[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 431

[EERE-2017-BT-TP-0029]

Energy Conservation Program: Test Procedure for Water-Source Heat Pumps

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

ACTION: Request for information (RFI).

SUMMARY: The U.S. Department of Energy ("DOE") is initiating a data collection process through this RFI to consider whether to amend DOE's test procedure for commercial water-source heat pumps ("WSHPs"). To inform interested parties and to facilitate this process, DOE has gathered data, identifying several issues associated with the currently applicable test procedure on which DOE is interested in receiving comment. The issues outlined in this document mainly concern: methods that are incorporated by reference by the applicable industry standard; efficiency metrics and calculations; additional specifications for the test methods; and any additional topics that may inform DOE's decisions in a future test procedure rulemaking,

including methods to reduce regulatory burden while ensuring the test procedure's accuracy. DOE welcomes written comments from the public on any subject within the scope of this document (including topics not raised in this RFI).

DATES: Written comments and information are requested and will be accepted on or before **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *http://www.regulations.gov*. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE-2017-BT-TP-0029, by any of the following methods:

- *Federal eRulemaking Portal*: *http://www.regulations.gov*. Follow the instructions for submitting comments.
- *E-mail*: *WSHP2017TP0029@ee.doe.gov*. Include the docket number EERE-2017-BT-TP-0029 in the subject line of the message.
- *Postal Mail*: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, Test Procedure RFI for Water-Source Heat Pumps, Docket No. EERE-2017-BT-TP-0029, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a compact disc

("CD"), in which case it is not necessary to include printed copies.

- *Hand Delivery/Courier*: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., 6th Floor, Washington, DC, 20024. Telephone: (202) 287-1445. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

No telefacsimilies (faxes) will be accepted. For detailed instructions on submitting comments and additional information on the rulemaking process, see section III of this document.

***Docket*:** The docket for this activity, which includes *Federal Register* notices, comments, and other supporting documents/materials, is available for review at *http://www.regulations.gov*. All documents in the docket are listed in the *http://www.regulations.gov* index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

The docket webpage can be found at: *https://www.regulations.gov/docketBrowser?rpp=25&po=0&D=EERE-2017-BT-TP-0029*. The docket webpage contains instructions on how to access all documents, including public comments, in the docket. See section III of this document for information on how to submit comments through *http://www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT: Mr. Antonio Bouza, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-4563. Email: *ApplianceStandardsQuestions@ee.doe.gov*.

Mr. Eric Stas, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue SW, Washington, D.C. 20585. Telephone: (202) 586-9507. Email: *Eric.Stas@hq.doe.gov*.

For further information on how to submit a comment, or review other public comments and the docket, contact the Appliance and Equipment Standards Program staff at (202) 287-1445 or by e-mail: *ApplianceStandardsQuestions@ee.doe.gov*.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Introduction

WSHPs are included in the list of "covered equipment" for which DOE is authorized to establish and amend energy efficiency standards and test procedures. (42 U.S.C. 6311(1)(B)-(D)) DOE's test procedure for WSHPs is prescribed at title 10 of the Code of Federal Regulations ("CFR") §431.96. The following sections discuss DOE's authority to establish and amend test procedures for WSHPs, as well as relevant background information regarding DOE's consideration of test procedures for this equipment.

A. Authority and Background

The Energy Policy and Conservation Act of 1975 ("EPCA" or "the Act"),[1] 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 industrial equipment. Title III, Part C[2] of EPCA, added by Public Law 95-619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes small, large, and very large commercial package air conditioning and heating equipment, which include the WSHPs that are the subject of this notice. (42 U.S.C. 6311(1)(B)-(D))

Under EPCA, DOE's energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of the Act 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 (b); 42 U.S.C. 6297) DOE may, however, grant waivers

[1] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015 (EEIA 2015), Public Law 114–11 (April 30, 2015).
[2] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A-1.

of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions of EPCA. (42 U.S.C. 6316(b)(2)(D))

The DOE testing requirements consist of test procedures that manufacturers of covered equipment must use 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 efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA.

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE is required to follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use, or estimated annual operating cost of covered equipment during a representative average use cycle or period of use and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2))

In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures and offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6314(b))

As discussed, WSHPs are a category of commercial package air conditioning and heating equipment. EPCA requires that the test procedures for commercial package air conditioning and heating equipment be those generally accepted industry testing procedures or rating procedures developed or recognized by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) or

by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), as referenced in ASHRAE Standard 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings" (ASHRAE Standard 90.1). (42 U.S.C. 6314(a)(4)(A)) Further, if such an industry test procedure is amended, DOE must amend its test procedure to be consistent with the amended industry test procedure, unless DOE determines, by rule published in the *Federal Register* and supported by clear and convincing evidence, that such amended test procedure would not meet the requirements in 42 U.S.C. 6314(a)(2) and (3) related to representative use and test burden. (42 U.S.C. 6314(a)(4)(B))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including WSHPs, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6314(a)(1)) In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures and offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6314(b)) If DOE determines that test procedure revisions are not appropriate, DOE must publish its determination not to amend the test procedures. (42 U.S.C. 6314(a)(1)(A)(ii)) DOE is publishing this RFI to collect data and information to inform its decision in satisfaction of the 7-year review requirement specified in EPCA. (42 U.S.C. 6314(a)(1))

B. Rulemaking History

DOE sets forth the test procedure for WSHPs with a cooling capacity less than 135,000 Btu/h at 10 CFR 431.96. The DOE test procedure currently incorporates by reference International Organization for Standardization (ISO) Standard 13256-1 (1998), "Water-source heat pumps-Testing and rating for performance-Part 1: Water-to-air and brine-to-air heat pumps," (ISO 13256-1:1998) and includes additional provisions for equipment set-up at 10 CFR 431.96(e). Paragraph (e) of 10 CFR 431.96 provides specifications for addressing key information typically found in the installation and operation manuals.

