ENERGY STAR® Program Requirements
Product Specification for Commercial Dishwashers

Draft Test Method
(Rev. Jan-2012)

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1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Commercial Dishwashers.

2 APPLICABILITY

This test method is applicable to commercial dishwashers, specifically: under counter; glasswashing; single tank, door type; pot, pan and utensil; dual sanitizing rinse; single tank conveyor; multiple tank conveyor and flight type machines. This test method may also be used to test machines that include a post-sanitizing rinse..

Note: This test method has not been validated for flight type machines; however, laboratories have indicated that the conveyor test method is applicable to flight type machines.

Note: A test method was developed for machines with a post-sanitizing rinse; however the method has not been validated in a laboratory.

Note: A test method is necessary for flight type machines since these products are included in the scope of the ENERGY STAR Version 2.0 specification. Flight type machines are not included in the scope of existing industry test procedures; however, laboratories with experience testing these machines have indicated that the conveyor test methods for both the water consumption and idle energy consumption tests can be used for flight type machines.

DOE and EPA welcome stakeholder feedback on the use of this ENERGY STAR Commercial Dishwasher Test Method for flight type machines.

Note: An industry test procedure does not currently exist for Dishwashers with a post-sanitizing rinse. A third party laboratory has indicated that the post-sanitizing rinse feature, as it is currently designed, does not consume energy in the Idle Mode; thus the idle energy test method is generally applicable machines to that include a post-sanitizing rinse. Therefore, DOE and EPA have incorporated language in this draft to address idle energy measurement for all machines, with and without a post-sanitizing rinse. The proposed water consumption test method for machines that include a post-sanitizing rinse has not been validated.

DOE and EPA welcome stakeholder feedback on post-sanitizing rinse features that have not been accounted for and the proposed post-sanitizing rinse water consumption test method. DOE and EPA also welcome stakeholder feedback on idle energy consumption of post-sanitizing rinse features.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Commercial Dishwashers.

A) Acronyms, Abbreviations, and Units:

1) ANSI: American National Standards Institute

2) ASTM: American Society for Testing and Materials

3) Btu: British Thermal Units

4) cfm: Cubic feet per minute

5) DOE: U.S. Department of Energy

6) EPA: U.S. Environmental Protection Agency

7) °F: Degrees Fahrenheit

8) ft: Feet

9) ft^3: Cubic feet

10) h: Hour(s)

11) in: Inch(es)

12) in. H_2O: Inches water

13) in. Hg: Inches mercury

14) kW: Kilowatt(s)

15) kWh: Kilowatt-hour(s)

16) lb: Pound(s)

17) min: Minute(s)

18) NSF: NSF International

19) psi: Pounds per square inch

20) psia: Pounds per square inch absolute

21) psig: Pounds per square inch gauge

22) °R: Degrees Rankine

23) s: Second(s)

24) UUT: Unit Under Test

25) V: Volt(s)

26) W: Watt(s)

27) Wh: Watt-hour(s)

B) General:

> **Note:** All definitions listed below that do not reference (*NSF/ANSI) 170-2010: Glossary of Food Equipment Terminology* or *ASTM F1920-11: Standard Test Method for Performance of Rack Conveyor, Commercial Dishwashing Machines* are taken directly from the ENERGY STAR Commercial Dishwashers Version 2.0 Draft 3 specification. They are included in the test method for clarity. DOE and EPA welcome stakeholder feedback on inclusion of these definitions in both the test method and specification.

1) Dishwashing Machine: A machine designed to clean and sanitize plates, pots, pans, glasses, cups, bowls, utensils, and trays by applying sprays of detergent solution (with or without blasting media granules) and a sanitizing rinse.

Note: Dishwashing Machines are referred to as Dishwashers throughout this Test Method.

2) Machine Types:

a) Stationary Rack Machine: A dishwashing machine in which a rack of dishes remains stationary within the machine while subjected to sequential wash and rinse sprays. This definition also applies to machines in which the rack revolves on an axis during the wash and rinse cycles.

i. Under Counter: A stationary rack machine with an overall height of 38 inches or less, designed to be installed under food preparation workspaces. Under counter dishwashers can be either chemical or hot water sanitizing, with an internal booster heater for the latter.

ii. Single Tank, Door Type: A machine designed to accept a standard nominal 20 inch x 20 inch dish rack which requires the raising of a door to place the rack into the wash/rinse chamber. Closing of the door typically initiates the wash cycle. Subcategories of single tank, stationary door type machines include: single rack, double rack, pot, pan, and utensil washers, chemical dump type and hooded wash compartment ("hood type"). Single tank, door type models can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

iii. Pot, Pan, and Utensil: A stationary rack, door type machine designed to clean and sanitize pots, pans, and kitchen utensils.

iv. Glasswashing: A stationary rack, under counter machine specifically designed to clean and sanitize glasses.

b) Conveyor Machine: A dishwashing machine that employs a conveyor or similar mechanism to carry dishes through a series of wash and rinse sprays within the machine.

i. Single Tank Conveyor: A conveyor machine that includes a tank for wash water followed by a sanitizing rinse. This type of machine does not have a pumped rinse tank. This type of machine may include a prewashing section ahead of the washing section and an

auxiliary rinse section for purposes of reusing the sanitizing rinse water between the power rinse and sanitizing rinse sections. Single tank conveyor dishwashers can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

ii. Multiple Tank Conveyor: A conveyor type machine that includes one or more tanks for wash water and one or more tanks for pumped rinse water, followed by a sanitizing rinse. This type of machine may include a pre-washing section before the washing section and an auxiliary rinse section for purposes of reusing the sanitizing rinse water between the power rinse and sanitizing rinse section. Multiple tank conveyor dishwashers can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

iii. Flight Type Conveyor: A conveyor machine where the dishes are loaded directly on the conveyor rather than transported with a rack. This machine is also referred to as a rackless conveyor.

c) Sanitation Methods:

i. Hot Water Sanitizing (High Temp) Machine: A machine that applies hot water to the surfaces of dishes to achieve sanitization.

ii. Chemical Sanitizing (Low Temp) Machine: A machine that applies a chemical sanitizing solution to the surfaces of dishes to achieve sanitization.

iii. Chemical Dump Type Machine: A low temp, stationary rack machine with a pumped recirculated sanitizing rinse.

iv. Dual Sanitizing Machine: A machine designed to operate as either a high temp or low temp machine.

3) Warewashing Machine Terminology

a) Product Family: Variations of one model offered within a single product line with design differences limited to: finish/color; length of pre-wash section, voltage, and orientation (e.g., corner, straight through models). Individual models represented by a product family must have the same sanitizing and post-sanitizing rinse water and idle energy consumption.

b) Water heater: Water Heater is defined in NSF International/American National Standards Institute (*NSF/ANSI) 170-2010: Glossary of Food Equipment Terminology; Section 3.223*.

c) Booster Heater: Booster Heater is defined in *NSF/ANSI 170-2010; Section 3.223.1*.

d) Sanitization: Sanitization is defined in *NSF/ANSI 170-2010; Section 3.176*.

e) Sanitizing Solution: Sanitizing Solution is defined in *NSF/ANSI 170-2010; Section 3.177*.

f) Washing: Washing is defined in *NSF/ANSI 170-2010; Section 3.221*.

g) Fresh Water: Fresh Water is defined in *NSF/ANSI 170-2010; Section 3.83*.

h) Sanitizing Rinse: Sanitizing Rinse is defined in *NSF/ANSI 170-2010; Section 3.173*.

i) Chemical Sanitizing Rinse: Chemical Sanitizing Rinse is defined in *NSF/ANSI 170-2010; Section 3.170*.

j) Hot Water Sanitizing Rinse: Hot Water Sanitizing Rinse is defined in *NSF/ANSI 170-2010; Section 3.171*.

k) Pumped Rinse: Pumped Rinse is defined in *NSF/ANSI 170-2010; Section 3.152*.

l) Auxiliary Rinse: Auxiliary rinse is defined in *NSF/ANSI 170-2010; Section 3.5*.

m) Recirculating Sanitizing Rinse: Recirculating Sanitizing Rinse is defined in *NSF/ANSI 170-2010; Section 3.160*.

n) Non-recirculating Pumped Sanitizing Rinse: Non-recirculating Pumped Sanitizing Rinse is defined in *NSF/ANSI 170-2010; Section 3.129*.

o) Post-sanitizing Rinse: Post-sanitizing Rinse is defined in *NSF/ANSI 170-2010; Section 3.172*.

p) Prewashing Unit: Prewashing Unit is defined in *NSF/ANSI 170-2010; Section 3.148*.

q) Rack: Rack is defined in *NSF/ANSI 170-2010; Section 3.155*.

4) Mode Definitions

a) Wash Mode: For stationary rack machines, the dishwasher is in wash mode when it is actively running a cycle and is spraying wash water (water that is neither part of the sanitizing rinse, post-sanitizing rinse, nor the prewashing unit).

b) Rinse Mode: For stationary rack machines, the dishwasher is in rinse mode when it is at the end of the actively running cycle and is spraying hot water or chemical sanitizing rinse water or a post-sanitizing rinse.

c) Dwell Mode: For stationary rack machines, the dishwasher is in dwell mode when it is actively running a cycle but is not in wash mode or rinse mode.

d) Idle Mode: For all dishwasher types, the dishwasher is in idle mode when it is not actively running but is still powered on and ready to wash dishes at the required temperature.

e) Energy Saver Mode: A dishwasher is in energy saver mode if, after inactivity, the dishwasher converts to a setting that consumes less energy than it does in idle mode (not all dishwashers include this feature).

