Appliance Standards Awareness Project
Natural Resources Defense Council
American Council for an Energy-Efficient Economy
California Energy Commission
Northwest Energy Efficiency Alliance

May 31, 2019

Ms. Jennifer Tiedeman
U.S. Department of Energy
Office of the General Counsel, GC-33
1000 Independence Avenue SW
Washington, DC 20585

RE: Docket Number EERE–2018–BT–TP–0020: Request for Information on the Measurement of Average Use Cycles or Periods of Use in DOE Test Procedures

Dear Ms. Tiedeman:

This letter constitutes the comments of the Appliance Standards Awareness Project (ASAP), Natural Resources Defense Council (NRDC), American Council for an Energy-Efficient Economy (ACEEE), California Energy Commission (CEC), and Northwest Energy Efficiency Alliance (NEEA) on the request for information (RFI) on the measurement of average use cycles or periods of use in DOE test procedures. 84 Fed. Reg. 9721 (March 18, 2019). We appreciate the opportunity to provide input to the Department.

Overview

We are pleased that DOE is requesting input on how test procedures could be more representative. However, we have serious concerns about the present RFI. DOE seems to suggest that the Energy Policy and Conservation Act (EPCA) requires a definition of "average use cycles or periods of use" that would make the program far less effective at actually saving energy. We strongly disagree with DOE's interpretation of EPCA. We also have concerns about the specific test procedure examples that DOE references in the RFI. In particular, we are concerned that DOE may be considering changes that would make test procedures *less* representative. We address each of these points in detail below.

In the last section we provide suggestions for ways that test procedures could be improved to be more representative, including capturing a range of cycle settings, capturing multiple load points, using load-based testing for air conditioning equipment, measuring standby and off mode power for commercial and industrial equipment, capturing the impact of internet connectivity on energy consumption, and addressing software and firmware updates post installation.

EPCA requirement for test procedures to capture "average use cycles or periods of use"

Throughout the RFI, DOE suggests that the meaning of "average use cycle" somehow precludes test procedures that incorporate multiple usage modes or settings. For example, DOE suggests that incorporating multiple wash settings and load sizes in the clothes washer test procedure may violate the requirement that tests "measure the energy use or efficiency during a representative use cycle or period of use." In other words, DOE is suggesting that EPCA forbids DOE from using the current clothes washer test procedure and other similarly comprehensive test procedures.

DOE is incorrect in this interpretation. Indeed, DOE's interpretation in this RFI is contrary to the purpose, history, and text of EPCA. In recent rulemakings DOE has interpreted "representative average use cycle or period of use" in a broader fashion than the Department currently contemplates and, in many cases, has consciously tried to capture a wide range of products' operation.[1] This has had multiple important effects. First, including a range of operating settings and modes in test procedures provides more accurate, useful information to the consumer, who consequently is better equipped to make purchasing decisions. Second, it helps ensure that manufacturers can't work around tests by optimizing a single "test mode" while doing little or nothing to improve the efficiency of modes that aren't tested. In other words, manufacturers that labor to truly make their products more energy efficient overall receive credit for it, and those that choose not to do not. The interpretation of EPCA advanced in this RFI would undo these benefits and make it virtually impossible to fairly and effectively administer the appliance standards program.

In the RFI, DOE suggests that its revised interpretation of "average use cycle" is compelled by EPCA. Not only does EPCA not *require* such an interpretation, it forbids it. As is clear from the purpose and history of the Act, Congress fully anticipated that the appliance standards program would actually result in the conservation of energy.[2] If DOE restricts the range of products' operation that is captured by test procedures, there would be no assurance that minimum efficiency standards would save energy and manufacturers could inflate the efficiency ratings of their products by exploiting loopholes. This might result in ostensibly high efficiency ratings, but such ratings would bear little relationship to products' real-world energy consumption. This result would make it virtually impossible for the program to achieve its goal of saving energy. The suggestion that Congress intended for EPCA to *require* a definition of "average use cycle" that would eviscerate the effectiveness of the appliance standards program is wholly incompatible with Congress' oft-repeated expectation that the program would improve the energy efficiency of products and reduce the nation's energy consumption.

Responses to the test procedure examples raised in the RFI

In the RFI, DOE refers to a number of specific test procedures including those for clothes washers, single package vertical air conditioners and heat pumps and water-source heat pumps, ceiling fans, refrigerators and freezers, and dehumidifiers. Below we provide responses to each of the specific examples.

