with DOE's assumption that 99 percent of all units sold are currently at baseline (R–12.5). (A.O. Smith, No.16 at p. 7, BWC, No.14 at p. 2) While Rheem agreed most shipments are at or near the baseline of R–12.5, it suggested that DOE should review the 99-percent assumption. (Rheem, No.15 at p. 5) The CA IOUs commented in the DOE compliance database, roughly 1149 out of 2428 models have an R-value above 12.5, and 660 models have an R-value at or above 15.625 (EL 1), suggesting that there is interest in equipment with insulation levels well above the current minimum levels. (CA IOUs, No.17 at p. 4)

Based on the comments received, DOE updated the baseline efficiency distribution used in the final determination based on the most recently available data from CCD. These data contain a greater number of models above baseline than there were at the time the June 2021 NOPD was published. Based on these new data, DOE revised its energy efficiency distribution in the no-new-standards case to match the data shown in Table IV.12 of this document. This update results in a revised distribution for this final determination of 68 precent at EL 0 (baseline), and 31 percent at EL 1, and less than 1 percent combined at ELs 2 and 3. The revised distribution of efficiencies weighted as a function of shipments by representative tank volume (gal) are shown in Table IV.13.

TABLE IV.12—FRACTION OF MODEL EFFICIENCY IN CCMS

(% of records)

Representative tank volume (gal.)	EL 0 (baseline)	EL 1	EL 2	EL 3
	R–12.5	R–15.62	R–18.75	R–30
80	7	0	0	0
175	19	4	0	0
375	18	6	0	0
750	19	6	0	0
1,500	10	8	0	0
3,500	0	2	0	0
5,000	0	1	0	0

Note: DOE notes that while there is some equipment currently distributed in commerce that achieves EL 3, the fraction of such equipment is very small when compared to rest of the market and is not reflected here due to rounding.

TABLE IV.13—FRACTION OF MODEL EFFICIENCIES AS A FUNCTION OF SHIPMENTS

(% of shipments)

Representative tank volume (gal.)	Shipments weight	EL 0 (baseline)	EL 1	EL 2	EL 3
		R–12.5	R–15.62	R–18.75	R–30
80		4	0	0	0
175		17	3	0	0
375		23	7	0	0
750		15	5	0	0
1,500		8	7	0	0
3,500		1	8	0	0
5,000		0	1	0	0

Note: DOE notes that while there is some equipment currently distributed in commerce that achieves EL 3, the fraction of such equipment is very small when compared to rest of the market and is not reflected here due to rounding.

4. Hot Water Supply Boiler Efficiency Trend

As stated previously, a potential standard increasing the insulation rating of UFWHST equipment would reduce thermal losses, which would in turn reduce the energy used by a building's hot water supply equipment to provide hot water.[26] Determining the impact of reduced UFHWST losses on the connected boiler(s) requires an estimate of the boiler efficiency. To estimate the efficiency of boiler systems, DOE used the No-New-Standards Case (EL 0) efficiency distribution data from the May 2016 CWH ECS NOPR[27] to calculate a single, market-weighted, average efficiency, which was 84.4 percent in 2016. For years beyond 2016 and future years through 2050, DOE used the *AEO 2022* data series ''Commercial: Stock Average Efficiency: Water Heating: Natural Gas: Reference case'' to project the efficiency trend of hot-water supply boilers.[28]

The CA IOUs suggested that the boiler efficiencies used in DOE's analysis of UFHWSTs might be too high and recommended that DOE revise its installed stock efficiency assumptions by using the NIA shipments estimates from the 2016 commercial packaged boilers (''CPB'') standards rulemaking. (CA IOUs, No.17 at pp. 3–4)

In response, DOE notes that the analysis preformed in support of the May 2016 CPB standards rulemaking has a number of outdated assumptions, and even the January 2020 CPB standards final rule,[29] while still relevant, does not include recent State and other initiatives promoting water heater efficiency that are captured in the *AEO 2022* data series ''Commercial: Stock Average Efficiency: Water Heating: Natural Gas: Reference case'' to project the efficiency trend of hot-water supply boilers.[30] For this final determination, DOE examined the efficiency distributions in the no-new-standards case for small and large commercial gas water heating boilers from the 2020 CPB standards final rule and found that that the resulting FFC savings were 0.061 quads, or 0.003 quads greater that DOE's estimation using the efficiency trend from *AEO 2022*.[31] [32] As DOE stated previously, the *AEO 2022* data on boiler efficiency is the most current data available, and despite showing slightly less cumulative energy savings than the trend from the 2020 CPB standards final rule, DOE has maintained its approach to use the most recently available information. Additionally, as in the June 2021 NOPD, DOE assumed no additional increase in boiler efficiency after 2050 (*i.e.,* the end date for the *AEO 2022* analysis). This efficiency trend for select years is shown in Table IV.13.