DOE initially incorporated ISO 13256-1:1998 as the referenced test procedure for WSHPs on October 21, 2004 (69 FR 61962), and DOE last reviewed the test procedure for WSHPs as part of a final rule for test procedures for commercial package air conditioners and heat pumps published on May 16, 2012 (77 FR 28928). Since then, the relevant industry standards have undergone a reevaluation process which did not result in substantive changes to the referenced standards. (See section II.C.1 of this RFI for a more complete explanation of the industry update process.) Because these actions by the relevant industry standard-setting bodies contained no substantive changes to the industry standard already incorporated by reference, DOE has tentatively concluded that the statutory trigger provisions of 42 U.S.C. 6314(a)(4)(B) do not provide a basis for DOE to review its WSHP test procedure at this time. Therefore, if DOE determines, based upon its assessment of the information submitted in response to this RFI,

that a rulemaking is necessary for a reevaluation of the WSHP test procedure, DOE would conduct such review under EPCA's 7-year-lookback authority. (42 U.S.C. 6314(a)(1))

II. Request for Information

In the following sections, DOE has identified a variety of issues on which it seeks input to aid in the development of the technical and economic analyses regarding whether amended test procedures for WSHPs may be warranted. Specifically, DOE is requesting comment on any opportunities to streamline and simplify testing requirements for WSHPs.

Additionally, DOE welcomes comments on other issues relevant to the conduct of this process that may not specifically be identified in this document. In particular, DOE notes that under Executive Order 13771, "Reducing Regulation and Controlling Regulatory Costs," Executive Branch agencies such as DOE are directed to manage the costs associated with the imposition of expenditures required to comply with Federal regulations. See 82 FR 9339 (Feb. 3, 2017). Pursuant to that Executive Order, DOE encourages the public to provide input on measures DOE could take to lower the cost of its regulations applicable to WSHPs consistent with the requirements of EPCA.

A. Scope and Definition

This RFI covers WSHPs, which DOE defines at 10 CFR 431.92, as a single-phase or three-phase reverse-cycle heat pump that uses a circulating water loop as the heat source for heating and as the heat sink for cooling. The main components are a compressor, refrigerant-to-

water heat exchanger, refrigerant-to-air heat exchanger, refrigerant expansion devices, refrigerant reversing valve, and indoor fan. Such equipment includes, but is not limited to, water-to-air water-loop heat pumps.

DOE notes that while the current Federal test procedure and energy conservation standards at 10 CFR 431.96 and 431.97 apply only to those WSHPs with a rated cooling capacity below 135,000 Btu/h (*i.e.*, within the covered equipment type of small commercial package air conditioning and heating equipment; 42 U.S.C. 6311(1)(B)), WSHPs also meet the definitions of the covered equipment types large and very large commercial package air conditioning and heating equipment. (42 U.S.C. 6311(8)(A),(C)-(D)) DOE understands that the market for WSHPs greater than 135,000 Btu/h may be limited, but DOE has identified some models on the market in the larger capacity range. Therefore, DOE may consider expanding the scope of the WSHP TP to include WSHPs with cooling capacity equal to or greater than 135,000 Btu/h.

Issue 1: DOE seeks data on the size of the market for WSHPs with a cooling capacity equal to or greater than 135,000 Btu/h. DOE also requests comment on whether there are any limitations, not otherwise captured in this RFI, associated with testing WSHPs in this large and very large capacity range.

B. Energy Efficiency Descriptor

For WSHPs, the cooling metric currently specified by DOE is the energy efficiency ratio (EER). 10 CFR 431.96. EER is the ratio of the produced cooling effect of the WSHP to its net work input, expressed in Btu/watt-hour, and measured at standard rating conditions. The heating mode metric currently specified by DOE for WSHPs is the coefficient of performance (COP).

Id. COP is the ratio of the produced heating effect of the WSHP to its network input, when both are expressed in identical units of measurement, and measured at standard rating conditions.

1. Fan Energy Use

DOE is aware that the energy use of field-installed fans will vary based on the use of the fan for various functions (e.g., economizing, ventilation, filtration, and auxiliary heat). Consequently, DOE is investigating whether changes to the WSHP test procedure are needed to properly characterize a representative average use cycle, including changes to more accurately represent fan energy use in field applications. DOE also seeks comment on any anticipated burdens associated with such potential changes to the WSHPs test procedure. DOE also requests information as to the extent that accounting for the energy use of fans in commercial equipment such as WSHPs would be additive of other existing accounting of fan energy use. DOE also seeks information as to whether accounting for the energy use of fan operation in WSHPs would alter measured efficiency, and if so, to what extent.

