This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: F2140 – 11 (Reapproved 2019)

An American National Standard

Standard Test Method for Performance of Hot Food Holding Cabinets[1]

This standard is issued under the fixed designation F2140; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method evaluates the preheat energy consumption and idle energy consumption of hot food holding cabinets. The food service operator can use this evaluation to select a hot food holding cabinet and understand its energy performance, temperature uniformity, and relative humidity (if applicable). A hot food holding cabinet is described as a commercial kitchen appliance that is used to hold hot food (usually no greater than 200°F) that has been cooked in a separate appliance at a specified temperature.

1.2 This test method is applicable to electric hot food holding cabinets.

1.3 The hot food holding cabinet can be evaluated with respect to the following (where applicable):

1.3.1 Energy input rate (10.2),

1.3.2 Temperature calibration (10.3),

1.3.3 Preheat energy consumption and time (10.4),

1.3.4 Energy consumption (idle energy rate) (10.5),

1.3.5 Energy consumption with water (humidity pan) device and relative humidity (if applicable) (10.5) and

1.3.6 Temperature uniformity (10.5).

1.4 The values stated in inch-pound units are to be regarded as standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASHRAE Document:*[2]

ASHRAE Guideline 2—1986 (RA90) "Engineering Analysis of Experimental Data"

2.2 *NSF Standard:*[3]

NSF/ANSI 4 - 2009 Commercial Cooking, Rethermalization, and Powered Hot Food Holding and Transport Equipment

3. Terminology

3.1 *Definitions:*

3.1.1 *cook-and-hold appliance, n*—a multiple-mode appliance intended for cooking food that may be used to hold the temperature of the food that has been cooked in the same appliance.

3.1.2 *drawer warmer, n*—an appliance that consists of one or more heated drawers and that is designed to hold hot food that has been cooked in a separate appliance at a specified temperature.

3.1.3 *energy input rate, n*—peak rate at which a hot food holding cabinet consumes energy (kW), typically reflected during preheat.

3.1.4 *heated glass merchandising cabinets, n*—an appliance with a heated compartment that is designed to display and maintain the temperature of hot food that has been cooked in a separate appliance.

3.1.5 *heater cycle, n*—a complete sequence of the heat source energizing, de-energizing, and energizing during the idle test. Heater cycle applies to snap-action style controls. Proportional style controls may not exhibit clear energized/de-energized sequences.

3.1.6 *holding cavity, n*—that portion of the appliance in which food products are held.

3.1.7 *hot food holding cabinet, n*—a heated, fully-enclosed compartment, with one or more solid or transparent doors, that is designed to maintain the temperature of hot food that has

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[2] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

[3] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.

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been cooked in a separate appliance. Does not refer to heated glass merchandising cabinets, drawer warmers or cook-and-hold appliances.

3.1.8 *idle energy rate—dry, n*—the rate of energy consumed (kW) by the hot food holding cabinet while "idling" the holding cavity at the control set point without using the humidity generating device, if applicable.

3.1.9 *idle energy rate—wet, n*—the rate of energy consumed (kW) by the hot food holding cabinet while "idling" the holding cavity at the control set point while generating humidity, if applicable.

3.1.10 *preheat energy, n*—amount of energy consumed by the hot food holding cabinet while preheating the cabinet from ambient room temperature (75 ± 2.5°F) to 150°F, with the control(s) set to a calibrated 150°F.

3.1.11 *preheat rate, n*—average rate (°F/min) at which the hot food holding cabinet is heated from ambient temperature (75 ± 2.5°F) to 150°F, with the control(s) set to a calibrated 150°F.

3.1.12 *preheat time, n*—time required for the hot food holding cabinet to preheat from ambient room temperature (75 ± 2.5°F) to 150°F, with the control(s) set to a calibrated 150°F.

3.1.13 *thermal cycle, n*—a complete sequence of center-cabinet peak to low to peak temperatures during the idle test. The thermal cycle can be used in place of the thermal cycle for units with proportional controls.

3.1.14 *uncertainty, n*—measure of systematic and precision errors in specified instrumentation or measure of repeatability of a reported test result.

3.1.15 *water device, n*—a humidity pan or similar water-holding vessel, which is filled with water, that is built into the cabinet.

4. Summary of Test Method

4.1 The hot food holding cabinet is connected to the appropriate metered energy source, and energy input rate is determined to confirm that the appliance is operating within 5 % of the nameplate energy input rate.