TABLE IV.14—AVERAGE STOCK EFFICIENCIES OF HOT-WATER SUPPLY BOILERS FROM 2025–2050

Year	Efficiency (%)
2025	89.5
2030	90.8
2035	92.3
2040	93.3
2045	93.9
2050	94.3

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for UFHWSTs. It addresses the efficiency levels examined by DOE and the projected FFC energy savings of each of these levels. As discussed previously, certain economic analyses were not conducted for this final determination because it was determined they would be of limited value due to the lack of data and high degree of uncertainty of the inputs to those analyses.

A. National Impact Analysis

This section presents DOE's estimates of the FFC NES that would result from each of the efficiency levels considered as potential amended standards.

1. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for UFHWSTs, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each efficiency level. The savings are measured over the entire lifetime of equipment purchased in the 30-year period that would begin in the year of anticipated compliance with amended standards (2025–2054). Table V.1 presents DOE's projections of the FFC National energy savings for each efficiency level considered for UFHWSTs. The savings were calculated using the approach described in section IV.D of this document.

TABLE V.1—CUMULATIVE FFC NATIONAL ENERGY SAVINGS FOR UFHWSTS; 30 YEARS OF SHIPMENTS (2025–2054)

	Efficiency level		
	1	2	3
Full-Fuel-Cycle Energy (quads)	0.015	0.029	0.058

OMB Circular A–4[33] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies

[26] While there is a wide range of equipment that building owners can use to produce hot water, for this analysis, DOE assumed that 100 percent of all hot water is produced by a hot water supply boiler. See section IV.E.1.b of this document for details.

[27] Available at: *https://www.regulations.gov/document?D=EERE-2014-BT-STD-0042-0016* (Last accessed: April 8, 2020).

[28] U.S. Energy Information Administration, Annual Energy Outlook (2022), Table 22, Commercial Sector Energy Consumption, Floorspace, Equipment Efficiency, and Distributed Generation (Available at: *https://www.eia.gov/outlooks/aeo/data/browser/#/?id=32-AEO2020&region=0-0&cases=ref2020&start=2018&end=2050&f=A&linechart=ref2020-d112119a.45-32-AEO2020&map=&ctype=linechart&sourcekey=0*) (Last accessed May 10, 2022).

[29] Available at: *https://www.regulations.gov/document?D=EERE–2013–BT–STD–0030*-0099 (Last accessed: April 8, 2020).

[30] U.S. Energy Information Administration, *Annual Energy Outlook (2021),* Table 22, Commercial Sector Energy Consumption, Floorspace, Equipment Efficiency, and Distributed Generation (Available at: *www.eia.gov/outlooks/aeo/data/browser/#/?id=32–AEO2021&cases=ref2021&sourcekey=0*) (Last accessed April 23, 2021).

[31] Commercial Packaged Boilers Final Rule National Impact Spreadsheet (Jan. 10, 2020) (Available at: *https://www.regulations.gov/document/EERE-2013-BT-STD-0030-0087*) See: Efficiency Distribution tables on worksheets: SGHW, and LGHW (Last accessed: April 22, 2022).

[32] The impacts of applying the no-new standards case efficiency trend from CPB can be examined as a sensitivity scenario in the accompanying energy savings estimation tool. (Available at: *https://www.regulations.gov/docket/EERE-2017-BT-STD-0021/document.*)

[33] U.S. Office of Management and Budget, *Circular A–4: Regulatory Analysis* (Sept. 17, 2003) (Available at: *www.whitehouse.gov/omb/circulars_a004_a-4/*).

to consider the variability of key elements underlying the estimates of benefits and costs. For this final determination, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of equipment shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[34] The review timeframe established in EPCA is generally not synchronized with the equipment lifetime, equipment manufacturing cycles, or other factors specific to UFHWSTs. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.2 of this document. The impacts are counted over the lifetime of UFHWSTs purchased in 2025–2034.