Issue 2: DOE requests data and information regarding what form(s) of auxiliary heating are installed in WSHPs, how frequently they operate, and whether they operate independently of the WSHP. Additionally, DOE requests data and information on how frequently WSHP supply fans are operated when there is no demand for heating or cooling (i.e., for fresh air ventilation or air circulation/filtration)

Issue 3: DOE requests data and information on the typical operating schedules or duty cycles for WSHP supply fans when there is no demand for heating or cooling. DOE also seeks

comment and information regarding the use of the indoor supply fan of WSHPs for any ancillary functions not mentioned above.

ISO 13256-1:1998 uses a fan power adjustment calculation to exclude fan power used for overcoming external resistance on ducted equipment. As a result, the calculation of efficiency only includes the fan power required to overcome the internal resistance of the unit. Similarly, only liquid pump power required to overcome the internal resistance of the unit is included in the effective power input used for efficiency calculation for WSHPs.

ISO 13256-1:1998 does not provide minimum external static pressure (ESP) requirements for ducted equipment; however, Table 9 of ISO 13256-1:1998 includes an operating tolerance (i.e., maximum variation of individual reading from rating conditions) and a condition tolerance (i.e., maximum variation of arithmetical average values from specified test conditions) for external resistance to airflow. ISO 13256-1:1998 does not specify to which values of ESP these tolerances are intended to apply.

Issue 4: DOE requests comment on whether the test procedure for WSHPs should include minimum ESP requirements for the indoor fan, and if so, what values would be representative of field installations. DOE seeks information on whether field ESP values typically vary with capacity, and whether fan power used for overcoming ESP should be included in the efficiency calculation for WSHPs intended to be used with ducting. Similarly, DOE seeks information on what ESP values are typical in field installations for the liquid pump and whether any allowance for external liquid pressure drop should be considered in the efficiency metric.

DOE is aware that some WSHPs may be installed with or without indoor air distribution ducts in the field. Depending on the type of installation, the test method specified in ISO 13256-1:1998 differs; section 4.1.2 of ISO 13256-1:1998 specifies provisions for WSHPs installed without ducts, and section 4.1.3 of that standard specifies provisions for WSHPs installed with ducts. DOE's preliminary research has not revealed any physical characteristics of WSHPs that distinguish them as being suitable for installation with ducts, without ducts, or both. ISO 13256-1:1998 does not specify how to determine whether a WSHP is to be tested using the ducted or non-ducted provisions.

Issue 5: DOE requests comment on what, if any, physical characteristics distinguish WSHPs that are suitable for installation with ducts from those suitable for installation without ducts. DOE also requests comment on whether any WSHP models can be installed either with or without indoor air distribution ducts. If models exist that can be installed both with or without ducts, DOE requests comment on whether manufacturers test such models using the provisions of section 4.1.2 of ISO 13256-1:1998, which is for heat pumps without duct connection, or using the provisions of section 4.1.3 of that standard for heat pumps with duct connection, or test such models using both provisions of sections 4.1.2 and 4.1.3.

ISO 13256-1:1998 provides requirements for airflow rates in section 4.1.5, including that: (a) non-ducted heat pumps shall be tested at airflow rates obtained at zero ESP; (b) ducted heat pumps with internal fans or with designated air movers be tested at the airflow rates obtained at zero ESP or the manufacturer-specified airflow rate, whichever is lower, and (c) ducted heat pumps without internal fans shall be tested at the manufacturer-specified airflow rate subject to a maximum internal pressure drop. Additionally, paragraph (e)(2) of 10 CFR 431.96 requires that

the airflow rate used for testing must be specified by the manufacturer in the installation and operation manuals being shipped to the commercial customer. ISO 13256-1:1998 does not indicate what speed setting should be used to achieve specified airflow for a fan with more than one speed setting. Also, in some cases, the airflow rate and pressure conditions specified by ISO 13256-1:1998 for a given ducted heat pump without an internal fan may not be achievable simultaneously. For example, the manufacturer-specified airflow may not be achievable below the maximum internal pressure drop specified in section 4.1.5.3 of ISO 13256-1:1998. ISO 13256-1:1998 does not provide an approach for simultaneously achieving the specified airflow rate and pressure conditions for such a case.

Issue 6: DOE requests comment on whether WSHP indoor fans typically have multiple speed settings, and if so, how manufacturers decide which speed setting to use during testing. Further, DOE requests comment on how the specified airflow is achieved during testing if none of the speed settings available with the indoor fan produce the specified airflow at the specified internal or external static pressure (when applicable).

ISO 13256-1:1998 uses a fan efficiency value of 0.3×10^3 Pascal-liters per second per watt to calculate the fan power associated with internal or external airflow resistance (see sections 4.1.3.1 and 4.1.3.2 of that test standard, respectively). However, DOE recognizes that fan and motor technology is evolving, including associated improvements in efficiency. Consequently, the fan efficiency value used in ISO 13256-1:1998 may not be reflective of these improvements for WSHPs that include an integral fan/motor that is based on new, more-efficient technology. On the other hand, DOE notes that for other air-conditioners and heat pumps (*e.g.*, central air-conditioners), indoor units that do not include integrated fans (*i.e.*, coil-only units) are

often installed with an existing, external fan that is part of a furnace. The furnace is not always replaced when the new indoor unit is installed. In these cases, the efficiency of the external fan (*i.e.*, the furnace fan) reflects performance of past fan technology. This scenario may or may not be relevant for WSHPs.