Clothes washers

DOE explains in the RFI that the Department previously concluded that "testing only the wash temperature options available on what has typically been considered the normal cycle, despite consumers being able to access the other temperature options by switching out of the normal cycle,

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[1] For example, the test procedure for commercial and industrial pumps measures power consumption at three or four different load points (depending on the pump configuration), and the test procedure for furnace fans incorporates operation in heating, cooling, and constant circulation modes.

[2] *See*, e.g., *Natural Resources Defense Council v. Herrington*, 768 F.2d 1355, 1377 (D.C. Cir. 1985) (quoting then Congressman Dingle and discussing the expectation of Congress that the additive savings of multiple appliance efficiency standards could be "enormous") (internal citations and quotation marks omitted).

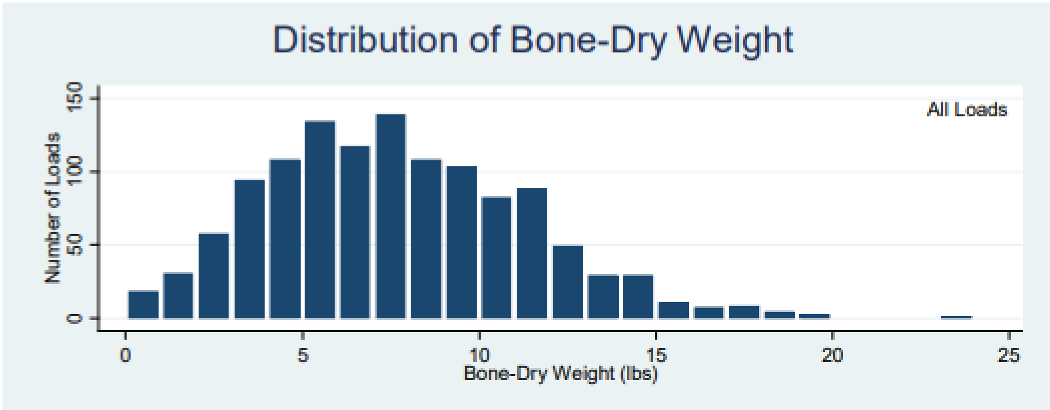
may not result in testing that 'contributes to an accurate representation of energy consumption as used by consumers.'" However, DOE now appears to be questioning whether testing at a range of wash and rinse temperatures fulfills the statutory requirement for test procedures to measure a "representative average use cycle or period of use." DOE also appears to be questioning other elements of the clothes washer test procedure such as the inclusion of three different load sizes.

The approach in the current clothes washer test procedure of capturing a range of wash and rinse temperature options as well as other factors that affect measured energy and water consumption, such as load size, is essential for ensuring a representative test procedure. For example, DOE noted in a 2010 test procedure proposed rule that "normal cycles" may not include the option of a warm rinse.[3] However, data from the Residential Energy Consumption Survey (RECS) indicate that almost 25% of households use a warm rinse.[4] Therefore, testing only those wash and rinse temperatures available as part of the "normal cycle" could miss a significant portion of the actual temperatures used by consumers in the field. Furthermore, testing only on the "normal cycle" could result in gaming of the test procedure. For example, manufacturers could choose to provide only low-energy-use cycles as part of the normal cycle but make it easy for consumers to select other cycles. Such a situation could result in an entirely unrepresentative test procedure that would neither ensure that the minimum standards are delivering savings in the field nor provide good information to consumers for making purchasing decisions.

Similarly, the current test procedure includes testing using three load sizes: a minimum load, an average load, and a maximum load, which vary with machine capacity. As shown in the figure below, a field study conducted by the Northwest Energy Efficiency Alliance (NEEA) found that there is a wide distribution of load sizes. Because efficiency varies as a function of load size, it is necessary for the test procedure to capture performance at a range of load sizes in order to be representative. If the test procedure instead was conducted at a single load size, for example, it would reflect performance at only a small portion of actual loads in the field. Furthermore, such an approach would encourage manufacturers to optimize efficiency at that one load size, which in turn would result in efficiency ratings that would not be representative of actual field performance. For example, consumers might purchase a washer that had been tested using a small load size, only for the unit to consume unexpectedly large amounts of energy and water when operated with a larger load. Incorporating multiple load sizes discourages manufacturers from optimizing for a single load size and provides better differentiation between more and less efficient products.