5) Test Method Terminology

a) Ambient Temperature: Ambient Temperature is defined in *NSF/ANSI 170-2010; Section 3.3*.

b) Flow Pressure: Flow Pressure is defined in *NSF/ANSI 170-2010; Section 3.74*.

c) Line Pressure: Line Pressure is defined in *NSF/ANSI 170-2010; Section 3.113*.

d) Rated Temperature: Rated Temperature is defined in *American Society for Testing and Materials (ASTM) F1920-11: Standard Test Method for Performance of Rack Conveyor, Commercial Dishwashing Machines; Section 3.1.7*.

e) Tank Heater Idle Rate: Tank Heater Idle Rate is defined in *ASTM F1920-11; Section 3.1.9*.

f) Uncertainty: Uncertainty is defined in *ASTM F1920-11; Section 3.1.10*.

4 TEST CONDUCT

A) Testing Order: The sanitizing and post-sanitizing rinse water consumption test shall be run before the idle energy consumption test. The Dishwasher shall be operated at the same settings (water level, cycle times, sanitizing mode, etc.) for both the water consumption test and the idle energy consumption tests.

B) Machines designed to be interchangeable in the field from high temp and low temp (i.e. Dual Sanitizing Machines), and vice versa, shall be tested at both settings.

C) Machines designed to be used either as a Dishwasher or a pot, pan, and utensil washer shall be tested at both settings.

D) If a machine includes an Energy Saver Mode, it shall be turned off or disabled.

> **Note:** DOE and EPA acknowledge stakeholders' desire to test products "as shipped". It is important, however, that the Dishwasher meet idle energy requirements for the entire duration of the idle energy test without the Energy Saver Mode activated (i.e., worst case scenario). Additionally, there may be significant variation in "as shipped" settings, making product comparison and validation difficult.

E) If a Dishwasher includes a prewash tank heater as an option, the model must be tested and reported separately from the same model without the prewash tank heater.

F) This test method may be used for Dishwashers with steam coil tank heat, but not Dishwashers with steam injection tank heat.

> **Note:** DOE and EPA welcome stakeholder feedback on a steam injection tank heat test method that may be evaluated for a future test method revision.

G) When the test method or referenced test procedures specify to use the nameplate or manufacturer's recommendations, instructions, specifications, or requirements, the information source shall be used in the following order of preference and documented in the test report: nameplate data, user manual, communication with manufacturer.

H) Throughout this test method, "may" refers to an action that is voluntary and "shall" refers to an action that is mandatory.

I) Since this test method will be used to qualify and/or verify products for ENERGY STAR, any issues that result in a termination of testing will require the test lab to obtain a replacement unit.

5 TEST SETUP

A) Water Consumption Test Instrumentation

1) Pressure Gauge: The pressure gauge shall be capable of measuring at least 0-60 pounds per square inch gage (psig) with a resolution of at least 1 psig and a maximum uncertainty of 1% of the measured value.

2) Scale: The scale shall be capable of measuring at least 0-100 pounds (lb) with a resolution of at least 0.01 lb and an accuracy of at least +/- 0.1 lb.

3) Stopwatch: The stopwatch shall have a resolution of at least 0.1 seconds (s) and an accuracy of at least +/- 0.2% of the time period being measured.

4) Vessel: The vessel for capturing the sanitizing and post-sanitizing rinse water shall be large enough (depending on the tank volume) to capture the water consumed during the entire water consumption test.

B) Idle Energy Consumption Test Instrumentation

Note: ASTM is in the process of revising ASTM F1920-11. DOE has discussed the proposed revisions in this test method with ASTM. Once the revised ASTM standard is published, it will include many of the revisions specified in this test method.

1) For all instruments, the specifications may be better than specified. Values provided are intended to be the minimum or maximum (depending on which is the worst case for the parameter) allowable.

2) Meters

a) Watt-hour Meters: For Dishwashers with electric tank or booster heat, the watt-hour meters for measuring the energy consumption of the Dishwasher and booster heater separately shall meet the requirements in *ASTM F1920-11; Section 6.1* with the following revisions.

Note: DOE and EPA propose modifying the following constraint on maximum uncertainty for consistency with other sections of ASTM F1920-11.

DOE and EPA welcome stakeholder feedback on this proposal.

i. The maximum uncertainty shall be no greater than 10% of the measured value.

b) Gas Meters: For Dishwashers with gas tank or booster heat, the gas meters for measuring the gas consumption of the Dishwasher and booster heater separately shall meet the requirements in *ASTM F1920-11; Section 6.2* with the following revision and additions.

Note: DOE and EPA propose deleting the maximum uncertainty of the pilot light gas meter constraint because it is an error in the ASTM F1920-11 standard.

DOE and EPA propose adding flow ranges so that labs will be able to choose gas meters that meet the testing range requirements.

DOE and EPA welcome stakeholder feedback on these proposals.

i. The requirement that the pilot light gas meter shall have a maximum uncertainty of at least 0.01 cubic feet (ft^3) shall be excluded.

ii. The tank heater gas meters shall be capable of measuring flows between at least 0.0 and 250 ft^3/hour (h) and the pilot light gas meters shall be capable of measuring flows between at least 0.0 and 10.0 ft^3/h.

c) Steam Flow Meters: For Dishwashers with steam coil tank heat, the steam flow meters shall meet the requirements in *ASTM F1920-11; Section 6.3* with the following addition.

Note: DOE and EPA propose adding the following flow range so that labs will be able to choose steam flow meters that meet the testing range requirements. DOE and EPA are also proposing a maximum frequency of data collection so that enough data are obtained for accurate calculations.

DOE and EPA welcome feedback on these proposals.

i. The steam flow meters shall be capable of measuring flows between at least 0.0 and 50 ft^3/hour and shall be capable of recording data at least as frequently as every second.

3) Pressure Gauges

a) Gas Pressure Gauge: For Dishwashers with gas tank heat, the gas pressure gauges shall meet the requirements in *ASTM F1920-11; Section 6.6.*

b) Steam Pressure Gauge: For Dishwashers with steam coil tank heat, the steam pressure gauges shall meet the requirements in *ASTM F1920-11; Section 6.4* with the following addition.

Note: DOE and EPA propose adding the following pressure range so that labs will be able to choose pressure gauges that meet the testing range requirements.

DOE and EPA welcome feedback on this proposal.

i. The steam pressure gauges shall be capable of measuring pressures between at least 0 and 100 psig.

4) Ventilation

a) Stationary Rack: For Dishwashers that are classified as stationary rack types, ventilation shall meet the requirements in *ASTM F1696-07: Standard Test Method for Energy Performance of Single-Rack, Door-Type Commercial Dishwashing Machines; Section 6.5*.

b) Conveyors: For Dishwashers that are classified as conveyor types, ventilation shall meet the requirements in *ASTM F1920-11; Section 6.5* with the following revision.

Note: DOE and EPA propose clarifying that manufacturer recommendations for the ventilation rates shall be used when they are provided instead of the ventilation rate specified in ASTM F1920-11.

DOE and EPA welcome feedback on this proposal.

i. Vent cowl exhaust ducts shall operate in accordance with the manufacturer's recommendation, if applicable, or at a nominal 200 cubic feet per minute (cfm) on the entrance side of the Dishwasher and 400 cfm on the exit side if the manufacturer does not provide recommendations.

5) Thermocouple Probes and Temperature Sensors

a) Thermocouple Probes: For all Dishwashers, the thermocouple probes shall meet the requirements in *ASTM F1920-11; Section 6.12* with the following revision and additions.

i. "Dishwater" shall be replaced with "Dishwasher".

Note: DOE and EPA propose adding a response time to ensure that the temperature probes accurately reflect the temperature at the time it is recorded. An additional use for the thermocouple probe is also identified.

DOE and EPA welcome feedback on these proposals.

ii. The thermocouple probes shall have a response time of less than two seconds.

iii. For Dishwashers with steam coil tank heat, the thermocouple probes shall be used for measuring the condensate water outlet temperature.

b) Ambient Air: For all Dishwashers, the temperature sensor for measuring ambient air temperatures in the range of 50 degrees Fahrenheit (°F) to 100°F shall have a resolution of at least 0.5°F and a maximum uncertainty of +/- 1°F.

c) Gas: For Dishwashers with gas tank heat, the temperature sensor shall meet the requirements in *ASTM F1920-11; Section 6.7.*

d) Steam: For Dishwashers with steam coil tank heat, the temperature sensor for measuring steam temperatures in the range of 200°F to 300°F shall have a resolution of at least 0.5°F and a maximum uncertainty of +/- 1°F.

6) Additional Requirements

a) Stop Watch: For all Dishwashers, the stop watch shall meet the requirements in *ASTM F1920-11; Section 6.10.*

b) Barometer: For Dishwashers with natural gas tank heat, a barometer shall be used if the gas flow meter does not correct for pressure. For Dishwashers with steam coil tank heat, a barometer shall be used for calculating absolute pressure from gage pressure if the pressure gauge does not correct for atmospheric pressure. The barometer shall meet the requirements in *ASTM F1920-11; Section 6.8.*

C) Commercial Dishwasher Installation

1) Commercial Dishwashers shall be installed per manufacturer's installation instructions. All packing material and protective packaging shall be removed.

2) Drain connections shall be accessible with sufficient space to allow capture vessel to be positioned beneath.