Issue 7: DOE seeks comment and data on whether the fan/motor efficiency factor used in the calculation of fan power for WSHPs is representative of units currently on the market and whether the value accurately represents the efficiency of existing fans that are not replaced in WSHP installations. DOE also requests comment on whether indoor fans are typically replaced when coil-only WSHPs are installed. DOE also seeks comment regarding potential test approaches that might lead to more direct representation of efficiency of the fan/motor combination under test instead of relying on a single factor for all units.

DOE notes that all of the issues considered in this section address potential changes to the test procedure for WSHPs that could be reflected in the cooling and/or heating efficiency metrics (*i.e.*, EER or integrated energy efficiency ratio (IEER; see section II.B.2), and COP) for WSHPs in order to make them more representative of the energy contributions of all operating modes. This approach would not regulate the fans separately from the end-use equipment (*i.e.*, the WSHP).

Issue 8: Assuming DOE has authority to address fans embedded in other commercial equipment such as WSHPs (a conclusion the agency has not yet reached), DOE is interested in receiving comment and other information on this topic. DOE requests comment on whether any of the issues considered in this section would result in double-regulation of the energy use of fans

in WSHPs, and if so, how. DOE further seeks comment as to whether or what portion of such fan operation is part of a "representative average use cycle" of a WSHP. DOE also seeks comment as to whether accounting for the energy use of fan operation in WSHPs would alter measured efficiency, and if so, to what extent.

2. Integrated Efficiency Metrics

DOE's test procedure for WSHPs does not include part-load conditions nor a seasonal metric that includes part-load performance. A seasonal metric is a weighted average of the performance of cooling or heating systems at different rating points intended to represent average efficiency over a full cooling or heating season. Several categories of commercial package air conditioning and heating equipment are rated using a seasonal metric, such as the IEER for air cooled commercial unitary air conditioners as discussed in section 6.2 of AHRI Standard 340/360-2015, "2015 Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment," ("AHRI 340/360-2015"). IEER is a weighted average of efficiency at the four load levels representing 100, 75, 50, and 25 percent of full-load capacity, each measured at an outdoor air condition representative of field operation at the given load level.

Issue 9: DOE requests information on whether a seasonal efficiency metric that incorporates part-load performance would be appropriate for WSHPs. DOE also requests input on the specific details of a seasonal energy efficiency metric that would best represent the average cooling seasonal efficiency of WSHPs, including specification of test conditions.

C. Test Procedure

1. ISO 13256-1:1998

At this time, ISO 13256-1:1998 is still the most current industry standard relevant to water-source heat pumps. In 2012, AHRI and ASHRAE reaffirmed ISO 13256-1:1998, and published a version denoted as ISO 13256-1:1998 (RA 2012). DOE tentatively determined that there are no changes to ISO 13256-1:1998 in the reaffirmed 2012 version. ISO 13256-1:1998 is also referenced in ASHRAE Standard 90.1 as the test procedure for testing and rating WSHPs. ASHRAE Standard 90.1 was updated on October 26, 2016, and this update references the reaffirmed version of ISO 13256-1:1998 that DOE tentatively determined contains no changes from the version of ISO 13256-1:1998 referenced in the previous version of ASHRAE Standard 90.1. Because neither of these actions by the relevant industry standard-setting bodies contained substantive changes to the industry standards already incorporated by reference, DOE has tentatively concluded that the statutory trigger provisions of 42 U.S.C. 6314(a)(4)(B) do not require DOE to review its WSHP test procedure at this time. Instead, if DOE determines, based upon its assessment of the information submitted in response to the RFI, that a rulemaking is necessary for a reevaluation of the WSHP test procedure, DOE would conduct such review under EPCA's 7-year-lookback authority. (42 U.S.C. 6314(a)(1))

2. Potential for Harmonization with ANSI/ASHRAE 37-2009

The test method used in ISO 13256-1:1998 is similar to the American National Standards Institute (ANSI)/ASHRAE 37-2009, "Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment" (ANSI/ASHRAE 37-2009). ANSI/ASHRAE 37-

2009 is the method referenced by the 2007 and 2015 versions of AHRI 340/360, "Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment" (AHRI 340/360). The 2015 version of AHRI 340/360 is referenced by ASHRAE Standard 90.1 for testing water-cooled commercial unitary air conditioners (WCUACs). DOE is considering whether using the same method of test for WSHPs and WCUACs is appropriate, given the similarities in the design of WSHPs and WCUACs.

Issue 10: DOE seeks comment on whether a single test method could be used for both WSHPs and WCUACs. DOE also seeks comment on any aspects of design, installation, and application of WSHPs that would make the use of ANSI/ASHRAE 37-2009 infeasible for WSHPs.

ISO 13256-1:1998 determines total cooling and heating capacities by averaging the results obtained using two test methods: the liquid enthalpy test method for the liquid side tests and the indoor air enthalpy test method for the air side tests. For non-ducted equipment, ISO 13256-1:1998 includes an option for conducting the air-side tests using the calorimeter room test method instead of the air enthalpy test method. The test standard also specifies that, for a test to be valid, the results obtained by the two methods used must agree within 5 percent. ANSI/ASHRAE 37-2009 requires two capacity measurements as well (i.e., for units with cooling capacity less than 135,000 Btu/h); the first method of measurement (i.e., the primary method) is used as the determination of the unit's capacity, while the second measurement (i.e., the secondary method) is used to confirm rather than to be averaged with the primary measurement.