[3] 75 Fed. Reg. 57575 (September 21, 2010).

[4] https://www.eia.gov/consumption/residential/data/2015/. Table HC3.1.



Source: https://neea.org/img/uploads/neea-clothes-dryer-field-study.pdf. Figure 18.

Single package vertical air conditioners and heat pumps and water-source heat pumps

The RFI states that DOE recently issued two RFIs for single package vertical air conditioners and heat pumps and water-source heat pumps asking "whether changes to the test procedures are needed with regard to fan energy use to properly characterize a representative average use cycle per 42 U.S.C. 6293(b), or whether including such energy use would be 'additive of other existing accounting of fan energy use.'" For all types of air conditioners and heat pumps, the test procedures must fully capture fan energy use in order to be representative. In particular, the test procedures must include realistic external static pressures and capture any fan operation outside of cooling and/or heating mode.

The supply fan on a commercial air conditioner or heat pump represents a significant portion of the total energy use of the equipment, in part because commercial air conditioners and heat pumps typically provide ventilation to a building in addition to cooling/heating. Since ventilation is required throughout the year, the supply fan on a commercial air conditioner or heat pump will operate for a significant number of hours per year when no cooling or heating is required. For commercial package air conditioners, for example, the supply fan can consume up to 50% or more of the total energy use of the equipment.[5] Therefore, if fan energy use is not adequately captured in the test procedures, the equipment efficiency ratings may be very misleading.

In the case of commercial package air conditioners, the current test procedure assumes an unrealistically low external static pressure. (The test procedure assumes external static pressures ranging from 0.2 to 0.75 in. w.c. depending on capacity, with the values for "small" and "large" equipment all no greater than 0.4 in. w.c., while in the analysis for the 2016 DFR, DOE assumed values of 0.75 and 1.25 in. w.c. [6]) The test procedure also does not capture energy use in ventilation mode. These factors result in the test procedure significantly underestimating fan energy use, and thus overestimating actual equipment efficiency. Furthermore, because fan energy use varies among models, not adequately capturing fan energy use means that the test procedure is not providing an accurate relative ranking of models. For example, in the analysis for the 2016 DFR, which attempted to incorporate realistic fan energy use in the field, total equipment energy use does not always decrease with increasing IEER levels. For "small" equipment, for example, DOE found that equipment at Efficiency

[5] https://www.regulations.gov/document?D=EERE-2013-BT-STD-0007-0105. Table 7.2.3.
[6] https://www.regulations.gov/document?D=EERE-2013-BT-STD-0007-0105. p. 7-5.

Level (EL) 3.5 (corresponding to an IEER of 15.8) would consume *more* energy than equipment at EL 3 (corresponding to an IEER of 14.8).[7]

In the RFI for single package vertical air conditioners and heat pumps, DOE noted that fan energy use in the field will be impacted by the use of the fan for economizing, ventilation, or other functions outside of cooling mode.[8] For water-source heat pumps, DOE noted in the RFI that the current test procedure does not specify minimum external static pressure requirements for ducted equipment and that fan power used for overcoming external resistance is excluded from the efficiency calculation.[9] As with the case of commercial package air conditioners, since it appears that the test procedures for single package vertical air conditioners and heat pumps and water-source heat pumps are not adequately capturing fan energy use, the test procedures are likely not producing reliable efficiency ratings for purchasers to make informed decisions. Furthermore, if fan energy use is not adequately captured, the test procedures are not appropriately valuing manufacturer innovations to improve fan efficiency, which would ultimately benefit consumers.

Ceiling fans

DOE explains in the RFI that "multi-mount" ceiling fans, which can be installed in either the standard or hugger position, must be tested in both positions. DOE argues that because it is more common for multi-mount fans to be installed in the standard position, testing in the hugger position may not meet the statutory test of measuring an average use cycle or period of use.

In response, multi-mount ceiling fans must be tested in both the standard and hugger positions. The ceiling fan standards that will take effect on January 1, 2020 include separate requirements for standard and hugger fans, and multi-mount fans must meet both requirements. This approach is appropriate because it creates a level playing field for all fans installed in the standard position (whether they are "standard" fans or multi-mount fans installed in the standard position) and all fans installed in the hugger position. If multi-mount ceiling fans were required to be tested only in the standard position and to meet only the standard for standard fans, consumers would have no assurance that multi-mount ceiling fans would provide a minimum level of efficiency when mounted in the hugger position. And manufacturers of hugger fans would be disadvantaged since manufacturers of multi-mount fans would not need to meet any efficiency requirement for the hugger position.