3) For steam coil tank heat Dishwashers, install instruments to provide dry superheated steam to the Dishwasher. Adjust the steam supply pressure to within +/- 2.5% of the operating pressure specified by the manufacturer. Install instrumentation to record the pressure, temperature, and volumetric flow rate of the steam supplied to the Dishwasher, the pressure and temperature of the condensate exiting the Dishwasher, and the barometric pressure during each test so that the measured gage pressures can be corrected to absolute pressure.

4) Stationary Rack Type: For Dishwashers that are classified as stationary rack types, the Dishwasher setup shall meet the requirements in *ASTM F1696-07; Sections 9.1-9.10* with the following revisions and additions.

Note: DOE and EPA propose modifying Section 9.3 of ASTM F1696-07 to make it consistent with Section 9.3 of ASTM F1920-11. Additionally, DOE and EPA propose allowing the use of water in lieu of an external booster heater for testing. During testing, the lab suggested that if a hot water supply at the required temperatures is available, it would be easier to use than an external booster heater. Testing burden is reduced by not having to acquire, set up, and run an external booster heater.

ASTM F1696-07 Section 9.4 does not provide sufficient detail on which components should be monitored during the idle energy test. In addition, it does not address testing of internal booster heater idle energy consumption. DOE and EPA propose revisions to clarify which components should be included in the idle energy test.

In ASTM F1696-07 Section 9.5, DOE and EPA propose a revision to account for gas flow meters that automatically correct for pressure and temperature.

DOE and EPA welcome feedback from stakeholders on these proposals.

a) In Section 9.3, the supply of water shall be within +/- 2°F of its manufacturer specified input temperature (not to exceed 140 +/- 2°F). For testing purposes, the Dishwasher may be connected to a source of water that is at the manufacturer specified sanitizing rinse temperature, +/- 1°F, in lieu of an external booster heater.

b) In Section 9.4, the watt-hour meters shall be connected so that all idle energy (including tank heater, motors, and controls) is monitored. For steam coil or gas Dishwashers, electric energy consumption shall be simultaneously monitored with steam or gas energy consumption. The Dishwasher and booster shall not be monitored as one energy load. For the idle energy test, internal booster heaters shall be monitored separately and the booster idle energy shall be subtracted from the total idle energy.

c) In Section 9.5, instrumentation to record both the pressure and temperature of the gas supplied to the Dishwasher and the barometric pressure is only necessary if the gas flow meter does not already correct for pressure and temperature.

5) Conveyors: For Dishwashers that are classified as conveyors, the Dishwasher setup shall meet the requirements in *ASTM F1920-11; Sections 9.1-9.11* with the following revisions and additions.

Note: Similar to Stationary Rack Type Dishwashers, DOE and EPA propose allowing the use of water in lieu of an external booster heater for testing of Conveyor units. During testing, the lab suggested that if a hot water supply at the required temperatures is available, it would be easier to use than an external booster heater. Testing burden is reduced by not having to acquire, set up, and run an external booster heater.

ASTM F1920-11 Section 9.4 does not provide sufficient detail on which components should be monitored during the idle energy test. In addition, it does not address testing of internal booster heater idle energy consumption. DOE and EPA propose revisions to clarify which components should be included in the idle energy test.

In ASTM F1920-11 Section 9.5, DOE and EPA propose a revision to account for gas flow meters that automatically correct for pressure and temperature.

DOE and EPA welcome feedback from stakeholders on these proposals.

a) In Section 9.3, for testing purposes, the Dishwasher may be connected to a source of water that is at the manufacturer specified sanitizing rinse temperature, +/- 1°F, in lieu of an external booster heater.

b) In Section 9.4, the watt-hour meters shall be connected so that all idle energy (including tank heater(s), motors, and controls) is monitored. For steam coil or gas Dishwashers, electric energy consumption shall be simultaneously monitored with steam or gas energy consumption. The Dishwasher and booster shall not be monitored as one energy load. For the idle energy test, internal booster heaters shall be monitored separately and the booster idle energy shall be subtracted from the total idle energy.

c) In Section 9.5, instrumentation to record both the pressure and temperature of the gas supplied to the Dishwasher and the barometric pressure is only necessary if the gas flow meter does not already correct for pressure and temperature.

D) Test Settings

1) Water Consumption Test Settings:

a) Fresh Water Sanitizing or Post-Sanitizing Rinse Stationary Rack Type Machines

i. If multiple cycle times are available, the Dishwasher shall be tested at the shortest time setting.

ii. If there is a post-sanitizing rinse, turn it on and ensure it remains on during testing.

iii. Water at 120 +/- 10°F shall be used.

iv. Based on manufacturer instructions, set the sanitizing or post-sanitizing rinse flow pressure based on the following:

- For machines marked for sanitizing or post-sanitizing rinse pressure ratings of 20 +/- 5 psig, the test shall be run at 20 +/- 1 psig.

- For machines marked for sanitizing or post-sanitizing rinse pressure ratings other than 20 +/- 5 psig, and a marked pressure range of greater than 5 psig, the test shall be run with the sanitizing or post-sanitizing rinse pressure set at both the minimum and maximum ratings marked on the unit +/- 1 psig.

- For machines marked for sanitizing or post-sanitizing rinse pressure ratings other than 20 +/- 5 psig, and a marked pressure range of less than or equal to 5 psig, the test shall be run with the sanitizing or post-sanitizing rinse pressure set at the minimum rating marked on the unit +/-1 psig.

Note: DOE and EPA are only aware of fresh water sanitizing rinse stationary rack type machines that use the same spray system for both the sanitizing rinse and post-sanitizing rinse currently available in the market.

DOE and EPA welcome feedback on any additional setup requirements for this post-sanitizing rinse design and other possible designs (such as a separate spray system for the post-sanitizing rinse) that should be accounted for.

b) Pumped Water Sanitizing or Post-Sanitizing Rinse Stationary Rack Type Machines

i. If multiple cycle times are available, the Dishwasher shall be tested at the shortest time setting.

ii. If there is a post-sanitizing rinse, turn it on and ensure it remains on during testing.

iii. Water at 120 +/- 10°F shall be used.

iv. The machine shall be filled to the manufacturer's recommended level. The same water level shall be used for the water consumption and idle energy tests for consistency.

Note: DOE and EPA are not aware of any pumped water sanitizing rinse stationary rack type machines with a post-sanitizing rinse currently available in the market.

DOE and EPA welcome feedback on any additional setup requirements that should be accounted for.

c) Fresh Water Sanitizing or Post-Sanitizing Rinse Conveyor Type Machines

i. If the conveyor speed is user adjustable, set to maximum conveyor speed and report the conveyor speed. If it is not user adjustable, retain the factory setting and report the conveyor speed.

ii. If there is a post-sanitizing rinse, turn it on and ensure it remains on during testing.

iii. Water at 120 +/- 10°F shall be used.

iv. Based on manufacturer instructions, set the rinse flow pressure based on the following:

- For machines marked for sanitizing or post-sanitizing rinse pressure ratings of 20 +/- 5 psig, the test shall be run at 20 +/- 1 psig.

- For machines marked for sanitizing or post-sanitizing rinse pressure ratings other than 20 +/- 5 psig, and a marked pressure range of greater than 5 psig, the test shall be run with the sanitizing or post-sanitizing rinse pressure set at both the minimum and maximum ratings marked on the unit +/- 1 psig.

- For machines marked for sanitizing or post-sanitizing rinse pressure ratings other than 20 +/- 5 psig, and a marked pressure range of less than or equal to 5 psig, the test shall be run with the sanitizing or post-sanitizing rinse pressure set at the minimum rating marked on the unit +/- 1 psig.

Note: DOE and EPA are not aware of any fresh water conveyor type machines with a post-sanitizing rinse currently available in the market.

DOE and EPA welcome feedback on any additional setup requirements that should be accounted for.

d) Pumped Water Sanitizing or Post-Sanitizing Rinse Conveyor Type Machines

i. If the conveyor speed is user adjustable, set to maximum conveyor speed and report the conveyor speed. If it is not user adjustable, retain the factory setting and report the conveyor speed.

ii. If there is a post-sanitizing rinse, turn it on and ensure it remains on during testing.

iii. Water at 120 +/- 10°F shall be used.

Note: DOE and EPA are not aware of any pumped water conveyor type machines with a post-sanitizing rinse currently available in the market.

DOE and EPA welcome feedback on any additional setup requirements that should be accounted for.

6 TEST METHODS FOR ALL PRODUCTS

6.1 Sanitizing and Post-Sanitizing Rinse Water Consumption

1) Fresh Water Sanitizing or Post-Sanitizing Rinse Stationary Rack Type Machines

   a) Completely dry and weigh the capture vessel.

   b) Operate the machine through three cycles. Verify that the wash, rinse (including post-sanitizing rinse if this feature is included), and dwell times are within 1 second of the manufacturer's specified values and that the water pressure is within 1 psig of the manufacturer's specified value. If they are not, make adjustments and operate the machine through additional cycles until they are (i.e. steady state is achieved). If the specified times are not reached, terminate testing.

Note: DOE and EPA are only aware of fresh water sanitizing rinse stationary rack type machines that use the same spray system for both the sanitizing rinse and post-sanitizing rinse. Thus, no additional pressure verification would be required.

DOE and EPA welcome feedback on additional operation requirements for this post-sanitizing rinse design and other possible designs (such as a separate spray system for the post-sanitizing rinse) that should be accounted for.

   c) Using the weighed capture vessel, catch all water that is sent to the drain during a complete cycle, including any water from a post-sanitizing rinse. Record the exact wash, rinse, and dwell times. It may take longer than the duration of the cycle for all of the water to drain; thus the vessel shall remain in place until the water flow from the cycle ceases.

   d) Weigh the filled vessel after the cycle, subtracting the weight of the capture vessel to calculate the weight of the water.

   e) Repeat steps a) through d) five times. Completely dry the vessel after each cycle.