Issue 11: DOE requests information on whether one of the two capacity measurements prescribed in ISO 13256-1:1998 consistently gives a higher or lower result than the other or

whether one of the methods can be considered more accurate for a range of different WSHP configurations and models. In addition, DOE requests comment on whether the ANSI/ASHRAE 37-2009 approach for determination of rated capacity (i.e., using the primary method's measurement as the rated capacity rather than averaging the two capacity measurements) would result in more representative ratings than the ISO 13256-1:1998 approach.

3. Accounting for Compressor Heat when Testing Split Systems

DOE has identified split-system WSHPs available on the market. For at least one of these split-system WSHP, the unit containing the compressor is intended for either indoor or outdoor installation. Where the compressor is installed in relation to the conditioned space and other system components impacts the capacity of the WSHP system and the provisions necessary for accurately measuring system capacity. DOE is considering whether the test procedure needs to provide additional specifications for split systems in order to properly account for compressor heat during testing of such WSHPs.

ISO 13256-1:1998 requires use of two methods to measure space-conditioning capacity provided by a WSHP. One of these methods, the indoor air enthalpy method (see normative annex B of ISO 13256-1:1998), measures capacity directly by measuring mass flow and enthalpy change of the indoor air.[3] The second method, the liquid enthalpy test method (see normative annex C of ISO 13256-1:1998), measures heat transferred at the liquid coil. This measurement is adjusted by adding or subtracting the total unit input power (including the compressor input

[3] The alternative calorimeter room test method (see normative annex E of ISO 13256-1:1998), allowed to be used instead of the indoor air enthalpy method for ductless WSHPs, also measures indoor space-conditioning capacity directly.

power) from the measured liquid side capacity in the heating or cooling mode tests, respectively, using the equations in normative annex C of ISO 13256-1:1998. This adjustment assumes that all compressor heat is absorbed and ultimately transferred to the conditioned space, increasing heating capacity or decreasing cooling capacity. This ignores any heat transferred from the components (e.g., pump, fan, compressor, controls) to their surroundings that does not contribute to space conditioning. ISO 13256-1:1998 may not accurately account for component losses (in the form of heat) for the indoor air enthalpy method either. The indoor air enthalpy method does not appear to capture any impacts of the heat transferred by the components if the equipment or the test facility are not designed or set up to ensure the heat is captured.

For testing of single-package WSHPs, ISO 13256-1:1998 provides specific instructions to ensure that all energy flows (including heat transfer) are accounted for appropriately. Specifically, section F7.5 of ISO 13256-1:1998 indicates that an enclosure as shown in Figure F-3 should be used when the compressor is in the indoor section and separately ventilated (i.e., air that absorbs compressor heat would not combine with supply air, which is used to measure capacity). Figure F-3 shows an insulated enclosure surrounding the indoor unit that ensures that separately-ventilated compressor air recombines with supply air to be included in capacity measurements. Hence, the heat rejected from the compressor shell is accounted for in the indoor air enthalpy method measurement. This test arrangement also reflects field performance of the WSHP because any compressor heat rejected to the indoors will heat the space, reducing cooling capacity and increasing heating capacity. For WSHPs where the compressor is in the indoor section but not separately ventilated, the air that absorbs compressor heat combines with supply

air and is accounted for in the indoor air enthalpy capacity measurements without the need for the enclosure in Figure F-3.

As discussed previously, for split-system WSHPs with the compressor in the liquid coil section, some of the compressor heat may be transferred to the ambient air surrounding the compressor/coil section and, therefore, may not be captured in the space-conditioning measurement. Under ISO 13256-1:1998, if a separate compressor/liquid coil section is placed in the indoor room (as shown in Figure F-1 of ISO 13256-1:1998), the compressor heat would not be captured by the indoor air enthalpy method, even though it does add heat to the indoor room. For a split-system WSHP for which the compressor/liquid coil section is always installed indoors, this issue might be remedied by using an arrangement similar to Figure F-3 and installing both the compressor/liquid coil section and the indoor air section (i.e., the section that includes the air-to-refrigerant coil) in the insulated enclosure, so that any heat associated with compressor cooling contributes to warming of the indoor air.

In contrast, for a split-system WSHP for which the compressor/liquid coil section is always installed outdoors, the air that absorbs compressor heat would not directly affect the conditioned space. For such a case, the arrangement of Figure F-1 of the test standard and avoiding adjustments that assume that the compressor heat that is absorbed by outdoor air is combined with supply air would be appropriate. However, for such a case, ambient temperature conditions surrounding the outdoor section in field installations would likely be warmer than the indoor conditions specified in ISO 13256-1:1998 (or cooler than indoor conditions when operating in heating mode), which might affect system performance in a different way. In addition, adding or subtracting the entire compressor input power to or from the capacity

calculated based on liquid temperature change likely overestimates the impact of compressor power input on the indoor-side capacity that is calculated using the liquid enthalpy-based method. ANSI/ASHRAE 37-2009 also includes a capacity measurement method for systems with outdoor coils that reject or absorb heat from a flowing liquid. However, this "outdoor liquid coil method" may not be used if the compressor is cooled (ventilated) by outdoor air (see ANSI/ASHRAE 37-2009, table 1 and section 7.6.1.2). This restriction applies because determination of cooling or heating capacity for a system with outdoor-air cooling of the compressor requires accounting for the compressor heat transferred to the outdoor air, the measurement of which is not specified in the outdoor liquid coil method. In contrast, ISO 13256-1:1998 does not include any restrictions on use of the liquid enthalpy test method – in fact, it is required for testing all WSHPs. The approach may have to be modified to be suitable for split-system WSHPs for which the compressor is housed in a section located outdoors.