TABLE V.2—CUMULATIVE FFC NATIONAL ENERGY SAVINGS FOR UFHWSTS; 9 YEARS OF SHIPMENTS (2025–2034)

	Efficiency level		
	1	2	3
Full-Fuel-Cycle Energy (quads)	0.005	0.009	0.018

2. Net Present Value of Consumer Costs and Benefits

As discussed in section IV.E of this document, increasing the size of UFHWSTs could necessitate alterations to doorways and mechanical rooms in certain replacement installations in order to get an UFHWST to its installation destination. Further, due to significant uncertainties regarding the costs of these alterations and the lack of data indicating the likelihood of such alterations being required, at this time, DOE is unable to estimate typical installation costs of UFHWSTs. Therefore, any analysis conducted by DOE regarding the LCC or PBP would be of limited value because of the lack of data and high degree of uncertainty of the inputs to those analyses, and as a result, DOE did not estimate the NPV of consumer costs and benefits.

B. Final Determination

After carefully considering the comments on the June 2021 NOPD and the available data and information, DOE has determined that the energy conservation standards for UFHWSTs do not need to be amended, for the reasons explained in the paragraphs immediately following.

EPCA specifies that for any commercial and industrial equipment addressed under 42 U.S.C. 6313(a)(6)(A)(i), including UFHWSTs, DOE may prescribe an energy conservation standard more stringent than the level for such equipment in ASHRAE Standard 90.1 only if ''clear and convincing evidence'' shows that a more-stringent standard would result in significant additional conservation of energy and is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(A)(ii)(II)) The ''clear and convincing'' evidentiary threshold applies both when DOE is triggered by ASHRAE action and when DOE conducts a 6-year-lookback rulemaking, with the latter being the basis for the current proceeding.

Because an analysis of potential economic justification and energy savings first requires an evaluation of the relevant technology, DOE first discusses the technological feasibility of amended standards. DOE then evaluates the energy savings potential and economic justification of potential amended standards.

1. Technological Feasibility

EPCA mandates that DOE consider whether amended energy conservation standards for UFHWSTs would be technologically feasible. (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(A)(ii)(II)) DOE has determined that increasing the R-value of insulation up to R–30 would improve the efficiency of UFHWSTs. As discussed in section IV.C.1 of this document, this increased R-value has been demonstrated in commercially-available jacketed UFHWSTs. These tanks have an advertised polyurethane foam thickness of 5 inches. For insulation thicknesses up to 3 inches, DOE has determined that an R-value per inch of 6.25 is appropriate. However, the R-value per inch of insulation appears to decrease to 6 beyond this foam thickness, so DOE used this slightly lower R-value-per inch in its Tank Thermal Loss Model for the max-tech level. Therefore, increasing the thickness of insulation up to a level of 5 inches has been demonstrated to be achievable in commercially-available jacketed UFHWSTs, and, thus, would be technologically feasible. (*See* section IV.C.1 of this document for further information.) Hence, DOE has determined that amended energy conservation standards for UFHWSTs would be technologically feasible.

2. Significant Conservation of Energy

EPCA also mandates that DOE consider whether amended energy conservation standards for UFHWSTs would result in result in significant additional conservation of energy. (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(A)(ii)(II)) In the present case, DOE estimates that amended standards for UFHWST would result in FFC energy savings of 0.015 quads at EL 1, 0.029 quads at EL 2, and 0.058 quads at

[34] Under 42 U.S.C. 6313(a)(6)(C)(i) and (iv), EPCA requires DOE to review its standards for covered ASHRAE equipment every 6 years, and it requires a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. If DOE makes a determination that amended standards are not needed, it must conduct a subsequent review within three years following such a determination. (42 U.S.C. 6313(a)(6)(C)(iii)(II)) Furthermore, if ASHRAE acts to amend ASHRAE Standard 90.1 for any of the enumerated equipment covered by EPCA, DOE is triggered to consider and adopt the amended ASHRAE levels, unless the Department has clear and convincing evidence to support more-stringent standard levels, which would result in significant additional energy savings and be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)) If DOE adopts the amended ASHRAE levels, compliance with amended Federal energy conservation standards would be required either two or three years after the effective date of the ASHRAE Standard 90.1 amendments (depending upon the equipment type in question). However, if DOE adopts more-stringent standards pursuant to the ASHRAE trigger, compliance with such standards would be required four years after publication of a final rule. (42 U.S.C. 6313(a)(6)(D)) As DOE is evaluating the need to amend the standards, the sensitivity analysis is based on the review timeframe associated with amended standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6-year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some equipment, the compliance period may be something other than 3 years.