4.2 The accuracy of the hot food holding cabinet's temperature control is checked at 150°F and adjusted as necessary to within ±5°F.

4.3 The amount of energy and time required to preheat the hot food holding cabinet to 150°F, based on a calibrated 150°F set point, is determined.

4.4 The rate of idle energy consumption is determined with the hot food holding cabinet set to maintain 150°F with no food load and no humidity generation.

4.5 The rate of idle energy consumption with water device and relative humidity (if applicable) with no food load.

4.6 The degree of temperature stratification at 150°F is determined.

5. Significance and Use

5.1 The energy input rate and thermostat calibration tests are used to confirm that the hot food holding cabinet is operating properly prior to further testing.

5.2 Preheat energy and time can be useful to food service operators to manage energy demands and to know how quickly the hot food holding cabinet can be ready for operation.

5.3 Energy consumption (idle energy rate) can be used by the food service operator to estimate energy consumption during operating periods.

5.4 Energy consumption (idle energy rate) with the water device can be used by the food service operator to estimate energy consumption during operating periods with the humidity device.

5.5 The relative humidity percentage can be used by operators to select a hot food holding cabinet that will meet their food-holding needs.

5.6 The temperature uniformity can be used by operators to choose a hot food cabinet that meets their food-holding needs.

6. Apparatus

6.1 *Data Acquisition System,* for measuring energy and temperatures, capable of multiple channel displays updating at least every 2 s.

6.2 *Humidity Measuring Device,* with an operating temperature range of 60 to 180°F, with an accuracy of ±2 % relative humidity.

6.3 *Stop Watch,* with a 1-s resolution.

6.4 *Thermocouple(s),* calibrated exposed junction industry standard type thermocouple probes, with a range of 0 to 250°F and an uncertainty of ±1°F.

6.5 *Watt-Hour Meter,* for measuring the electrical energy consumption of a hot food holding cabinet, shall have a resolution of at least 10 W·h and a maximum uncertainty no greater than 1.5 % of the measured value for any demand greater than 100 W. For any demand less than 100 W, the meter shall have a resolution of at least 10 W·h and a maximum uncertainty no greater than 10 %.

7. Reagents and Materials

7.1 *Aluminum Sheet Pans,* measuring 18 × 26 × 1 in. for the idle tests. (Pans measuring 13 × 18 × 1 in. may be used for smaller units if the larger pans do not fit).

8. Sampling, Test Units

8.1 *Hot Food Holding Cabinet*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the hot food holding cabinets according to the manufacturer's instructions in an appropriate space. All sides of the hot food holding cabinets shall be a minimum of 3 ft from any side wall, side partition, or other operating appliance. The associated heating or cooling system for the space shall be capable of maintaining an ambient temperature of 75 ± 2.5°F within the testing environment.

9.2 Connect the hot food holding cabinet to a calibrated energy test meter. A voltage regulator may be required during tests if the voltage supply is not within ±2.5 % of the manufacturer's nameplate voltage.

9.3 Confirm (while the elements are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test.

NOTE 1—It is the intent of the testing procedure herein to evaluate the performance of a hot food holding cabinet at its rated electric voltage. If an electric unit is rated dual voltage (that is, designed to operate at either 208 or 240 V with no change in components), the voltage selected by the manufacturer and/or tester shall be reported. If a hot food holding cabinet is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, preheat time) may differ at the two voltages.

9.4 Assure that the hot food holding cabinet's vent (if applicable) is closed for all tests.

9.5 For the preheat test and the idle test, each tested cabinet will have a minimum of three thermocouples regardless of the physical size of the unit, as described in NSF/ANSI 4 - 2009:

Thermocouple #1: (when facing the front of the unit) 5.0 ± 0.25 in. (127 ± 6.0 mm) from the left interior wall, 5.0 ± 0.25 in. (127 ± 6.0 mm) down from the ceiling, and centered front-to-back.

Thermocouple # 2: centered front-to-back, centered top-to bottom, centered left-to-right.

Thermocouple #3: (when facing the unit) 5.0 ± 0.25 in. (127 ± 6.0 mm) from the right interior wall, 5.0 ± 0.25 in. (127 ± 6.0 mm) above the internal floor of the unit, and centered front-to-back.

9.5.1 If interior spatial constraints prohibit the placement of thermocouples as specified above, alternate locations shall be selected to comply with the intent of the standard.