Issue 12: DOE seeks comment on whether there are split-system WSHPs on the market for which the unit containing the compressor is intended only for outdoor installation or only for indoor installation (or whether all such units can be used for either indoor or outdoor installation). DOE also seeks information regarding manufacturers' practices for testing split-system WSHPs for which the compressor is not housed in the section containing the indoor refrigerant-to-air coil. First, for units in which the compressor section is to be installed outdoors, DOE seeks comment on whether manufacturers test these units using "outdoor" rooms for the outdoor section, and, if so, what outdoor room conditions are used for the test. Second, for testing systems for which the compressor section is to be installed indoors, DOE seeks comment regarding what provisions are adopted during testing to properly account for the compressor heat. For both situations, DOE also

seeks comment on whether any adjustments are made to the capacity equations in order to properly account for the compressor heat.

4. Refrigerant Line Losses

Split-system WSHPs have refrigerant lines that can transfer heat to and from their surroundings, which can incrementally affect measured capacity. ISO 13256-1:1998 indicates, for both the indoor air enthalpy test method (annex B) and the liquid enthalpy test method (annex C), in sections B4.2 and C3.3 of the industry standard, that if line loss corrections are to be made, they shall be included in the capacity calculations. DOE believes that these procedures may benefit from additional specificity, specifically regarding what circumstances require line loss corrections and what method to use to determine an appropriate correction.

DOE notes that sections 7.3.3.4 and 7.3.4.4 of ANSI/ASHRAE 37-2009 prescribe methods for calculating and including line losses for both heating and cooling capacity calculations in the outdoor air enthalpy method, in order to obtain an energy balance with results from the indoor air enthalpy method; these procedures and calculations are for air-cooled split systems in which the "outdoor unit" is generally located outdoors. In contrast, the "outdoor unit" for a split-system WSHP (i.e., the section that contains the liquid/refrigerant heat exchanger) could be located either outdoors or indoors. Similar to the issue of accounting for compressor heat (as discussed in section II.C.3), for a split-system WSHP for which the compressor/liquid coil section is always installed indoors, the impacts of refrigerant line losses on capacity could be captured by using the arrangement of Figure F-3 in Annex F of ISO 13256-1:1998 and installing the compressor/liquid coil section in the insulated enclosure, so that any heat transfer from the refrigerant lines to the surrounding air contribute to warming or cooling of the indoor air. When

such a system is tested in this fashion, line loss calculations may not be needed. However, there may be test scenarios for which line loss calculations are needed.

Issue 13: DOE requests comment on whether the methods prescribed in ANSI/ASHRAE 37-2009 for calculating line losses are appropriate for WSHPs. In addition, DOE requests comment on what modification might be made to the procedure in ISO 13256-1:1998 in order to address further refrigerant line losses—specifically, what test situations require their use in the capacity calculations, and which do not. DOE also requests comment on how manufacturers of split-system WSHPs currently incorporate line loss adjustments into both heating and cooling capacity calculations. Further, DOE requests comment on whether manufacturers of split-system WSHPs use test set-ups that capture the effects of refrigerant line losses in capacity measurements (e.g., installing both the indoor coil and liquid coil sections of the split-system WSHP within an insulated enclosure).

5. Standardized Heat Capacity for Water

For the liquid enthalpy test method in annex C of ISO 13256-1:1998, the variables used to calculate the heating and cooling capacity include liquid mass flow rate, specific heat capacity of the liquid, liquid temperatures entering and leaving the unit, and total unit power. The test standard requires the use of water as the liquid medium when testing water-loop heat pumps; however, no value or method for calculating the specific heat capacity of water is provided. Specification of a standard value or calculation method for the specific heat capacity of water may improve the repeatability of the WSHP test procedure.

Issue 14: DOE seeks comment on whether a standard value or calculation method for the specific heat capacity of water should be specified in the WSHP test procedure for calculating the capacity of WSHPs when using the liquid enthalpy method. If a standard value should be used, DOE seeks comments on what that value should be.

6. Discharge Coefficients for Airflow Measurement

ISO 13256-1:1998 section D.1 requires airflow measurements to be made in accordance with the provisions specified in several different industry test standards, "as appropriate."[4] However, ISO 13256-1:1998 is not explicit regarding the circumstances under which the different airflow measurement approaches included in these industry test standards should be used.