EL 3 (the max-tech level) over a 30-year analysis period (2025–2054), as realized by the connected hot-water supply boiler. However, as discussed throughout this document, there are significant uncertainties related to these results.

First, as discussed in section IV.C.1 of this document, there appears to be a reduction in R-value per inch of insulation in units with insulation thickness greater than 3 inches, generating uncertainty with regard to the performance of models above EL 2.

Second, as discussed in section IV.D.3 of this document, when comparing the results of the Tank Thermal Loss model to measured standby losses, the predicted rate of standby losses ranged from as low as 58 percent of the measured losses up to 90 percent of the measured losses. Furthermore, DOE's model would predict the same level of standby losses for tanks with identical storage volumes, dimensions, number of ports, and nominal insulation levels, whereas measured standby losses for such comparable tanks differed by up to 8.5 percent. These findings suggest that there may be variations in the extent of R–12.5 coverage between units, even between units from the same manufacturer. As discussed in section IV.C.2 of this document, it may not be practical to insulate all surfaces of UFHWSTs with polyurethane foam due to the nature of the insulation application process or the need to retain access to certain ports. Differences in manufacturers' tank designs, manufacturing processes, or their interpretations of the R–12.5 insulation requirement could lead to variations in the amount of tank surface area that is actually insulated with R–12.5. Therefore, tanks that appear to have the same attributes and insulation may have different levels of standby losses in the field. This variation makes it very difficult for DOE to characterize the representative performance of a ''baseline'' UFHWST, or the expected performance at any potential amended standard level, with a high degree of confidence since there is significant variation in thermal energy losses at a given efficiency level (R-value) that cannot be readily predicted or otherwise accounted for in the analysis.

Third, as discussed in section IV.F.5 of this document, due to the niche nature of this marketplace, it is difficult to accurately predict how the market would respond to amended standards (*e.g.,* whether any manufacturers would face disproportionately high conversion costs, what changes may result to the distribution of tank sizes sold, if consumers would select different equipment to meet their water heating needs, or whether manufacturers might consolidate or exit the market). This uncertainty in standards-case shipments projections propagates uncertainty into the estimates of national energy savings.

Due to the uncertainties in characterizing the efficiency performance of models above EL 2, the uncertainties in characterizing the representative field energy use of both baseline models and models at all ELs, and the uncertainty in projecting standards-case shipments, DOE has determined that it lacks clear and convincing evidence that amended energy conservation standards for UFHWSTs would result in significant additional conservation of energy.

3. Economic Justification

In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens, considering to the greatest extent practicable the seven statutory factors discussed previously (see section II.A of this document). (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(B)(ii)(I)–(VII))

One of those seven factors is the savings in operating costs throughout the estimated average life of the product in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses of the products that are likely to result from the standard. (42 U.S.C. 6313(a)(6)(C)(i); 42 U.S.C. 6313(a)(6)(B)(ii)(II)) This factor is typically assessed using the LCC and PBP analysis, as well as the NPV.

As discussed in section IV.E.1 and V.A.2 of this document, there are significant uncertainties with regard to installation costs of models with increased insulation thickness. Specifically, increasing the size of UFHWSTs could necessitate alterations to doorways and mechanical rooms in certain replacement installations in order to get an UFHWST to its installation destination. Further, due to significant uncertainties regarding the costs of these alterations and the lack of data indicating the likelihood of such alterations being required, at this time, DOE is unable to estimate typical installation costs of UFHWSTs.

In addition, as discussed in section IV.D.1 of this document, even small adjustments to several critical inputs to the Thermal Tank Loss Model could have a large impact on any energy use and LCC results and could significantly alter the findings.

For these reasons, DOE did not conduct an economic analysis for this rulemaking. EPCA requires that DOE determine, supported by clear and convincing evidence, that adoption of a uniform national standard more stringent than that in ASHRAE Standard 90.1 would result in significant additional conservation of energy *and* be technologically feasible *and* economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)(II); emphasis added) The inability to make a determination, supported by clear and convincing evidence, with regard to any one of the statutory criteria prohibits DOE from adopting more-stringent standards regardless of its determinations as to the other criteria. Due to the significant uncertainties related to installation costs and energy use, DOE could not reasonably conduct an analysis of economic justification, because those uncertainties would propagate into the results of any such analysis. Therefore, the result of such economic analysis would fail to produce the clear and convincing evidence required under the statute to demonstrate that amended standards for UFHWSTs would be economically justified, thereby providing an additional basis for DOE's decision to move forward with a final determination.