2) Pumped Water Sanitizing or Post-Sanitizing Rinse Stationary Rack Type Machines

   a) Completely dry and weigh the capture vessel.

   b) Operate the machine through three cycles. Verify that the wash, rinse, and dwell times are within one second of the manufacturer's specified values and that the water is within 0.25 inch (in) of the water fill line. If it is not, adjust the water pressure until the water is within 0.25 inch of the water fill line. If the water is still not within 0.25 inch of the water fill line, the wash, rinse, and dwell times may be adjusted, but the new times shall be recorded. If the specified times and/or water fill level are not reached, terminate testing.

Note: DOE and EPA are not aware of any pumped water sanitizing rinse stationary rack type machines currently on the market with a post-sanitizing rinse.

DOE and EPA welcome feedback on additional operation requirements that should be accounted for.

c) Using the weighed capture vessel, catch all water that is sent to the drain during a complete cycle, including any water from a post-sanitizing rinse. Record the exact wash, rinse, and dwell times. It may take longer than the duration of the cycle for all of the water to drain; thus the vessel shall remain in place until the water flow from the cycle ceases.

d) Weigh the filled vessel after the cycle, subtracting the weight of the capture vessel to calculate the weight of the water.

e) Repeat steps a) through d) five times. Completely dry the vessel after each cycle.

3) Fresh Water Sanitizing or Post-Sanitizing Rinse Conveyor Type Machines

a) Completely dry and weigh the capture vessel.

b) Activate the sanitizing rinse solenoid and the post-sanitizing rinse solenoid, if there is one, for 5 minutes (min). Do not activate any other component(s) of the Dishwasher that sends water to the drain. If there is a lever that actuates the sanitizing rinse solenoid or post-sanitizing rinse solenoid, the lever may be held down to simulate operation. Verify that the water pressure is within 1 psig of the manufacturer's specified value. If it is not, make adjustments and operate the machine until it is (i.e. steady state is achieved).

Note: DOE and EPA are not aware of any fresh water conveyor type machines with a post-sanitizing rinse currently on the market.

DOE and EPA welcome feedback on additional operation requirements that should be accounted for.

c) Using the weighed capture vessel, catch all water that is sent to the drain during 1 min +/- 1 second of continuous operation of the sanitizing rinse and post-sanitizing rinse solenoids (record the exact time). Do not activate any other component(s) of the Dishwasher that sends water to the drain. If there is a lever that actuates the sanitizing rinse solenoid or post-sanitizing rinse solenoid, the lever may be held down to simulate operation. It may take longer than 1 min for all of the water to drain; thus the vessel shall remain in place until the water flow from solenoid activation ceases.

d) Weigh the filled vessel, subtracting the weight of the capture vessel to calculate the weight of the water.

e) Repeat steps a) through d) five times. Completely dry the vessel after each test run.

4) Pumped Water Sanitizing or Post-Sanitizing Rinse Conveyor Type Machines

a) Completely dry and weigh the capture vessel.

b) Activate the sanitizing rinse solenoid and the post-sanitizing rinse solenoid, if there is one, for 5 min. Do not activate any other component(s) of the Dishwasher that sends water to the drain. If there is a lever that actuates the sanitizing rinse solenoid or post-sanitizing rinse solenoid, the lever may be held down to simulate operation. Verify that

the pumped sanitizing rinse and post-sanitizing rinse operate correctly. If they do not, terminate testing.

Note: DOE and EPA are not aware of any pumped water conveyor type machines with a post-sanitizing rinse currently available in the market.

DOE and EPA welcome feedback on additional operation requirements for post-sanitizing rinse units that should be accounted for.

c) Using the weighed capture vessel, catch all water that is sent to the drain during 1 minute +/- 1 second of continuous operation of the sanitizing rinse and post-sanitizing rinse solenoids (record the exact time). Do not activate any other component(s) of the Dishwasher that sends water to the drain. If there is a lever that actuates the sanitizing rinse solenoid or post-sanitizing rinse solenoid, the lever may be held down to simulate operation. It may take longer than 1 minute for all of the water to drain; thus the vessel shall remain in place until the water flow from solenoid activation ceases.

d) Weigh the filled vessel, subtracting the weight of the capture vessel to calculate the weight of the water.

e) Repeat steps a) through d) five times. Completely dry the vessel after each test run.

6.2 Idle Energy Consumption for Stationary Rack Type Machines

Note: Test Method sections for determining idle energy consumption for steam coil tank heat are new. DOE and EPA encourage stakeholder feedback.

1) General measurements shall be taken and recorded as specified in *ASTM F1696-07; Section 10.1* with the following revisions and additions.

a) Steam coil units shall also be included in Section 10.1.1.

Note: DOE and EPA propose disregarding ASTM F1696-07 Section 10.1.1.2 because it conflicts with ASTM F1696-07 Sections 10.2 and 10.3 and the revisions to those sections proposed in this test method.

DOE and EPA propose revisions to ASTM F1696-07 Section 10.1.2 to account for gas flow meters that automatically correct for pressure and temperature. DOE and EPA propose removing ASTM F1696-07 Section 10.1.2.6 because it conflicts with ASTM F1696-07 Sections 10.2 and 10.3 and the revisions to those sections proposed in this test method.

Testing indicated that the ASTM F1696-07 steam coil test method needs additional specificity. DOE and EPA propose clarifications to Section 10.1.4.

The intent of the “maximum energy input rate” (i.e. maximum power) test is not clear during DOE’s evaluation. DOE and EPA propose revisions to specify the intent.

DOE and EPA welcome stakeholder feedback on these proposals.

b) Section 10.1.1.2 shall be disregarded.

c) The higher heating value shall be measured for all tests with a gas powered tank heater or booster. The other measurements specified in Section 10.1.2 shall only be taken if the

gas meter does not already correct the gas volume based on temperature and pressure. Section 10.1.2.6 shall be removed.

d) Section 10.1.4 shall be replaced with "For Dishwashers that use steam coils for tank heat, the steam temperature, pressure, and volumetric flow rate at Dishwasher inlet, water temperature and pressure at Dishwasher outlet, and barometric pressure shall be recorded at no greater than one second of every test. Make any necessary corrections to the measurements as required by the instruments (i.e. correction for elevation of pressure gauge above pressure line, etc.)."

e) Ensure that the Dishwasher is operating within manufacturer specifications. Note which components of the Dishwasher are included in the manufacturer's power consumption ratings and set up instruments to monitor only those components. If power consumption ratings are not provided, amps may be measured and compared with manufacturer's ratings.

f) Section 10.1.5 shall be used if there are several components of the Dishwasher included in the power consumption ratings. Peak input rate (i.e. maximum power) shall be determined and recorded. If the difference between the recorded value and the manufacturer specified input is greater than 5%, testing shall be terminated.

Note: Although ASTM F1696-07 specifies that the manufacturer may make appropriate changes or adjustments to the dishwasher, the manufacturer shall not make adjustments to the Dishwasher under test for ENERGY STAR testing.

2) For Dishwashers with steam coil tank heat, allow the Dishwasher tank to idle for one tank heater "on" cycle, with the exterior service door(s) closed. As the tank heater cycles on for the second time, record the amount of time between steam entering the volumetric flow meter and exiting as condensate with a stopwatch as t_{delay} (seconds). This time delay is used to compare the data from the inlet to the corresponding data from the outlet. Adjust testing times so that there is enough data to account for this delay.

3) The tank heater "maximum energy input rate" (i.e. maximum power) shall be measured and reported as specified in *ASTM F1696-07; Section 10.2* with the following revisions and additions.

Note: During testing, DOE found that the tank heater "maximum energy input rate" (i.e. maximum power) test was unnecessarily burdensome and did not meet the intended goal of ensuring that the Dishwasher is operating correctly. Additionally, testing showed that details for testing steam coil and gas tank heat units are needed. Therefore DOE and EPA propose revisions.

DOE and EPA welcome stakeholder feedback on these proposals.

a) If there is a rating for the tank heater, follow the steps below. If the tank heater is included as part of a total power consumption rating, follow the steps below while monitoring the total power consumption for all components included in the rating.

b) Section 10.2.1 shall be removed.

c) Section 10.2.2 shall be replaced with the following:

i. Instruments shall be connected so that only the energy (for steam and gas tank heat) or power (for electric tank heat) consumption of the tank heater is measured. Fill the Dishwasher tank with water.

ii. For electric tank heaters, commence monitoring the power of the tank heater within +/- 2 seconds of the time that the tank heater cycles on. Stop monitoring the power within +/- 2 seconds of the time that the tank heater cycles off. Record the maximum power value as the "maximum energy input rate".

iii. For gas tank heaters, allow the tank heater to idle for one "on" cycle to allow the burner orifices to heat up. Commence monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles on for the second time. Stop monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles off. Record the time and energy consumption of the tank heater during the complete "on" cycle.

iv. For steam coil tank heaters, commence monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles on. Stop monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles off. Record the time and energy consumption of the tank heater during the complete "on" cycle.

d) Section 10.2.3 shall be followed as written with the following revision.

i. The tank heater "maximum energy input rate" (i.e. maximum power) for the Dishwasher under test shall be determined in accordance with Section 7.6 of this test method.

ii. If the difference between the recorded value and the manufacturer specified input is greater than 5%, testing shall be terminated.