Some of the airflow measurement approaches specified in ISO 13256-1:1998 use a nozzle apparatus. Airflow can be derived from measuring the change in pressure across a nozzle of known geometry. Airflow derivations using this approach often include a discharge coefficient (i.e., the ratio of actual discharge air to theoretical discharge air) to account for factors that reduce the actual discharge air, such as nozzle resistance and airflow turbulence. In general, as the nozzle throat diameter decreases, nozzle resistance increases, thereby reducing actual discharge which is characterized by a lower discharge coefficient. Turbulent airflow (as

[4] ISO 3966:1977, "Measurement of fluid flow in closed conduits – Velocity area method using Pitot static tubes;" ISO 5167-1:1991, "Measurement of fluid flow by means of pressure differential devices – Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full;" and ISO 5221:1984, "Air Distribution and air diffusion – Rules to methods of measuring airflow rate in an air handling duct.

characterized by Reynolds numbers[5]) and temperature also impact the discharge coefficient. Section F8.9 of annex F to ISO 13256-1:1998 uses a look-up table that specifies the discharge coefficient based on the eight different Reynolds numbers for nozzles with a throat diameter smaller than 12.5 centimeters, and a fixed discharge coefficient of 0.99 for nozzles with a throat diameter equal to or greater than 12.5 centimeters. In contrast, ANSI/ASHRAE 37-2009, which is a common industry standard for measuring airflow for similar equipment, includes provisions regarding the nozzle airflow measuring apparatus that are identical to the provisions in ISO 13256-1:1998, except for the method used to determine the coefficient of discharge. ANSI/ASHRAE 37-2009 uses a calculation to determine the discharge coefficient for nozzles with a throat diameter smaller than 25 centimeters, and a fixed discharge coefficient of 0.99 for nozzles with a throat diameter equal to or greater than 25 centimeters.

ISO 13256-1:1998 section F8.9 uses a second lookup table that specifies the temperature factor, used to calculate the Reynolds number, based on eight different air temperatures. For measured air temperature and calculated Reynolds numbers, ISO 13256-1:1998 does not specify what approach should be applied to determine the coefficient of discharge for air temperatures and Reynolds numbers that fall between the values specified in the look-up tables.

Issue 15: DOE requests comment on which of the methods specified in ISO 13256-1:1998 (i.e., ISO 3966:1977, ISO 5167-1:1991, and ISO 5221:1984) are used by manufacturers to measure airflow of WSHPs, and whether this varies based on WSHP capacity or configuration.

[5] Reynolds number is a dimensionless number that characterizes the flow properties of a fluid. Section F8.9 of ISO 13256-1:1998 includes an equation for calculating Reynolds number that depends on a temperature factor, air velocity, and throat diameter.

DOE requests comment on whether it should incorporate by reference additional industry test standards that outline the calculation method for airflow, such as ANSI/ASHRAE 37-2009. DOE also requests information on how manufacturers determine the coefficient of discharge for air temperatures and Reynolds numbers that fall between the values specified in the look-up table in section F8.9 of annex F to ISO 13256-1:1998.

7. Duct Loss Adjustments

In the calculations for cooling and heating capacities for the indoor air enthalpy test method of ISO 13256-1: 1998, the test standard includes a footnote in sections B3 and B4 of annex B stating that the equations do not provide allowances for heat leakage in the test equipment (i.e., duct losses). In contrast, section 7.3.3.3 of ANSI/ASHRAE 37-2009 addresses duct loss adjustments.

Issue 16: DOE requests confirmation whether the duct loss adjustments as described in section 7.3.3.3 of ANSI/ASHRAE 37-2009 are used to adjust capacity measured using the indoor air enthalpy method when testing WSHPs. DOE requests comment on whether any other type of adjustments are used to address the fact that the capacity equations of ISO 13256-1:1998 do not provide allowances for heat leakage in the test equipment.

8. Water Flow Rate

Section 4.1.6 of ISO 13256-1:1998 indicates that WSHPs shall be tested using the water flow rate specified by the manufacturer, with a few exceptions depending on whether the WSHP includes an integral pump and whether the flow rate is automatically adjusted. DOE has

reviewed publicly-available WSHP product literature and notes that manufacturers often list multiple water flow rates in performance data.

In contrast, the test method for WCUACs (AHRI 340/360-2007) specifies both the water inlet and outlet temperatures to be 85 °F and 95 °F, respectively, which determines the water flow rate setting. ISO 13256-1:1998 does not include water outlet temperature rating conditions for WSHPs, so the water flow rate cannot be set by adjusting to match the prescribed test conditions.

Issue 17: DOE requests comment on how manufacturers select water flow rate when testing WSHPs in cases where multiple flow rates are provided in product literature. DOE also requests comment on what the typical water temperature rise is during testing, and whether the typical test temperature rise is representative of field operation.

9. Indoor Air Measurements

Indoor air temperature and humidity are key parameters that affect WSHP performance, and for this reason, ISO 13256-1:1998 requires accurate indoor air condition measurements. However, DOE has tentatively determined that the method set forth in ISO 13256-1:1998 would benefit from additional specification as to indoor air temperature measurement. For air-cooled and evaporatively-cooled commercial unitary air conditioners, Appendix C of AHRI 340/360-2015 provides details on entering outdoor air temperature measurement, including air sampling tree and aspirating psychrometer requirements, but AHRI 340/360-2015 does not state that these provisions apply for measurement of entering indoor air temperature and leaving indoor air temperature. DOE is considering whether the requirements contained in Appendix C of AHRI

340/360-2015 (excluding the temperature uniformity requirements in Table C2) would be appropriate for indoor air measurements for testing WSHPs.

Issue 18: DOE requests comment on whether the requirements for outdoor entering air measurement in Appendix C of AHRI Standard 340/360-2015 (excluding the temperature uniformity requirements in Table C2), such as air sampling requirements and aspirating psychrometer requirements, would be appropriate for measurement of indoor air entering and leaving temperatures for WSHPs.