4. Summary

Based on the reasons stated in the foregoing discussion, DOE has determined that the energy conservation standards for unfired hot water storage tanks do not need to be amended, because it lacks ''clear and convincing'' evidence that amended standards would result in significant additional conservation of energy or be economically justified.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review,'' 76 FR 3821 (Jan. 21, 2011), requires agencies, to the extent permitted by law, to: (1) Propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this regulatory action is consistent with these principles.

OMB has determined that this final determination does not constitute a ''significant regulatory action'' under section 3(f) of E.O. 12866. Accordingly, this action was not subject to review under E.O. 12866 by OIRA at OMB.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (''IRFA'') and a final regulatory flexibility analysis (''FRFA'') for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (*www.energy.gov/gc/office-general-counsel*).

The Small Business Administration (''SBA'') considers a business entity to be a small business, if, together with its affiliates, it employs less than a threshold number of workers specified in 13 CFR part 121. The size standards and codes are established by the 2017 North American Industry Classification System (''NAICS''). Unfired hot water storage tank manufacturers are classified under NAICS code 333318, ''Other Commercial and Service Industry Machinery Manufacturing.'' The SBA sets a threshold of 1,000 employees or fewer for an entity to be considered as a small business in this category. DOE conducted a focused inquiry into small business manufacturers of the equipment covered by this final determination. The Department used available public information to identify potential small manufacturers. DOE accessed the Compliance Certification Database to create a list of companies that import or otherwise manufacture the unfired hot water storage tanks covered by this final determination. Using these sources, DOE identified a total of 48 distinct manufacturers of unfired hot water storage tanks. Of these manufacturers, DOE identified 37 manufacturers that are potential small businesses.

DOE reviewed this final determination under the provisions of the Regulatory Flexibility Act and the policies and procedures published on February 19, 2003. The final determination does not amend any energy conservation standards for UFHWSTs. On the basis of the foregoing, DOE certifies that this final determination will have no significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared an FRFA for this final determination. DOE will transmit this certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act of 1995

This final determination, which determines that amended energy conservation standards for UFHWSTs are unneeded under the applicable statutory criteria, imposes no new informational or recordkeeping requirements. Accordingly, OMB clearance is not required under the Paperwork Reduction Act. (44 U.S.C. 3501 *et seq.*)

D. Review Under the National Environmental Policy Act of 1969

DOE has analyzed this final determination in accordance with the National Environmental Policy Act (''NEPA'') and DOE's NEPA implementing regulations (10 CFR part 1021). DOE's regulations include a categorical exclusion for actions including interpretations and ruling with respect to existing regulation. 10 CFR part 1021, subpart D, appendix A4. DOE has completed the necessary review under NEPA and has determined that this final determination would not have a significant individual or cumulative impact to human health and/or environment, and is consistent with actions contained in DOE categorical exclusion A4. See 10 CFR 1021.410. Therefore, DOE has determined that promulgation of this final determination is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, and does not require an environmental assessment or an environmental impact statement.

E. Review Under Executive Order 13132

E.O. 13132, ''Federalism,'' 64 FR 43255 (August 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this final determination and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that is the subject of this final determination. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (*See* 42 U.S.C. 6316(a) and (b); 42 U.S.C. 6297) As this final determination does not amend the standards for UFHWSTs, there is no impact on the policymaking discretion of the States. Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 12988, ''Civil Justice Reform,'' imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a), section 3(b) of E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of E.O. 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final determination meets the relevant standards of E.O. 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

DOE examined this final determination according to UMRA and its statement of policy and determined that the final determination does not contain a Federal intergovernmental mandate, nor is it expected to require expenditures of $100 million or more in any one year by State, local, and Tribal governments, in the aggregate, or by the private sector. As a result, the analytical requirements of UMRA do not apply.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This final determination would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), DOE has determined that this final determination will not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M–19–15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at: *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf.* DOE has reviewed this final determination under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

E.O. 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) Is a significant regulatory action under Executive Order 12866, or any successor Executive Order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that this final determination, which does not amend energy conservation standards for UFHWSTs, is not a significant energy action under E.O. 12866. Moreover, it will not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as a significant energy action by the Administrator at OIRA. Accordingly, it is not a significant energy action, and DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (''OSTP''), issued its Final Information Quality Bulletin for Peer Review (''the Bulletin''). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the

Bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions." 70 FR 2664, 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a report describing that peer review.[35] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences ("NAS") to review DOE's analytical methodologies to ascertain whether modifications are needed to improve the Department's analyses. DOE is in the process of evaluating the resulting December 2021 NAS report.[36]

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this final determination prior to its effective date. The report will state that it has been determined that the final determination is not a "major rule" as defined by 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final determination.

