AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE
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October 28, 2019

Ms. Catherine Rivest Office of Energy Efficiency and Renewable Energy
Building Technologies Program
Room EE-5B
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585-0121

Re: AHRI Comments in Response to Department of Energy's Request for Information and Notice of Data Availability Regarding the Energy Conservation Standards for Computer Room Air Conditioners and Dedicated Outdoor Air Systems *[Docket Number EERE-2017-BT-STD-0017]*

Dear Ms. Rivest:

These comments are submitted by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) in response to the U.S. Department of Energy's (DOE) request for information (RFI) and notice of data availability (NODA) regarding the computer room air conditioners (CRACs) and dedicated outdoor air systems (DOASes) appearing in the *Federal Register* on September 11, 2019.

AHRI is the trade association representing manufacturers of heating, cooling, water heating, and commercial refrigeration equipment. More than 300 members strong, AHRI is an advocate for the industry and develops standards for and certifies the performance of many of the products manufactured by our members. In North America, the annual output of the HVACR and water heating industry is worth more than $44 billion. In the United States alone, the HVACR and water heating industry supports 1.3 million jobs and $256 billion in economic activity annually.

Computer Room Air Conditioners

DOE should not adopt 90.1-2016 levels for national levels

DOE acknowledges the complicated analysis of ASHRAE 90.1–2016 levels for CRAC classes covered by DOE standards in the NODA/RFI. ASHRAE Standard 90.1–2016 adopted efficiency levels in terms of NSenCOP based on test procedures in AHRI 1360–2016, while DOE's current standards are in terms of SCOP based on the test procedures

in ANSI/ASHRAE 127–2007. DOE performed a crosswalk analysis to compare the stringency of the ASHRAE Standard 90.1–2016 efficiency levels with the current Federal standards. The committee left many efficiencies unchanged and later, DOE expressed concern that the metric conversion may have actually lowered efficiencies for several product classes. AHRI agrees with DOE's assessment that, if ASHRAE Standard 90.1 leaves the energy efficiency level unchanged (or lowers the energy efficiency level), as compared to the energy efficiency level specified by the uniform national standard adopted pursuant to EPCA, that DOE does not have the authority to conduct a rulemaking to consider a higher standard for that equipment pursuant to 42 U.S.C. 6313(a)(6)(A). Therefore, AHRI recommends DOE not adopt ASHRAE 90.1-2016 levels for any product class with equal, or lower efficiencies. These decisions were deemed appropriate at the time of adoption in ASHRAE 90.1-2016.

Further, DOE should not amend national standards for any product class where efficiencies were increased in ASHRAE 90.1-2016. In 2018 and 2019, DOE worked with the ASHRAE 90.1 committee, and AHRI members, to review the methodology for the metric conversion and efficiency levels. An agreement was reached by both parties during those discussions and Addendum "be" to ASHRAE 90.1-2016 was approved by the committee and will become part of the 2019 edition of 90.1.

DOE should analyze and consider Addendum "be" levels and metric for the national standard

The DOE conducted an analysis of the energy conservation standards implemented in the 2016 edition of ASHRAE Standard 90.1 in this NODA/RFI. In the 2016 edition of 90.1, the metric for computer room air conditioners changed from sensible coefficient of performance (SCOP) to net sensible coefficient of performance (NSenCOP). The change in metric was accompanied by a change in test procedure reference for CRACs from ASHRAE 127-2007 to AHRI 1360-2016, "Performance Rating of Computer and Data Processing Room Air Conditioners," which in turn references ANSI/ASHRAE Standard 127-2012, "Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners." The NODA/RFI outlines the changes between the old and new metrics, the impacts to efficiency level, and net sensible cooling capacity demarcations for the products. However, during the mechanical subcommittee and full committee meetings of ASHRAE SSPC 90.1 in Houston in January 2018, DOE expressed reservations about the efficiencies specified in the 2016 edition of Standard 90.1 stemming from the conversion from an old metric (SCOP) to the metric introduced in 2016 (NSenCOP). AHRI and DOE met several times to discuss changes in test procedure and efficiency metric including several test condition changes that change efficiency ratings for most equipment classes, compare methodologies on proposals, and develop a compromise proposal. Together, we agreed upon a crosswalk analysis and determined minimum efficiency levels in terms of NSenCOP that are no less stringent than the existing Federal standards in terms of SCOP.