Note: Although ASTM F1696-07 specifies that the manufacturer may make appropriate changes or adjustments to the dishwasher, the manufacturer shall not make adjustments to the Dishwasher under test for ENERGY STAR testing.

e) For machines with steam coil tank heat, using an appropriately sized vessel that is completely dry, catch all water from the outlet during the test. Weigh the filled vessel, subtracting the weight of the capture vessel to calculate the weight of the water. Calculate the total mass of the inlet steam during the test and confirm that it is within 5% of the mass of water measured from the outlet stream. If the difference is greater than 5%, adjust the quality of the steam until the difference is less than 5% and rerun the tank heater "maximum energy input rate" (i.e. maximum power) test.

4) If there is a booster heater, the booster heater maximum energy input rate shall be measured and reported as specified in *ASTM F1696-07; Section 10.3* with the following revisions and additions.

Note: During testing, DOE found that the booster heater "maximum energy input rate" (i.e. maximum power) test was unnecessarily burdensome and did not meet the intended goal of ensuring that the Dishwasher is operating correctly. Therefore DOE and EPA propose revisions.

DOE and EPA welcome stakeholder feedback on these proposals.

a) If there is a rating for the booster heater, follow the steps below. If the booster heater is included as part of a total power consumption rating, follow the steps below while monitoring the total power consumption for all components included in the rating.

b) Section 10.3.1 shall be replaced with the following:

i. Instruments shall be connected so that only the energy (for gas booster heat) or power (for electric booster heat) consumption of the booster heater is measured. Fill the booster heater with water.

ii. For electric booster heaters, commence monitoring the power of the booster heater within +/- 2 seconds of the time that the booster heater cycles on. Stop monitoring the power within +/- 2 seconds of the time that the booster heater cycles off. Record the maximum power value as the "maximum energy input rate".

iii. For gas booster heaters, allow the tank heater to idle for one "on" cycle to allow the burner orifices to heat up. Commence monitoring the elapsed time and energy consumption of the booster heater within +/- 2 seconds of the time that the booster heater cycles on for the second time. Stop monitoring the elapsed time and energy consumption of the booster heater within +/- 2 seconds of the time that the booster heater cycles off. Record the time and energy consumption of the booster heater during the complete "on" cycle.

c) Section 10.3.2 shall be followed as written with the following revision.

i. The booster heater "maximum energy input rate" (i.e. maximum power) for the Dishwasher under test shall be determined in accordance with Section 7.6 of this test method.

ii. If the difference between the recorded value and the manufacturer specified input is greater than 5%, testing shall be terminated.

Note: Although ASTM F1696-07 specifies that the manufacturer may make appropriate changes or adjustments to the dishwasher, the manufacturer shall not make adjustments to the Dishwasher under test for ENERGY STAR testing.

5) If there is a booster heater for high temperature machines, the booster temperature shall be calibrated as follows:

Note: This section is a modified version of ASTM F1920-11 Section 10.5. There are enough changes to the original text that the full paragraph is provided for clarity. Proposed changes are italicized below. The conveyor method is used in this section for stationary rack machines because it is more up to date than ASTM F1696-07.

DOE and EPA propose including a tolerance on the sanitizing rinse temperature to provide guidance on the required accuracy of the temperature. Additionally, DOE and EPA propose that the minimum temperature, instead of average temperature, should be set to 181 +/- 1°F to be consistent with realistic operation. DOE and EPA propose additional language to clarify how to determine that the stabilized flowing rinse temperature is correct.

DOE and EPA welcome stakeholder feedback on these proposals.

a) *For external booster heaters,* while monitoring the water inlet of the booster heater *or water source* and Dishwasher (rinse manifold) temperature, initiate a Dishwasher cycle. Adjust the booster heater *or water source* to the manufacturer's recommended sanitizing rinse temperature *+/- 1°F*, if adjustable. If the manufacturer does not have a recommended external booster heater setting, then set the booster heater thermostat such that the *minimum* temperature of water at the Dishwasher manifold (measured only

during the rinse) is 181°F +/- 1°F. If the machine is supplied with an internal booster heater, retain the factory setting of the thermostat.

b) Run a machine cycle with an empty dishrack placed in the machine. Confirm that the stabilized flowing rinse temperature is above the manufacturer's rated rinse temperature minus 1°F. If the stabilized flowing rinse temperature is below the manufacturer's nameplate rated rinse temperature minus 1°F, adjust the thermostat per the manufacturer's instructions.

6) The wash tank temperature shall be set as specified in *ASTM F1920-11; Section 10.6* with the following revisions and additions.

Note: The conveyor method is referenced in this section for stationary rack machines because it is more up to date than ASTM F1696-07.

DOE and EPA propose that the minimum temperature, instead of average temperature, should be used to be consistent with realistic operation. Additionally, DOE and EPA propose including a maximum temperature so that the temperature remains relatively consistent within a reasonable range. DOE and EPA propose additional language to clarify how to determine that the temperature is correct.

DOE and EPA welcome stakeholder feedback on these proposals.

a) "Dishwater" shall be replaced with "Dishwasher". Verify that the minimum tank heater temperature during the three consecutive heater cycles is above the manufacturer's recommended setting minus 1°F and the maximum temperature is not more than 15°F higher than the minimum measured temperature. Repeat for all tanks.

b) Run a machine cycle with an empty dishrack placed in the machine to confirm that the minimum tank temperature(s) during the test is above the manufacturer's recommended setting minus 1°F and the maximum temperature is not more than 15°F higher than the minimum measured temperature If the tank temperature(s) is not correct, adjust the thermostat per the manufacturer's instructions.

7) The idle energy rate (i.e. power) shall be measured as follows:

Note: This section is a modified version of ASTM F1696-07 Section 10.8. There are enough changes to the original text that the full text is provided for clarity.

Proposed changes to the original procedure are italicized in section a) below. DOE and EPA propose including a time tolerance for measurements that are dependent on time to provide guidance on the required accuracy of the measurement.

DOE and EPA also propose extending the test to 10 heater cycles if there have not been 10 heater cycles during the three hour testing period. ASTM has determined that 10 heater cycles are sufficient to account for cycle variations. DOE and EPA propose including a maximum temperature so that the temperature remains relatively consistent within a reasonable range.

Section b) includes a new test method for internal booster heaters. DOE and EPA acknowledge that booster heaters have idle energy consumption; however, many commercial Dishwashers use an external booster heater. Thus, requiring the inclusion of internal booster heater idle energy in the total idle energy value would unfairly penalize Dishwashers that include an internal booster heater. However, there are some machines that do not physically allow separate monitoring of the internal booster heater. For these machines, internal booster heater idle energy must be included in the total idle energy value.

DOE and EPA welcome stakeholder feedback on these proposals.

a) If the Dishwasher does not have an internal booster heater:

   i. Allow the Dishwasher to fill and energize the tank heater.

   ii. With the door(s) closed, allow the Dishwasher tank to idle for two tank heater "on" cycles *for stabilization*. Commence monitoring elapsed time, *tank* temperature, and *total* energy consumption of the Dishwasher *within +/- 2 seconds* of the time that the tank heater "on" cycles for the *third* time.

   iii. Allow the Dishwasher to idle for 3 hours *+/- 2 seconds*. *If there have not been 10 distinct heater cycles during the 3 hour period, continue to run the test and record data. Stop the test within +/- 2 seconds of the tenth time that the heater cycles off.* Record the final elapsed time and energy consumption of the Dishwasher.

   iv. Record the minimum tank temperature during the test and confirm that it is at or above the *manufacturer's specified* minimum tank temperature minus 1°F, as applicable. If the minimum tank temperature during the idle energy test is below the manufacturer's specified tank temperature *minus 1°F*, the test is invalid and must be repeated. *If the tank temperature exceeds 15°F of the measured minimum tank temperature, the test is invalid and must be repeated.* Adjust the thermostat per the manufacturer's instructions and repeat the steps in i through iii.

b) If the Dishwasher has an internal booster heater:

   i. Allow the Dishwasher to fill and energize the tank heater and booster heater.

   ii. With the door(s) closed, allow the Dishwasher tank and booster heater to idle for two "on" cycles each for stabilization. Commence monitoring elapsed time, tank temperature, and total energy consumption of the Dishwasher within +/- 2 seconds of the time that the tank heater cycles "on" for the third time.

   iii. Allow the Dishwasher to idle for 3 hours +/- 2 seconds. If there have not been 10 distinct heater cycles during the 3 hour period, continue to run the test and record data. Stop the test within +/- 2 seconds of the tenth time that the heater cycles off. Record the final elapsed time and energy consumption of the Dishwasher.

   iv. If the booster heater cannot be disconnected during the test, the booster idle energy consumption shall be subtracted from the total idle energy consumption.

      - If possible, sub-monitor the idle energy consumption of the booster heater during the Dishwasher idle energy test described in steps i through iii above.

      - If the booster heater idle energy cannot be simultaneously measured with the Dishwasher idle energy, the booster heater idle energy may be monitored at a different time; however, the test must include the same number of booster heater "on" cycles that were in the Dishwasher idle energy test. Repeat steps i through iii above, but record the energy consumption of the booster heater instead of the total Dishwasher energy consumption.

- If the booster heater cannot be separately monitored or sub-monitored, the booster heater idle energy consumption shall not be subtracted from the total idle energy consumption.

v. Record the minimum tank temperature during the test(s) and confirm that it is at or above the manufacturer's specified minimum tank temperature minus 1°F, as applicable. If the minimum tank temperature during the idle energy test is below the manufacturer's specified tank temperature minus 1°F, then the test is invalid and must be repeated. If the tank temperature exceeds 15°F of the measured minimum tank temperature, the test is invalid and must be repeated. Adjust the thermostat per the manufacturer's instructions and repeat the steps in i through iv.