Signing Authority

This document of the Department of Energy was signed on May 18, 2022, by Kelly J. Speakes-Backman, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on May 18, 2022.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energyl

[FR Doc. 2022–11128 Filed 5–23–22; 8:45 am]

BILLING CODE 6450–01–P

[35] The 2007 "Energy Conservation Standards Rulemaking Peer Review Report" is available at the following website: *www.energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0.* (Last accessed Feb. 21, 2022.)

[36] The December 2021 NAS report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards.* (Last accessed Feb. 21, 2022.)

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 39

[Docket No. FAA–2021–1071; Project Identifier AD–2021–01055–E; Amendment 39–22044; AD 2022–10–06]

RIN 2120–AA64

Airworthiness Directives; Rolls-Royce Corporation Turboshaft Engines

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: The FAA is superseding Airworthiness Directive (AD) 2017–18–14, which applied to certain Rolls-Royce Corporation (RRC) 250 model turboshaft engines. AD 2017–18–14 required repetitive visual inspections and fluorescent penetrant inspections (FPIs) of the 3rd-stage turbine wheel and removal from service of the 4th-stage turbine wheel. This AD was prompted by in-service turbine blade failures that resulted in the loss of power and engine in-flight shutdowns. This AD requires replacement of the 3rd-stage and 4th-stage turbine wheels. This AD also revises the applicability to include an additional turboshaft engine model. The FAA is issuing this AD to address the unsafe condition on these products.

DATES: This AD is effective June 28, 2022.

ADDRESSES: For service information identified in this final rule, contact Rolls-Royce Corporation, 450 South Meridian Street, Mail Code NB–01–06, Indianapolis, IN 46225; phone: (317) 230–2720; email: *HelicoptCustSupp@Rolls-Royce.com*; website: *www.rolls-royce.com.* You may view this service information at the Airworthiness Products Section, Operational Safety Branch, FAA, 1200 District Avenue, Burlington, MA 01803. For information on the availability of this material at the FAA, call (817) 222–5110.

Examining the AD Docket

You may examine the AD docket at *https://www.regulations.gov* by searching for and locating Docket No. FAA–2021–1071; or in person at Docket Operations between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. The AD docket contains this final rule, any comments received, and other information. The address for Docket Operations is U.S. Department of Transportation, Docket Operations, M–30, West Building Ground Floor, Room W12–140, 1200 New Jersey Avenue SE, Washington, DC 20590.

FOR FURTHER INFORMATION CONTACT: John Tallarovic, Aviation Safety Engineer, Chicago ACO, FAA, 2300 E Devon Avenue, Des Plaines, IL 60018; phone: (847) 294–8180; email: *john.m.tallarovic@faa.gov.*

SUPPLEMENTARY INFORMATION:

Background

The FAA issued a notice of proposed rulemaking (NPRM) to amend 14 CFR part 39 to supersede AD 2017–18–14, Amendment 39–19023 (82 FR 42443, September 8, 2017), (AD 2017–18–14). AD 2017–18–14 applied to certain RRC 250–C20, –C20B, –C20F, –C20J, –C20R, –C20R/1, –C20R/2, –C20R/4, –C20W, –C300/A1, and –C300/B1 turboshaft engines with either a 3rd-stage turbine wheel, part number (P/N) 23065818, or a 4th-stage turbine wheel, P/N 23055944 or RR30000240, installed. The NPRM published in the **Federal Register** on January 14, 2022 (87 FR 2365). The NPRM was prompted by in-service turbine blade failures that resulted in the loss of power and engine in-flight shutdowns. Since the FAA issued AD 2017–18–14, the manufacturer redesigned the 3rd-stage turbine wheel. The manufacturer published Rolls-Royce Alert Commercial Engine Bulletin (CEB) CEB A–1428/CEB A–72–4111 (single document), which describes procedures for replacement of the 3rd-stage turbine wheel, P/N 23065818, with the new increased blade fillet 3rd-stage turbine wheel, P/N M250–10473. Additionally, the FAA determined that the RRC 250–C20C (T63–A–720) model turboshaft engine is also susceptible to the unsafe condition. In the NPRM, the FAA proposed to require replacement of the 3rd-stage and 4th-stage turbine