In addition, while the standard position is the more common mounting configuration for multi-mount fans, DOE estimates that more than one-quarter of multi-mount fans are installed in the hugger position. Without testing in the hugger position, consumers who install multi-mount fans in the hugger position would have no reliable information about the efficiency performance of the product that would be relevant to them. Furthermore, consumers would not be able to compare a multi-mount fan that they intend to install in the hugger position to other hugger fans.

Refrigerators and freezers

In the RFI, DOE describes the current test procedure for refrigerators and freezers as "streamlined" such that it is "not unduly burdensome, while still being designed to reasonably provide results that are

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[7] https://www.regulations.gov/document?D=EERE-2013-BT-STD-0007-0105. Table 7.2.3.
[8] 83 Fed. Reg. 34503 (July 20, 2018).
[9] 83 Fed. Reg. 29050 (June 22, 2018).

representative of an average use cycle or period of use." In particular, DOE highlights that rather than testing at typical room temperature conditions (i.e. 72°F) with door openings, the test procedure instead simulates field performance by testing at 90°F without door openings.

While we agree that testing refrigerators and freezers at an ambient temperature of 90°F without door openings has been a reasonable approach to date, the test procedure would be more representative if it better reflected actual field conditions. We would expect that there would be some variation among models in terms of their efficiency performance at more representative conditions compared to their performance at the current test conditions. In other words, two models that have the same energy consumption as measured by the current test procedure could potentially perform significantly differently at more representative conditions. A test procedure that better represented field conditions would thus provide better information to consumers. In addition, the current testing approach encourages refrigerator and freezer designs that are optimized for a 90°F ambient condition rather than designs that are optimized for more typical ambient temperatures, which does not benefit consumers. Finally, testing at a more representative ambient temperature could better capture the potential efficiency gains of variable-speed compressors. In particular, we would expect that a refrigerator's compressor would cycle more often at an ambient temperature of 72°F than at 90°F and, therefore, that the benefits of variable-speed compressors, which can match the required refrigeration load, would be greater at 72°F. The current test procedure may thus not be adequately reflecting the benefits of variable-speed compressors.

DOE states in the RFI that requiring actual door openings would introduce test variability and increase test burden. However, we note that a relatively new IEC test procedure—IEC 62552:2015—provides a method to better reflect the field performance of refrigerators and freezers, including the impact of door openings and food loadings, without requiring a series of actual door openings to be performed. The IEC test procedure includes two steady-state tests at ambient temperatures of 16°C and 32°C (61°F and 90°F). The results of these two steady-state tests can be weighted based on representative ambient temperatures in a specific jurisdiction (e.g. representative ambient temperatures for the U.S.). The IEC test procedure also includes a "load processing efficiency" test, which involves opening the cabinet doors a single time to place water loads in the refrigerator and freezer compartments and measuring the energy required to return the unit to stable operating conditions. The total annual energy consumption of a unit under test is then calculated by summing the results of the individual tests (which include the impact of defrost and any auxiliaries such as anti-sweat heaters).

We encourage DOE to evaluate the IEC test procedure, which may be more representative than the current DOE test procedure without imposing an undue test burden. According to BSH, the goals of the IEC test procedure, among others, included reflecting real usage conditions, delivering accurate and reproducible results, and keeping testing costs at a moderate level.[10] And according to the United Nations Environment Programme, compared to previous refrigerator and freezer test procedures, the IEC test procedure "achieves good reproducibility, shorter test duration and costs (for most refrigerator types) and is less prone to cheating."[11] Because the IEC test procedure is an international test standard, which is being adopted in other major economies,[12] harmonizing with the IEC test procedure could reduce test burden on manufacturers who sell products internationally.

[10] http://ccm.ytally.com/fileadmin/user_upload/Workshop/6.Workshop/Publications/H%C3%A4rlen.pdf.
[11] http://united4efficiency.org/wp-content/uploads/2017/06/U4E-RefrigerationGuide-201705-Final-R1.pdf
[12] http://ccm.ytally.com/fileadmin/user_upload/Workshop/6.Workshop/Publications/H%C3%A4rlen.pdf.