6.3 Idle Energy Consumption for Conveyor Type Machines

Note: Test Method sections for determining idle energy consumption for steam coil tank heat are new. DOE and EPA encourage stakeholder feedback.

1) General measurements shall be taken and recorded as specified in *ASTM F1920-11; Section 10.1* with the following revisions and additions.

a) Steam coil units shall also be included in Section 10.1.1.

Note: DOE and EPA propose disregarding ASTM F1920-11 Section 10.1.1.2 because it conflicts with ASTM F1920-11 Sections 10.2 and 10.3 and the revisions to those sections proposed in this test method.

DOE and EPA propose revisions to ASTM F1920-11 Section 10.1.2 to account for gas flow meters that automatically correct for pressure and temperature. DOE and EPA propose removing ASTM F1920-11 Section 10.1.2.6 because it conflicts with ASTM F1920-11 Sections 10.2 and 10.3 and the revisions to those sections proposed in this test method.

Testing indicated that the ASTM F1920-11 steam coil test method needs additional specificity. DOE and EPA propose clarifications to Section 10.1.4.

The intent of the "maximum energy input rate" (i.e. maximum power) test is not clear. DOE and EPA propose revisions to specify the intent.

DOE and EPA welcome stakeholder feedback on these proposals.

b) Section 10.1.1.2 shall be disregarded.

c) The higher heating value shall be measured for all tests with a gas powered tank heater or booster. The other measurements specified in Section 10.1.2 shall only be taken if the gas meter does not already correct the gas volume based on temperature and pressure. Section 10.1.2.6 shall be removed.

d) Section 10.1.4 shall be replaced with "For Dishwashers that use steam coils for tank heat, the steam temperature, pressure, and volumetric flow rate at Dishwasher inlet, water temperature and pressure at Dishwasher outlet, and barometric pressure shall be recorded at no greater than one second of every test. Make any necessary corrections to the measurements as required by the instruments (i.e. correction for elevation of pressure gauge above pressure line, etc.)."

e) Ensure that the Dishwasher is operating within manufacturer specifications. Note which components of the Dishwasher are included in the manufacturer's power consumption ratings and set up instruments to monitor only those components. If power consumption ratings are not provided, amps may be measured and compared with manufacturer's ratings.

f) Section 10.1.5 shall be used if there are several components of the Dishwasher included in the power consumption ratings. Peak input rate (i.e. maximum input rate) shall be determined and recorded. If the difference is greater than 5%, testing shall be terminated.

Note: Although ASTM F1920-11 specifies that the manufacturer may make appropriate changes or adjustments to the dishwasher, the manufacturer shall not make adjustments to the Dishwasher under test for ENERGY STAR testing.

2) For Dishwashers with steam coil tank heat, with the exterior service door(s) closed, allow the Dishwasher tank to idle for one tank heater "on" cycle. As the tank heater cycles on for the second time, record the amount of time between steam entering the volumetric flow meter and exiting as condensate with a stopwatch as t_{delay} (seconds). This time delay is used to compare the data from the inlet to the corresponding data from the outlet. Adjust testing times so that there is enough data to account for this delay.

3) The tank heater "maximum energy input rate" (i.e. maximum power) shall be measured and reported as specified in *ASTM F1920-11; Section 10.2* with the following revisions and additions.

Note: During testing, DOE found that the tank heater "maximum energy input rate" (i.e. maximum power) test was unnecessarily burdensome and did not meet the intended goal of ensuring that the Dishwasher is operating correctly. Additionally, testing showed that details for testing steam coil and gas tank heat units are needed. Therefore, DOE and EPA propose revisions.

DOE and EPA welcome stakeholder feedback on these proposals.

a) If there is a rating for the tank heater(s), follow the steps below. If the tank heater(s) are included as part of a total power consumption rating, follow the steps below while monitoring the total power consumption for all components included in the rating.

b) Section 10.2.1 shall be replaced with the following:

i. Instruments shall be connected so that only the energy (for steam and gas tank heat) or power (for electric tank heat) consumption of the tank heater is measured. Fill the Dishwasher tank with water.

ii. For electric tank heaters, commence monitoring the power of the tank heater within +/- 2 seconds of the time that the tank heater cycles on. Stop monitoring the power within +/- 2 seconds of the time that the tank heater cycles off. Record the maximum power value as the "maximum energy input rate".

iii. For gas tank heaters, allow the tank heater to idle for one "on" cycle to allow the burner orifices to heat up. Commence monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles on for the second time. Stop monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles off. Record the time and energy consumption of the tank heater during the complete "on" cycle.

iv. For steam coil tank heaters, commence monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles on. Stop monitoring the elapsed time and energy consumption of the tank heater within +/- 2 seconds of the time that the tank heater cycles off. Record the time and energy consumption of the tank heater during the complete "on" cycle.

c) Section 10.2.2 shall be followed as written with the following revision.

i. The tank heater "maximum energy input rate" (i.e. maximum power) for the Dishwasher under test shall be determined in accordance with Section 7.6 of this test method.

ii. If the difference between the recorded value and the manufacturer specified input is greater than 5%, testing shall be terminated.

Note: Although ASTM F1920-11 specifies that the manufacturer may make appropriate changes or adjustments to the dishwasher, the manufacturer shall not make adjustments to the Dishwasher under test for ENERGY STAR testing.

d) For machines with steam coil tank heat, using an appropriately sized vessel that is completely dry, catch all water from the outlet during the test. Weigh the filled vessel, subtracting the weight of the capture vessel to calculate the weight of the water. Calculate the total mass of the inlet steam during the test and confirm that it is within 5% of the mass of water measured from the outlet stream. If the difference is greater than 5%, adjust the quality of the steam until the difference is less than 5% and rerun the tank heater "maximum energy input rate" (i.e. maximum power) test.

4) If there is a booster heater, the booster heater maximum energy input rate shall be measured and reported as specified in *ASTM F1920-11; Section 10.3* with the following revisions and additions.

Note: During testing, DOE found that the booster heater "maximum energy input rate" (i.e. maximum power) test was unnecessarily burdensome and did not meet the intended goal of ensuring that the Dishwasher is operating correctly. Therefore DOE and EPA propose revisions.

DOE and EPA welcome stakeholder feedback on these proposals.

a) If there is a rating for the booster heater, follow the steps below. If the booster heater is included as part of a total power consumption rating, follow the steps below while monitoring the total power consumption for all components included in the rating.

b) Section 10.3.1 shall be replaced with the following:

i. Instruments shall be connected so that only the energy (for gas booster heat) or power (for electric booster heat) consumption of the booster heater is measured. Fill the booster heater with water.

ii. For electric booster heaters, commence monitoring the power of the booster heater within +/- 2 seconds of the time that the booster heater cycles on. Stop monitoring the power within +/- 2 seconds of the time that the booster heater cycles off. Record the maximum power value as the maximum energy input rate.

iii. For gas booster heaters, allow the tank heater to idle for one "on" cycle to allow the burner orifices to heat up. Commence monitoring the elapsed time and energy consumption of the booster heater within +/- 2 seconds of the time that

the booster heater cycles on for the second time. Stop monitoring the elapsed time and energy consumption of the booster heater within +/- 2 seconds of the time that the booster heater cycles off. Record the time and energy consumption of the booster heater during the complete "on" cycle.

c) Section 10.3.2 shall be followed as written with the following revision.

i. The booster heater "maximum energy input rate" (i.e. maximum power) for the Dishwasher under test shall be determined in accordance with Section 7.6 of this test method.

ii. If the difference between the recorded value and the manufacturer specified input is greater than 5%, testing shall be terminated.

Note: Although ASTM F1920-11 specifies that the manufacturer may make appropriate changes or adjustments to the dishwasher, the manufacturer shall not make adjustments to the Dishwasher under test for ENERGY STAR testing.

5) If there is a booster heater for high temperature machines, the booster temperature shall be calibrated as follows:

Note: This section is a modified version of ASTM F1920-11 Section 10.5. There are enough changes to the original text that the full paragraph is provided for clarity. Proposed changes are italicized below.

DOE and EPA propose including a tolerance on the sanitizing rinse temperature to provide guidance on the required accuracy of the temperature. Additionally, DOE and EPA propose that the minimum temperature, instead of average temperature, should be set to 181 +/- 1°F to be consistent with realistic operation. DOE and EPA propose additional language to clarify how to determine that the stabilized flowing rinse temperature is correct.

DOE and EPA welcome stakeholder feedback on these proposals.

a) *For external booster heaters,* while monitoring the water inlet of the booster heater *or water source* and Dishwasher (rinse manifold) temperature, initiate a Dishwasher cycle. Adjust the booster heater *or water source* to the manufacturer's recommended sanitizing rinse temperature *+/- 1°F*, if adjustable. If the manufacturer does not have a recommended external booster heater setting, then set the booster heater thermostat such that the *minimum* temperature of water at the Dishwasher manifold (measured only during the rinse) is 181°F +/- 1°F. If the machine is supplied with an internal booster heater, retain the factory setting of the thermostat.

b) Run an empty dishrack through the machine. Confirm that the stabilized flowing rinse temperature is above the manufacturer's rated rinse temperature minus 1°F. If the stabilized flowing rinse temperature is below the manufacturer's nameplate rated rinse temperature minus 1°F, adjust the thermostat per the manufacturer's instructions.