Addendum “be” to 90.1-2016 updated the efficiency requirements for Computer Room air conditioners as listed in table 6.8.1-11 (which is for the floor mounted computer room units only) and adds a new table 6.8.1-19 (which covers small ceiling mounted computer room units). The efficiencies in table 6.8.1-11 were updated to better align with the industry levels. In all cases, there was an increase in energy efficiency, most increasing in the order of three to five percent. For the efficiency increases in table 6.8.1-11, payback periods are in the order of two to three years and well below what the 90.1 scalar limit of 10 for a 15-year life, which meets the 90.1 definition of cost effective. New table 6.8.1-19 reflects energy efficiency levels technologically justified for the current market of small ceiling-mounted computer room units. It is the first time these products have been included in ASHRAE 90.1. During this process, DOE performed a crosswalk analysis and concluded that the levels in addendum “be” are more stringent than the current national levels. This addendum was generated by AHRI, discussed in depth with DOE, and approved by the 90.1 committee to address all backsliding concerns from the 2016 levels. As a result of the 90.1 committee work conducted in 2018 and 2019, DOE should not adopt the 2016 levels, and instead should adopt levels in ASHRAE 90.1-2019, as implemented from Addendum “be,” for the national standard.

AHRI would not support DOE adopting revised energy efficiency levels for a subset of product classes because it would create a situation where the timing of standards is disharmonized within a product-type. This disharmonization would create an unending, continuous cycle of regulation for this equipment – an untenable situation.

During Addendum “be” discussions, DOE’s analysis also supported the increased capacity demarcations for downflow and upflow-ducted equipment classes (from 65,000 and 240,000 Btu/h to 80,000 and 295,000 Btu/h), which reflect the increase in sensible cooling capacity that results from changes in test conditions. AHRI recommends that DOE adopt new energy efficiency metrics for the national standard and revise capacity demarcations for relevant product classes to be published in the 2019 edition of 90.1.

DOE should revise shipment data and market share by equipment class

AHRI surveyed members to collect data for CRAC equipment shipments by year and market share by equipment class. Within 60 days, AHRI plans to submit a business confidential document with the total number of annual CRAC shipments for the years 2012-2018. AHRI received enough data to provide estimate market share for the classes of CRAC equipment specified in Table III.10 of the DOE NODA and RFI. DOE has overestimated the water-cooled and glycol-cooled market. Details will be provided in the business confidential submission.

CRAC metrics will continue to evolve

In a long-term project, AHRI is developing an annualized and/or part-load standard that will reflect the incorporation of variable speed fans and variable capacity compressors into the equipment. It is envisioned that an annualized metric will also reflect the use of built-in system economizers. AHRI's standards development process includes AHRI members that manufacture the relevant products as well as outside stakeholders with an interest in the standard.

Issues on which DOE seeks feedback

- *CRAC Issue 1*: Yes, there have been market changes for CRACs that may justify a new rulemaking to consider more-stringent standards, but these are more accurately reflected in the Addendum "be" to 90.1-2016 (and 90.1-2019). The levels in the 2016 edition, analyzed in the NODA/RFI, reflected the technology standard and market status for products at that time; however, DOE should not analyze these efficiency levels for the national standard. Adopting the 2016 levels for those levels that have increased would create adverse market conditions resulting from splitting the product class. AHRI recommends DOE analyze levels in the 2019 edition of 90.1, which are all more stringent than the current federal minimums, are economically justified, and reflect current technology.

  It is imperative that the levels for an entire equipment type remain in a single rulemaking cycle. Considering some levels for improvement now, and some at a later date will sap resources from the industry and slow efforts to further evolve the metrics to account for part-load operation.

- *CRAC Issue 2*: In theory AHRI agrees with the methodology and crosswalk analysis in the RFI/NODA with only slight discrepancies in some of the percentages presented therein. The efficiencies developed by AHRI and DOE for Addendum "be" to 90.1-2016 and consequently 90.1-2019 address all of the shortcomings from the DOE crosswalk and discussed in the RFI/NODA. All NSenCOP values developed in Addendum "be" to 90.1-2016, and incorporated into 90.1-2019, are equal to or greater than the DOE crosswalk values from the current Federal standard.

- *CRAC Issue 3*: CRAC unit operation can vary based on operational requirements from site to site. Elaborate, programmable controls can be incorporated into the equipment along with variable capacity compressors and variable speed fans. Fan speed and compressor capacity can be controlled independently from sensors in the room or within the CRAC units. Users can set up equipment responses based on specific room configuration. But as these sensors, and technological options

are non-uniform and site-specific, scaling the May 2012 final rule UECs using NSenCOP values for higher efficiency levels is a reasonable approach.