Dehumidifiers

DOE explains in the RFI that while dehumidifiers in the field cycle between dehumidification mode and off-cycle mode, the current test procedure specifies separate tests in each of the modes (including low-power modes) and assigns prescribed hours of operation to each mode. DOE states that this is another example of a "streamlined" approach.

Updates to the dehumidifier test procedure in recent years to capture additional modes of operation such as fan-only operation and standby and off mode have made the test procedure more representative by more fully capturing annual energy use. However, we are concerned that the current test procedure does not capture the importance of control strategies or the potential benefits of variable-speed technology.

When the compressor of a dehumidifier cycles on and off during typical use to meet the dehumidification load, there are associated cycling losses. Cycling losses can be especially significant for dehumidifiers if the fan continues to run after the compressor shuts off because this results in re-evaporation of moisture that has been removed by the unit. Yet by measuring the different operation modes separately, the current test procedure does not capture these cycling losses. Dehumidifiers with variable-speed compressors could potentially significantly improve efficiency both by reducing cycling losses and by being able to reduce the compressor speed during low-load periods of operation. However, these potential benefits are not captured at all in the current test procedure. A manufacturer of a dehumidifier with a variable-speed compressor would thus have no way to differentiate their product, and consumers would not have information to allow them to fairly compare variable-speed dehumidifiers to conventional single-speed models.

We encourage DOE to explore a load-based test for dehumidifiers, which we believe could significantly improve representativeness. A load-based test would better reflect how all dehumidifiers perform in the field including capturing the impacts of cycling losses, the potential benefits of variable-speed compressors, and the importance of control strategies. We do not believe that a load-based test would necessarily increase testing time since a single load-based test could potentially replace the various individual tests that are currently conducted.

Recommendations for how existing test procedures could be amended to be more representative

In the section above we provided a few recommendations for how specific test procedures could be amended to be more representative. While not an exhaustive list, below we describe six general ways that a range of test procedures could be amended to be more representative: capturing a range of cycle settings; capturing a range of load points; capturing the performance of air conditioning equipment under dynamic conditions, including the impact of controls; capturing standby and off mode power consumption for commercial and industrial equipment; capturing network mode; and addressing software and firmware updates post installation.

Capturing a range of cycle settings

Products such as clothes dryers and dishwashers offer a range of cycle settings, and yet testing is conducted using only the "normal" cycle. For clothes dryers, while testing using only the "normal" cycle may have been reasonable in the past, we believe that it will be important to test at multiple settings in the future as dryers continue to offer an increasing number of settings and testing at a single setting could allow for gaming of the test procedures. For example, a dryer could be designed with a “normal” setting where the dryer performed very efficiently but with a very long cycle time. In this case, many consumers may immediately select a faster cycle and never revert to using the “normal” cycle, in which case the dryer’s tested rating would be entirely unrepresentative of its performance in the field. Similarly, for dishwashers, manufacturers could choose to provide a “normal” setting that is very efficient but does not adequately clean the dishes. Many consumers in this case may also immediately select a different cycle (such as a “heavy” cycle), in which case the dishwasher’s tested rating would also be entirely unrepresentative of its performance in the field. We encourage DOE in future test procedure rulemakings for products that offer a range of cycle settings to ensure that the test procedures reasonably capture the product’s range of operation.

Capturing a range of load points

There are a range of test procedures that measure performance at just a single load point even though the equipment operates at a wide range of load points in the field. For example, many test procedures for air conditioners and heat pumps use EER as the metric for cooling efficiency, which measures performance only at full load. Similarly, the efficiency metrics for electric motors, small electric motors, and residential and commercial boilers reflect only full-load performance. Yet these equipment types may rarely operate at full load in actual use. Two models with the same full-load efficiency rating may provide very different efficiency performance over the course of a year due to significant differences in part-load performance. Test procedures that only reflect full-load performance are thus not providing a reasonable representation of actual energy use.

Furthermore, test procedures that reflect only full-load performance are failing to capture the benefits of technologies that can significantly improve part-load performance. For example, typical non-condensing commercial boilers are single-stage, and cycling losses of these boilers can be significant at low loads. In contrast, most condensing commercial boilers are modulating, and the efficiency of these boilers increases as the firing rate decreases. Yet these part-load benefits of condensing commercial boilers are not captured at all in the current test procedure. Manufacturers thus have no way to distinguish the part-load efficiency benefits of their products, and purchasers do not have reliable information about efficiency over the range of operating points. We encourage DOE in future test procedure rulemakings to consider test procedures that capture part-load performance.