6) The tank temperature(s) shall be calibrated as specified in *ASTM F1920-11; Section 10.6* with the following revisions and additions.

Note: DOE and EPA propose that the minimum temperature, instead of average temperature, should be used. Additionally, DOE and EPA are proposing to include a maximum temperature so that the temperature remains relatively consistent within a reasonable range. DOE and EPA propose additional language to clarify how to determine that the temperature is correct.

DOE and EPA welcome stakeholder feedback on these proposals.

a) "Dishwater" should be replaced with "Dishwasher". Verify that the minimum tank heater temperature during the three consecutive heater cycles is above the manufacturer's recommended setting minus 1°F and the maximum temperature is not more than 15°F higher than the measured minimum temperature. Repeat for all actively heated tanks.

b) Run an empty dishrack through the machine to confirm that the minimum tank temperature(s) during the test is above the manufacturer's recommended setting minus 1°F and the maximum temperature is not more than 15°F higher than the measured minimum temperature If the tank temperature(s) is not correct, adjust the thermostat per the manufacturer's instructions.

7) The wash tank pump and conveyor motor shall be calibrated as specified in *ASTM F1920-11; Section 10.7* with the following revision.

a) Section 10.7.1 is applicable to all pumps (not just the wash pump).

8) The idle energy rate (i.e. power) shall be measured as follows:

Note: This section is a modified version of ASTM F1920-11 Section 10.9. There are enough changes to the original text that the full text is provided for clarity.

Proposed changes to the original procedure are italicized in section a) below. DOE and EPA propose including a time tolerance for measurements that are dependent on time to provide guidance on the required accuracy of the measurement.

DOE and EPA also propose extending the test to 10 heater cycles if there have not been 10 heater cycles during the three hour testing period. ASTM has determined that 10 heater cycles are sufficient to account for cycle variations. DOE and EPA propose including a maximum temperature so that the temperature remains relatively consistent within a reasonable range.

Section b) includes a new test method for internal booster heaters. DOE and EPA acknowledge that booster heaters have idle energy consumption; however, many commercial Dishwashers use an external booster heater. Thus, requiring the inclusion of internal booster heater idle energy in the total idle energy value would unfairly penalize Dishwashers that include an internal booster heater. However, there are some machines that do not physically allow separate monitoring of the internal booster heater. For these machines, internal booster heater idle energy must be included in the total idle energy value.

DOE and EPA welcome stakeholder feedback on these proposals.

a) If the Dishwasher does not have an internal booster heater:

i. Allow the Dishwasher to fill and energize the tank heater(s).

ii. *For single tank machines,* with the exterior service door(s) closed, allow the Dishwasher tank to idle for two tank heater "on" cycles *for stabilization*. Commence monitoring elapsed time, *tank* temperature, and *total* energy consumption of the Dishwasher *within +/- 2 seconds* of the time that the tank heater on "cycles" for the *third* time.

iii. *For multiple tank machines, with the exterior service door(s) closed, allow each of the Dishwasher tanks to idle for two "on" cycles for stabilization. Commence monitoring the elapsed time and total energy consumption of the Dishwasher and the temperature of all the tanks within +/- 2 seconds of the time that one of the tank heaters "on" cycles again after all tank heaters have "on" cycled twice.*

iv. Allow the Dishwasher to idle for 3 hours +/- *2 seconds*. *If there have not been 10 distinct tank heater cycles for all tank heaters during the 3 hour period, continue to run the test and record data. Stop the test within +/- 2 seconds of the time that one of the tank heaters cycles off again after all tank heaters have "on" cycled ten times.* Record the final elapsed time and energy consumption of the Dishwasher.

v. Record the minimum tank temperature during the test and confirm that it is at or above the manufacturer's *specified* minimum tank temperature minus 1°F, as applicable. If the *minimum* tank temperature during the idle energy test was below the manufacturer's *specified* tank temperature minus 1°F, the test is invalid and must be repeated. *If the tank temperature exceeds 15°F of the measured minimum tank temperature, the test is invalid and must be repeated.* Adjust the thermostat per the manufacturer's instructions and repeat the steps in i through iv.

b) If the Dishwasher has an internal booster heater:

i. Allow the Dishwasher to fill and energize the tank heater(s).

ii. For single tank machines, with the exterior service door(s) closed, allow the Dishwasher tank to idle for two tank heater "on" cycles for stabilization. Commence monitoring elapsed time, tank temperature, and total energy consumption of the Dishwasher within +/- 2 seconds of the time that the tank heater cycles "on" for the third time.

iii. For multiple tank machines, with the exterior service door(s) closed, allow each of the Dishwasher tanks to idle for two "on" cycles for stabilization. Commence monitoring the elapsed time and total energy consumption of the Dishwasher and the temperature of all the tanks within +/- 2 seconds of the time that one of the tank heaters "on" cycles again after all tank heaters have "on" cycled twice.

iv. Allow the Dishwasher to idle for 3 hours +/- 2 seconds. If there have not been 10 distinct tank heater cycles for all tank heaters during the 3 hour period, continue to run the test and record data. Stop the test within +/- 2 seconds of the time that one of the tank heaters cycles off again after all tank heaters have "on" cycled ten times. Record the final elapsed time and energy consumption of the Dishwasher.

v. If the booster heater cannot be disconnected during the test, the booster idle energy rate shall be subtracted from the total idle energy rate.

- If possible, sub-monitor the idle energy rate of the booster heater during the Dishwasher idle energy test described in steps i through iv above.

- If the booster heater idle energy cannot be simultaneously measured with the Dishwasher idle energy, the booster heater idle energy may be monitored at a different time; however, the test must include the same number of booster heater "on" cycles that were in the Dishwasher idle

energy test. Repeat steps i through iv above, but record the energy consumption of the booster heater instead of the total Dishwasher energy consumption.

- If the booster heater cannot be separately monitored or sub-monitored, the booster heater idle energy shall not be subtracted from the total idle energy.

vi. Record the minimum tank temperature during the test(s) and confirm that it is at or above the manufacturer's specified minimum tank temperature minus 1°F, as applicable. If the minimum tank temperature during the idle energy test is below the manufacturer's specified tank temperature minus 1°F, then the test is invalid and must be repeated. If the tank temperature exceeds 15°F of the measured minimum tank temperature, the test is invalid and must be repeated. Adjust the thermostat per the manufacturer's instructions and repeat the steps in i through v.

7 CALCULATIONS

7.1 Racks per Hour

Note: DOE and EPA acknowledge that the calculations in Sections 7.1 through 7.3 could be simplified and combined into one equation. Since gallons per rack is an ENERGY STAR metric, however, it is important to show how it is derived. Clarifications are also provided for the NSF metrics (racks per hour and gallons per hour), such as truncating racks per hour and including the number of racks in the gallons per hour calculation.

A) Fresh Water or Pumped Water Sanitizing or Post-Sanitizing Rinse Stationary Type Machines

Equation 1: Racks per Hour for Stationary Type Machines

$$Racks\ per\ Hour = \frac{3600\ seconds\ x\ NR}{(WT + RT + DT + LT)(seconds)}$$

Where:

Racks per Hour = Number of racks washed per hour, truncated to the next lowest whole number
NR = Number of racks washed per cycle
WT = Wash time (i.e. amount of time spent in wash mode) in seconds as recorded during test
RT= Rinse time (i.e. amount of time spent in rinse mode, including a post-sanitizing rinse) in seconds as recorded during test
DT = Dwell time (i.e. amount of time spent in dwell mode) in seconds as recorded during test
LT = Load time (30 seconds for under counter Dishwashers, 5 seconds for straight through door-type Dishwashers, 7 seconds for corner door-type Dishwashers, 30 seconds for front load/unload door-type Dishwashers)

B) Fresh Water or Pumped Water Sanitizing or Post-Sanitizing Rinse Conveyor Type (excluding Flight Type) Machines

Equation 2: Racks per Hour for Conveyor Type Machines

$$Racks\ per\ Hour = \frac{CS\ x\ \frac{60\ minutes}{hour}}{RL\ x\ \frac{1\ ft}{12\ in}}$$

Where:

Racks per Hour = Number of racks washed per hour, truncated to the next lowest whole number
RL= Rack length (use 20 inches)
CS= Manufacturer specified maximum conveyor speed in feet per minute

7.2 Sanitizing and Post-Sanitizing Rinse Water Consumption (Gallons per Hour, GPH)

A) Fresh Water or Pumped Water Sanitizing or Post-Sanitizing Rinse Stationary Type Machines

Equation 3: Gallons per Hour for Stationary Type Machines

$$Gallons\ per\ Hour = \frac{\sum_{n=1}^{5} \frac{Measured\ Weight\ of\ water\ for\ cycle\ n\ (lbs)}{5\ cycles}}{\frac{8.34\ lbs}{gal}} x \frac{Racks\ per\ Hour}{NR}$$

Where:

Racks per Hour = Number of racks washed per hour, truncated to the next lowest whole number, as calculated in Section 7.1
NR = Number of racks washed per cycle

B) Fresh Water or Pumped Water Sanitizing or Post-Sanitizing Rinse Conveyor Type (including Flight Type) Machines

Equation 4: Gallons per Hour for Conveyor Type Machines

$$Gallons\ per\ Hour = \frac{\sum_{n=1}^{5} \frac{Measured\ Weight\ of\ water\ for\ test\ run\ n\ (lbs)}{Rinse\ Activation\ Duration\ for\ test\ run\ n\ (seconds)}}{5\ test\ runs\ x\ \frac{8.34\ lbs}{gal}\ x\ \frac{1\ hour}{3600\ seconds}}$$

Where:

Measured Weight of water for test run n = Weight of water sent to capture vessel from one minute of sanitizing rinse and post-sanitizing rinse solenoid activation
Rinse Activation Duration = Measured duration of sanitizing rinse and post-sanitizing rinse solenoid activation (one minute +/- one second)

Note: The ENERGY STAR Draft 3 Version 2.0 specification uses GPH as the water consumption metric for Flight Type machines (as opposed to GPR for other Conveyor machines). Thus, the GPH equation above is the only equation required to determine the water consumption of Flight Type machines.