- *CRAC Issue 4*: AHRI finds DOE's proposed approach to determine the UEC of upflow units using the fractional increase or decrease in NSenCOP relative to the baseline downflow unit in a given equipment class grouping of condenser system and capacity as reasonable and an acceptable method to use.

- *CRAC Issue 5*: In the NODA/RFI, DOE assumed that buildings that do not identify the presence of a data center but contain more than 10 servers would require a CRAC in the absence of a central chiller or district chilled water system. The IT industry, and those that manufacture air-conditioners for mission-critical facilities, typically use "racks" and "kW per rack" for the space load requirement. If each server is between 0.5 and 2 kW, and they are all installed on a rack, then a 10 kW load would be assumed. A 10 kW load could be handled by a CRAC. It should be noted that cooling needs have increased since 2012 and that several third-party market studies have looked at the breakdown of the IT cooling market in the US.

- *CRAC Issue 6*: There is no typical amount of oversizing of a specific piece of equipment that is employed by CRAC customers. Rather than oversizing, mission critical facilities often plan for redundancy. In some cases, a facility is designed for its full load even if initially it will have a smaller load. In other cases, even if the infrastructure is installed, not all of the CRACS are installed and/or operated on day one. Units are brought online as the facility's load increases. As CRACs are designed for mission critical cooling, redundancy within the facility should be considered when properly designing the space. Depending on the facility requirements, that could be as little as N+1 to as much as 2N. However, redundant units are not always run simultaneously as the need is for cooling to continue in the event of a failure. Facilities that incorporate growth plans in initial design, would also typically employ controls strategies to ensure temperature and humidity in the facility are tightly controlled. Redundant units would be included in shipments analysis. Oversizing equipment without proper equipment controls and facility sensors would make it difficult to maintain proper conditions within the data center. DOE is likely overestimating energy use if it uses any oversize factor in its energy use analysis. AHRI recommends DOE not oversize equipment in its energy use analysis. The oversize factor would likely not change with equipment capacity or equipment class. AHRI agrees it is appropriate to apply DOE's cooling calculation to data centers of all sizes.

- *CRAC Issue 7*: The ASHRAE Datacom Series Book 2, "IT Equipment Power Trends," third edition, published in 2018 shows power consumption trends for all types of IT equipment through 2026. This is what the industry uses to estimate server power and expectations of future server stock and energy use in many different types of data centers.

- *CRAC Issue 8*: Similar to the response to Issue 6, installed redundancy practices differ by facilities. There are no trends by customer type (i.e., private business versus government) or by CRAC capacity. Redundancy requirements are determined by each customer based on their business and the specific function of the data center. In limited circumstances, such as a tornado destruction avoidance design, a 2N redundancy for cooling may be required by some customers. Also, once the quantity of redundant units is determined, the customer will decide on the control strategy for the facility. Typically, redundant units would be left in standby mode.

- *CRAC Issue 9*: Based on data AHRI has collected, DOE's estimates for annual shipment for the total CRAC market in 2012, in Table III.9 is reasonable. AHRI plans to submit annual shipment data as business confidential separate from this submission.

- *CRAC Issue 10*: AHRI also plans to submit market share estimates by equipment class and capacity range in a business confidential submission. It was not possible to obtain market share by climatic region.

- *CRAC Issue 11*: AHRI plans to submit market share by equipment class along with a description of the methodology used to determine this information. Our data does not include a breakdown of upflow units between upflow ducted and upflow non-ducted or data on shipments for horizontal-flow equipment classes.

- *CRAC Issue 12*: At present, AHRI has no data and offers no feedback on DOE's stock calculation, particularly data about the number of small data centers that use CRACs, and any data or information about the current stock of CRACs. However, there is a market trend called "edge" computing that refutes DOE's assumption that buildings with a chiller or chilled water system will not use CRACs. With the advent of "Edge" computing, a large office building with a chilled water system may

have an “Edge” room that is very critical to a business operation. This room may have its own CRAC-based cooling system if there were customer concerns with the reliability and availability of the office chilled water system.

- *CRAC Issue 13*: AHRI is concerned that if DOE determines no-new standards for some CRACs, then it would create a serial rulemaking situation for this equipment. Rather than amend efficiencies for a small subset of products, DOE should analyze and adopt efficiencies published in ASHRAE 90.1-2019. In either case, amended energy conservation standards will result in the elimination or possible redesign of products that would fall below the minimum requirements. That determination would be made by each manufacturer based on the volume of products that they sell in each category. Amending some, but not all, of the product’s efficiencies could result in higher non-amended products rather than the typical “roll up” DOE assumes. Again, AHRI would like to emphasize the importance of considering the efficiencies in ASHRAE 90.1-2019 as the consideration for the national standard.