10. Refrigerant Charging

ISO 13256-1:1998 does not provide any specific guidance on setting and verifying the refrigerant charge of a unit. In a test procedure final rule for central air conditioners (CACs) and heat pumps (HPs) published on June 8, 2016 ("June 2016 CAC TP final rule"), DOE established a comprehensive approach for refrigerant charging that improves test reproducibility. 81 FR 36992, 37030-37031. The approach specifies which set of installation instructions to use for charging, explains what to do if there are no instructions, specifies that target values of parameters are the centers of the ranges allowed by installation instructions, and specifies tolerances for the measured values. Id. The approach also requires that refrigerant line pressure gauges be installed for single-package units, unless otherwise specified in manufacturer instructions. Id. These methods could be considered for the WSHP test procedure.

Issue 19: DOE seeks comment on whether it would be appropriate to adopt an approach for charging requirements for WSHPs similar or identical to the approach adopted in the June 2016 CAC TP final rule. DOE seeks comments regarding which parts of the approach should or

should not be adopted, and for what reasons they might or might not be suitable for application to WSHPs. DOE is also interested in receiving data that demonstrate how sensitive the performance of a WSHP is relative to changes in the various charge indicators used for different charging methods, specifically the method based on sub-cooling.

11. Voltage

ISO 13256-1:1998 requires that for units rated with dual nameplate voltages, the test be performed at both voltages or at the lower voltage if only a single rating is to be published. DOE understands that voltage can affect the measured efficiency of air conditioners and is, therefore, considering adding provisions to its test procedure that specify at which nameplate voltage to conduct the test for dual nameplate voltage units.

Issue 20: DOE requests data and information demonstrating the effect of voltage on air conditioning equipment (including, but not limited to, WSHPs). Specifically, DOE seeks comment on whether there is a consistent relationship between voltage and efficiency, and if so, whether testing at a lower voltage will typically result in a higher or lower tested efficiency. Further, DOE requests feedback on whether certain voltages within common dual nameplate voltage ratings (e.g., 208/230 V) are more representative of typical field installation.

D. Other Test Procedure Topics

In addition to the issues identified earlier in this document, DOE welcomes comment on any other aspect of the existing test procedures for WSHPs not already addressed by the specific areas identified in this document. DOE particularly seeks information that would improve the repeatability, reproducibility of the test procedures, as well as the ability of the test procedure to

provide results that are representative of actual use. DOE also requests information that would help DOE create a procedure that would limit manufacturer test burden through streamlining or simplifying testing requirements. Comments regarding the repeatability and reproducibility are also welcome.

DOE also requests feedback on any potential amendments to the existing test procedure that could be considered to address impacts on manufacturers, including small businesses. Regarding the DOE test method, DOE seeks comment on the degree to which the DOE test procedure should consider and be harmonized with the most recent relevant industry standards for WSHPs, and whether there are any changes to the DOE test method that would provide additional benefits to the public. DOE also requests comment on the benefits and burdens of adopting any industry/voluntary consensus-based or other appropriate test procedure, without modification. As discussed, the current DOE test procedure relies on ISO 13256-1:1998, with some additional provisions specified for equipment set-up. 10 CFR 431.96(e).

Additionally, DOE requests comment on whether the existing test procedures limit a manufacturer's ability to provide additional features to consumers of WSHPs. DOE particularly seeks information on how the test procedures could be amended to reduce the cost of new or additional features and make it more likely that such features are included on WSHPs.

III. Submission of Comments

DOE invites all interested parties to submit in writing by [**INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**], comments and

information on matters addressed in this notice and on other matters relevant to DOE's consideration of amended test procedures for WSHPs. These comments and information will aid in the development of a test procedure NOPR for WSHPs if DOE determines that amended test procedures may be appropriate for this equipment.

Submitting comments via *http://www.regulations.gov*. The *http://www.regulations.gov* webpage will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *http://www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information ("CBI")). Comments submitted through *http://www.regulations.gov* cannot be claimed as CBI. Comments received through the website

will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *http://www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *http://www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery, or mail. Comments and documents submitted via email, hand delivery, or mail also will be posted to *http://www.regulations.gov*. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information on a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery, please provide all items on a CD, if feasible. It is not necessary to submit printed copies. No facsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, written in English and free of any defects or viruses.

Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

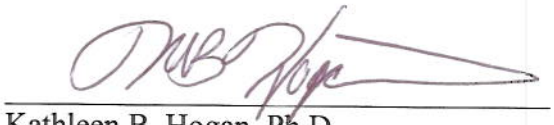
Confidential Business Information. According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked "non-confidential" with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

DOE considers public participation to be a very important part of the process for developing test procedures and energy conservation standards. DOE actively encourages the participation and interaction of the public during the comment period in each stage of a rulemaking process. Interactions with and between members of the public provide a balanced discussion of the issues and assist DOE in a rulemaking process. Anyone who wishes to be added to the DOE mailing list to receive future notices and information about this proceeding should contact Appliance and Equipment Standards Program staff at (202) 287-1445 or via e-mail at *ApplianceStandardsQuestions@ee.doe.gov*.

Signed in Washington, D.C., on June 18, 2018.



Kathleen B. Hogan, Ph.D.
Deputy Assistant Secretary for Energy Efficiency
Energy Efficiency and Renewable Energy