7.3 Sanitizing and Post-Sanitizing Rinse Water Consumption

A) Fresh Water or Pumped Water Sanitizing or Post-Sanitizing Rinse Stationary Rack Type Machines

Equation 5: Gallons per Rack for Stationary Type Machines

$$Gallons\ per\ Rack = \frac{Gallons\ per\ Hour}{Racks\ per\ Hour}$$

Where:

Gallons per Hour= Water use in gallons per hour, as calculated in Section 7.2
Racks per Hour= Number of racks washed per hour, truncated to the next lowest whole number, as calculated in Section 7.1

B) Fresh Water or Pumped Water Sanitizing and Post-Sanitizing Rinse Conveyor Type (excluding Flight Type) Machines

Equation 6: Gallons per Rack for Conveyor Type Machines

$$Gallons\ per\ Rack = \frac{Gallons\ per\ Hour}{Racks\ per\ Hour}$$

Where:

Gallons per Hour= Water use in gallons per hour, as calculated in Section 7.2
Racks per Hour= Number of racks washed per hour, truncated to the next lowest whole number, as calculated in Section 7.1

C) Pot, Pan, and Utensil Type Machines

Equation 7: Gallons per Square Foot for Pot, Pan, and Utensil Type Machines

$$Gallons\ per\ Square\ Foot = \frac{Gallons\ per\ Rack}{Square\ foot\ of\ rack}$$

Where:

Gallons per Rack= Water use in gallons per hour, as calculated in Section 7.3A)
Square foot of rack= Manufacturer specified rack area in ft^2 for machine tested

7.4 Gas Energy Consumption

A) The gas energy consumption rate shall be calculated as specified in *ASTM F1920-11; Section 11.3* with the following revision.

1) Equation (2) shall only be used to calculate V if the gas meter does not already correct the gas volume based on temperature and pressure using the same standard values for temperature and pressure that were used to calculate the higher heating value in *ASTM F1920-11; Section 10.1.2*.

7.5 Steam Coil Energy Consumption

Note: Calculations for determining idle energy consumption for steam coil tank heat are new. DOE and EPA encourage stakeholder feedback.

A) Inlet Steam Mass Flow Rate

1) Find the measured pressure and temperature values for the inlet stream for each data point in the superheated or saturated steam tables[1] (depending on the state of the steam) and record the listed density (ρ_{Steam}). If the exact pressure and temperature are not listed in the table, interpolate between the two closest pressure and temperature values to calculate the density.

2) Calculate the mass flow rate for each data point as follows:

Equation 8: Inlet Steam Mass Flow Rate for Steam Coil Machines

$$\dot{M}_{Steam} = \dot{V}_{Steam}\, x\, \rho_{Steam}$$

Where:

$\dot{M}_{Steam}$ = Mass flow rate of steam (pounds (lb)/h)
$\dot{V}_{Steam}$ = Measured volumetric flow rate of steam (ft^3/h)
ρ_{Steam}= Density of steam (lb/ft^3), calculated from steam tables

B) Inlet Steam Total Mass

Equation 9: Inlet Steam Total Mass for Steam Coil Machines

$$M_{Total} = \sum_{i=1}^{N} (\dot{M}_{Steam,i}\, x\, t_i)\, x\, \frac{1\ hour}{3600\ seconds}$$

Where:

M_{Total}= Total steam consumption during time period (lb)
$\dot{M}_{Steam,i}$ = Instantaneous steam mass flow rate for each data point (lb/h)
N = Total number of data points during time period, excluding extra data to account for t_{delay}
t_i = Time interval of each data point (seconds)

C) Inlet Stream Enthalpy

1) Find the measured pressure and temperature values for the inlet steam for each data point in the superheated or saturated steam tables (depending on the state of the steam) and record the listed enthalpy (H_{Inlet}). If the exact pressure and temperature are not listed in the table, interpolate between the two closest pressure and temperature values to calculate the enthalpy.

D) Outlet Water Enthalpy

1) Find the pressure value for the outlet water for each data point in the saturated steam tables. Record the listed saturated liquid enthalpy value ($H_{Saturated}$) and saturated temperature value ($T_{Saturated}$). If the exact pressure is not listed in the table, interpolate between the two closest pressure values to calculate the enthalpy.

[1] "Steam tables" throughout this test procedure refers to any steam table source based on the International Association for the Properties of Water and Steam Formulation 1997 for the Thermodynamic Properties of Water and Steam for Industrial Use.

2) Calculate the enthalpy of the outlet water for each data point as follows:

Equation 10: Outlet Water Enthalpy for Steam Coil Machines

$$H_{Outlet} = H_{Saturated} - (C_p \, x \, (T_{Saturated} - T_{Measured}))$$

Where:

H_{Outlet} = Enthalpy of Dishwasher outlet stream (British thermal units (Btu)/lb)
$H_{Saturated}$ = Saturated liquid enthalpy value listed in steam tables (Btu/lb)
C_p = Heat capacity of water (1 Btu/lb °F)
$T_{Saturated}$ = Saturated liquid temperature value listed in steam tables (°F)
$T_{Measured}$ = Recorded temperature of liquid water outlet stream during test (°F)

E) Instantaneous Energy Consumption

1) Calculate the energy for each data point as follows:

Equation 11: Instantaneous Energy Consumption for Steam Coil Machines

$$E_i = \dot{M}_{Steam,i} \, x \, \left(H_{Inlet,i} - H_{Outlet,i+t_{delay}}\right) x \, t_i \, x \, \frac{1 \, hour}{3600 \, seconds}$$

Where:

E_i = Instantaneous energy consumption for each data point (Btu)
$\dot{M}_{Steam,i}$= Calculated mass flow rate of steam for each data point (lb/h)
$H_{Inlet,i}$= Enthalpy of Dishwasher inlet steam for each data point (Btu/lb)
$H_{Outlet,i+t_{delay}}$ = Enthalpy of Dishwasher outlet water for each data point (Btu/lb)
t_{delay} = Measured time between steam entering the flow meter and exiting as water (seconds)
t_i = Time interval of each data point (seconds)

F) Total Energy Consumption

Equation 12: Total Energy Consumption for Steam Coil Machines

$$E_{Total} = \sum_{i=1}^{N} (E_i) + E_{Electric}$$

Where:

E_{Total} = Total energy consumption during test (active or idle) (Btu)
E_i= Instantaneous energy consumption for each data point (Btu)
$E_{Electric}$ = Electric energy consumption during test
N = Total number of data points, excluding extra data to account for t_{delay}

7.6 Booster and Tank Heater Maximum Power

A) The idle energy input rate (i.e. maximum power) shall be calculated as specified in *ASTM F1920-11; Section 11.4* if a direct measurement of power was not taken.

1) The value 60 provided in the equation is a conversion factor from minute to hours.

2) This calculation shall also be used for steam.

7.7 Idle Energy Rate (Power)

A) The idle energy rate (i.e. power) shall be calculated as specified in *ASTM F1920-11; Section 11.5* with the following clarification, and additions.

1) The value 60 provided in the equation is a conversion factor from minute to hours.

2) This calculation shall also be used for steam.

3) If the idle energy rate (i.e. power) is reported in Btu/h, convert it to kilowatts (kW) based on the following equation:

Equation 13: Idle Energy Rate Conversion

$$E_{Idle\ rate}\ (kW) = E_{Idle\ rate}\left(\frac{Btu}{h}\right) x \frac{kW}{3412\ Btu/h}$$

7.8 Internal Booster Heater Idle Energy Rate (Power)

A) The booster heater idle energy rate (i.e. power) shall be calculated using the same equation as specified in *ASTM F1920-11; Section 11.5* for the tank heater idle energy rate with the following clarification and addition.

1) The value 60 provided in the equation is a conversion factor from minute to hours.

2) If the internal booster heater idle energy rate (i.e. power) is reported in Btu/h, convert it to kW based on the following equation:

Equation 14: Internal Booster Heater Idle Energy Rate Conversion

$$E_{Idle\ rate}\ (kW) = E_{Idle\ rate}\left(\frac{Btu}{h}\right) x \frac{kW}{3412\ Btu/h}$$

8 REFERENCES

A) ASTM F857-07. Standard Specification for Hot Water Sanitizing Commercial Dishwashing Machines, Stationary Rack Type. Published April 2007.

B) ASTM F858-07. Standard Specification for Hot Water Sanitizing Commercial Dishwashing Machines, Single Tank, Conveyor Rack Type. Published April 2007.

C) ASTM F1920-11. Standard Test Method for Performance of Rack Conveyor, Commercial Dishwashing Machines. Published July 2011.

D) ASTM F1696-07. Standard Test Method for Energy Performance of Single-Rack, Door-Type Commercial Dishwashing Machines. Published November 2007.

E) NSF/ANSI 3-2010. Commercial Warewashing Equipment. November 2, 2010.

F) NSF/ANSI 170-2010. Glossary of Food Equipment Terminology. April 6, 2011.