- *CRAC Issue 14*: AHRI agrees that 15 years is an appropriate average value for CRAC equipment lifetime, provided it is properly maintained. We have no data to suggest equipment lifetime would vary based on equipment class and/or efficiency level.

CRAC Issues 15-25 were duplicative of Issues 3-14 and have already been answered, above.

Dedicated Outdoor Air Conditioners

Comments on DOE analysis, current 90.1 levels

AHRI strongly agrees with DOE’s tentative position that existing DOE test procedures are not appropriate for DOAS units.

AHRI believes the current 90.1 minimum efficiency requirements reflect the current market. However, we agree that AHRI 920-2015 is not ideal and as DOE notes, AHRI is currently revising AHRI 920-2015. DOE is participating on the standards committee and has noted in the RFI/NODA that AHRI 920-Draft includes changes and clarifications to the current industry test standard.

While AHRI agrees with DOE's decision to not to rely on existing ratings based on this test standard as the basis for the efficiency levels established for this document, AHRI is concerned with the approach to DOE relied on a single manufacturer's equipment literature for a single 20-ton capacity air-cooled DOAS models, even if it has sufficient design details of key components and performance data to evaluate efficiency. AHRI will work with manufacturers to compile additional data, to be submitted within 60 days. AHRI does not agree with DOE's EL1 and EL2 proposals as explained in replies to specific DOE issues, below.

Metrics are changing in revised 920

AHRI agrees that amendments to a uniform national standard that reflect the relevant amended versions of ASHRAE Standard 90.1 would also help reduce compliance and test burdens on manufacturers by harmonizing the Federal requirements, when appropriate, with industry best practices. This harmonization would be further facilitated by establishing not only consistent energy efficiency levels and design requirements between ASHRAE Standard 90.1 and the Federal requirements, but comparable metrics as well; however, AHRI 920-2019 is on the cusp of publication. In the 2019 edition of the standard, the ratings calculations have changed so significantly that the metric names have changed. New metrics have also been added.

AHRI 920-2019 will transition the primary metric from ISMRE to ISMRE2. DX-DOAS units will no longer be required to reheat to "neutral air" (70-75 °F) on the supply airstream. With a changed standard rating conditions, industry felt a name change was important to avoid confusion with ISMRE calculated using the 2015 standard. It should also be noted that ISMRE2 calculation weights used with MRE values at conditions A, B, C, and D are different than ISMRE's. Conditions C and D vary between the 2015 and 2019 versions and the return air condition changes at Point D are very unfavorable with ERV. Supply Air Fan (SAF) external static pressure (ESP) increases about 0.6 in.wg., or 150-percent, between the 2015 and 2019 versions depending on unit size. Return air and (RAF) ESP, required with ERV, increases static pressure similarly to SAF ESP. It should also be noted that part load unloading requirements are much more demanding. A C_d penalty of 35% is applied whenever compressor capacity cannot be reduced to match load. Excess moisture removal capacity beyond the design leaving dew point is no longer credited at part load conditions.

Likewise, there has been a transition from ISCOP to ISCOP2. ISCOP2 includes a new COP_{DOAS} metric and involves essentially the same changes as the transmission from ISMRE to ISMRE2.

Two new metrics have been added, $ISMRE2_{70}$, and $COP_{DOAS,x.}$ $ISMRE2_{70,}$ which uses reheat, is an application rating that can be used to highlight the efficiency of a unit that does provide neutral air. Optimal energy savings require customers to consider both ISMRE2 and ISMRE2-70 and favor one versus the other depending on the application.

Coefficient of Performance of the DX-DOAS Unit ($COP_{DOAS,x}$), has been added to 920. The COP of the DX-DOAS Unit determined by the Total Heating Capacity – DX-DOAS and the unit's electrical input power at the corresponding compressor capacity control that provides, or most closely provides, a Supply Air dry bulb temperature within the allowed Supply Air dry-bulb temperature range (where x signifies the Standard Rating Condition), expressed in Watts per Watts.

ERV testing options for performance calculations have been added. Option 1 allows for the full test of DX-DOAS unit with ERV attached and operating. Option 2 tests the DX-DOAS with ERV attached but not operating. Calculations using certified data from ERV (AHRI 1060) certification program are used to calculate total unit performance. Option 2 is required because very few labs can test larger DOAS equipment with ERVs.