Capturing the performance of air conditioning equipment under dynamic conditions, including the impact of controls

Current test procedures for residential and commercial air conditioning equipment (including air conditioners, heat pumps, and dehumidifiers) are based on steady-state performance, which does not reflect how equipment operates in the field. In actual use, single-speed air conditioning equipment will cycle on and off to meet the load. However, the associated cycling losses are not captured by most test procedures, which are generally based on full-load tests. Even test procedures that do attempt to capture cycling losses, such as the test procedure for central air conditioners and heat pumps, do not reflect the actual cycling behavior of units under dynamic conditions. Variable-speed equipment can modulate the compressor speed to match the load. However, because most current test procedures are based on full-load performance, the energy savings associated with variable-speed equipment are not captured at all for equipment such as dehumidifiers, packaged terminal air conditioners and heat pumps, and computer room air conditioners. Furthermore, current test procedures that attempt to capture the potential benefits of variable-speed equipment, such as the test procedure for central air conditioners and heat pumps, do so by testing the equipment at fixed compressor and fan speeds. This approach fails to capture the huge impact that a unit's control strategy can have on the actual efficiency of variable-speed equipment. For example, a variable-speed unit with poorly designed controls may cycle frequently even though it has the capability to just match the load.

We encourage DOE to evaluate load-based testing for residential and commercial air conditioning equipment, which could significantly improve the representativeness of the test procedures by better reflecting how all units perform in the field under dynamic conditions, including the impact of controls. The latest draft of the CSA load-based testing standard for residential air conditioners and heat pumps (CSA EXP07:19) may provide a good model for developing load-based test procedures. Under the draft CSA test procedure, a unit under test cycles on and off as it would in the field, and its controls operate as they would in the field to manage compressor and fan speeds and defrost operation.

Capturing standby and off mode power consumption for commercial and industrial equipment

Most existing test procedures for commercial and industrial equipment do not capture standby and off mode power consumption. While we recognize that standby and off mode generally represent a small portion of total energy use for commercial and industrial equipment, failing to capture this energy consumption nevertheless means that the test procedures are not reflecting total annual energy use. Furthermore, we would expect that standby and off mode power consumption may vary significantly among models, and yet the current test procedures provide no way to communicate these differences to purchasers. We encourage DOE in future test procedure rulemakings for commercial and industrial equipment to develop methods to capture standby and off mode power consumption.

Capturing network mode

Manufacturers are increasingly offering products that are "connected." For example, as of May 2019, there were 83 refrigerators, 8 freezers, 4 clothes washers, 7 clothes dryers, 5 dishwashers, and 13 room air conditioners certified to ENERGY STAR as meeting the ENERGY STAR definition for "connected."[13] Most of these products use a Wi-Fi connection. Products with such connected functionality consume energy in "network mode," which is not currently captured in the DOE test procedures. We understand that the IEC 62301 test procedure defines "network mode" and provides a method for measuring network mode power consumption. We encourage DOE in future test procedure rulemakings to incorporate measurements of network mode to better represent the total annual energy consumption of products with a network mode.

Addressing software and firmware updates post installation

Products that can be connected to the internet are often able to receive software and firmware updates after they are installed, which have the potential to affect measured energy use. It is critical that product efficiency ratings remain valid after such software or firmware updates. Otherwise, a manufacturer could circumvent the standards by designing a product to perform very efficiently when tested, but then change the efficiency performance significantly through a software or firmware update provided once the product is installed. This situation would result in the test procedure being entirely unrepresentative of actual performance. DOE recognized this issue in a 2015 test procedures final rule for clothes washers, noting that some models on the market offer the capability to download custom

[13] https://www.energystar.gov/products. Accessed May 10, 2019.

wash cycles directly from the manufacturer. The rule stated that "this technology could be readily used to update the Normal cycle, or any alternate cycles that may be included in the energy test cycle, which could change the energy and water use of the cycle used for DOE testing."[14] DOE addressed this issue by specifying that "The determination of the energy test cycle must take into consideration all cycle settings available to the end user, including any cycle selections or cycle modifications provided by the manufacturer via software or firmware updates to the product, for the basic model under test."[15] We encourage DOE to apply a similar approach to other products.

Thank you for considering these comments.

Sincerely,

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[14] 80 Fed. Reg. 46757 (August 5, 2015).
[15] 80 Fed. Reg. 46761.