NOTE 2—The intent is for the thermocouples to form a diagonal in the unit while being centered front to back. See example in Fig. 1.

NOTE 3—The thermocouple placement in 9.5 is in accordance with NSF/ANSI 4 - 2009.

9.5.2 For the wet idle energy consumption test, install a relative humidity sensor in the geometric center of the hot food holding cabinet.

9.6 The idle energy consumption test will use sheet pans. The equipment shall be tested with one tray at the top, middle, and bottom of the hot holding cabinet.

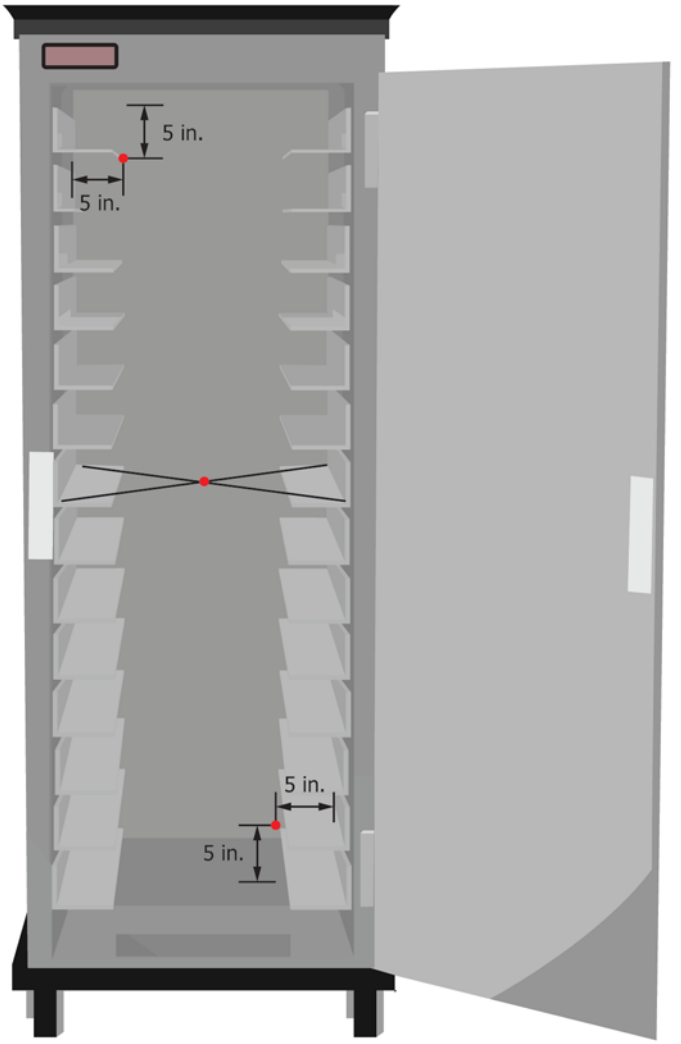

FIG. 1 Placement of Thermocouples

10. Procedure

10.1 *General:*

10.1.1 For the hot food holding cabinets, record the following for each test run:

10.1.1.1 Voltage while elements are energized,

10.1.1.2 Ambient temperature, and

10.1.1.3 Energy input rate during or immediately prior to each test run.

10.1.2 For each test run, confirm that the peak input rate is within ±5 % of the rated nameplate input. If the difference is greater than 5 %, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the hot food holding cabinet.

10.2 *Energy Input Rate:*

10.2.1 Set the temperature controls to 150°F and turn on the hot food holding cabinet.

10.2.2 Start recording time and energy consumption when the elements are energized and stop recording when the heaters commence cycling (not when the hot food holding cabinet's ready light comes on). For units with proportional controls, record time and energy consumption while the heaters are operating at their peak input.

NOTE 4—A cabinet's ready light is an indication that the cabinet is up to temperature and not an indication of whether the elements are on or drawing power. It is the intent of this Energy Input Rate procedure to monitor the energy during a continuous period when the elements are energized.

10.2.3 Confirm that the measured input rate or power is within 5 % of the rated nameplate input or power (it is the intent of the test procedure herein to evaluate the performance of a hot food holding cabinet at its rated energy input rate). If the difference between measured and rated input rate is greater than 5 %, then contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the test hot food holding cabinet or supply another hot food holding cabinet for testing.

10.3 *Temperature Calibration:*