These changes may seem drastic between the first and second edition of a standard, but they were agreed to relevant stakeholders, including DOE.

DOE has overestimated the DOAS market

In the NODA/RFI DOE has overestimated the DOAS market. AHRI has collected data from manufacturers and plans to submit that data to DOE as business confidential within 60 days.

Issues on which DOE seeks feedback

- *DOAS Issue 1*: AHRI supports DOE's proposed approach of evaluating water-cooled DOASes as a single category (with classes still disaggregated by those models with energy recovery and those models without energy recovery) using the specified cooling tower condenser water entering temperature conditions, and evaluating water-source heat pump DOASes as a single category (with classes still disaggregated by those models with energy recovery and those models without energy recovery) using the specified water-source (rather than ground-source) inlet fluid temperature conditions. AHRI 920-Draft also consolidates categories.

- *DOAS Issue 2*: AHRI agrees a cross walk is needed and we commit to working with DOE to develop an acceptable crosswalk based on calculations and test data if available. Regardless of the methodology, AHRI supports a maximum capacity for regulated products – equivalent of 760 MBtu/h at condition A in 920.

- *DOAS Issue 3*: AHRI will work with members to provide ranges of ISMRE and ISCOP levels that are available on the market by equipment class and capacity, in order to assist with selection of efficiency levels. We believe it will indicate that existing ASHRAE minimum efficiencies accurately represent the current market. Ratings with optional ERV will be based on "Option 2 like" ratings. AHRI supports ISMRE as the regulated metric.

- *DOAS Issue 4*: DOE requests comment on the appropriateness of using the above approach to develop UECs for DOASes, whether alternative assumptions should be made in the calculations, or whether an alternate source of DOAS unit energy consumption values is available. If DOE receives performance data for DOASes, then it will derive UECs by matching building loads to DOAS performance.

  AHRI is concerned there is an error in digital scroll assumptions. A 20-percent efficiency improvement overestimates the impact of installing a digital scroll. While a digital scroll provides capacity control, it does not provide an efficiency increase over three- or four-step compressor control. It would provide a modest improvement over a single- or two-step DOAS based on the equipment cycling, but these products do not provide the necessary control consumers require so they are rarely purchased. Digital scrolls are implemented primarily for control purposes.

  Baseline efficiency products vary in capacity with different manufacturers using different approaches. AHRI recommends DOE seek detailed information directly from manufacturers on technology in baseline products but generally, small equipment (below 10 ton) is two-stage or digital, without inverter control, with small heat exchangers. Above 10 tons, equipment is typically four-stage or digital, without inverter control, with larger heat exchangers. For the purposes of the technology analysis, industry would support the first step being inverter control and second step being larger condenser with more surface area.

- *DOAS Issue 5*: AHRI is unable to respond to DOE's request for data from field studies and laboratory testing which show system performance curves and how capacity and efficiency vary with outdoor air temperature, heating/cooling load, ventilation load, and any other factors that impact capacity and efficiency. AHRI recommends DOE ask manufacturers for this information.

- *DOAS Issue 6*: In the NODA/RIF DOE has overestimated the number of annual shipments (36,000 units in 2016) for DX-DOAS. Significant DOAS shipment

volume is relatively new to the market. AHRI will submit shipment data collected from members within 60 days.

- *DOAS Issue 7*: DOAS are commonly paired with local, in-space cooling systems including VRF multi-split systems, water-source heat pumps, chilled beams, and room fan coils.

- *DOAS Issue 8*: With modifications mentioned above, AHRI generally supports DOE's proposed approach to determine the no-standards-case efficiency distribution for DOASes.

- *DOAS Issue 9*: AHRI did not collect shipments data by efficiency.

- *DOAS Issue 10*: AHRI supports the proposed approach of applying the lifetime developed for the January 2016 CUAC-CUHP CWAF DFR.

Additional DOAS measure implemented in Addendum bi to 90.1-2013

AHRI would like to call attention to another measure relevant to DOAS implemented in as an addendum to 90.1-2013. Addendum "bi" limits heating the DOAS supply air to 60°F (15°C) when the majority of the building is expected to require cooling. This can be established based either on zone conditions or outdoor air temperature. Zones that do not require cooling can provide heating to neutral with the zone conditioning system. This control requirement was implemented to limit the energy a DOAS uses to provide a "neutral" supply temperature that matches the space setpoint. Any energy use analysis should account for this control requirement.

AHRI appreciates the opportunity to provide these comments. If you have any questions regarding this submission, please do not hesitate to contact me.

Sincerely,

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