INTERNATIONAL

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An American National Standard

Standard Test Method for Performance of Refrigerated Buffet and Preparation Tables[1]

This standard is issued under the fixed designation F2143; 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 covers evaluation of the energy consumption ~~and refrigeration performance~~ of refrigerated buffet and preparation tables. The food service operator can use this evaluation to select a refrigerated buffet and preparation table and understand its energy performance.

1.2 This test method is applicable to electric self-contained refrigerators used for holding and displaying refrigerated food in an open area.

1.3 The refrigerated buffet and preparation table can be evaluated with respect to the following (where applicable):

1.3.1 Maximum ~~energy input rate,~~ power, or maximum current draw (10.1),

1.3.2 Thermostat calibration (10.4), and

1.3.3 ~~Lid up energy rate and temperature performance~~ Energy consumption (10.5~~), and~~).

~~1.3.4 Lid down energy rate (10.6).~~

1.4 The values stated in inch-pound units are to be regarded as standard. The SI units given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *NSF Standard:*[2]

~~NSF, Listing-Food Equipment and Related, Components and Material~~

ANSI/NSF 7 Commercial Refrigerators and Freezers

2.2 *ASHRAE Guideline:*[3]

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

2.3 *ANSI/ASHRAE Standards:*[4]

~~ANSI/ASHRAE 117 Method of Testing Closed Refrigerators~~

ANSI/ASHRAE ~~72~~72-2014 Method of Testing Open Refrigerators for Food Stores

2.4 *Food and Drug Administration, U.S. Public Health Service Regulation:*[5]

Food Code, 1999

3. Terminology

3.1 *Definitions:*

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.06 on Productivity and Energy Protocol.

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

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

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, http://www.ntis.gov.

~~3.1.1 *box car average, n*—a location's thermocouple temperature averaged over a 1-h period. During the 4-h holding energy rate test, thermocouple temperatures are recorded at 5-min intervals. The first box car average is the average of readings 1 through 12. The second box car average is the average of temperature readings 2 through 13, and so on.[6]~~

~~3.1.2 *energy input rate, n*—peak rate at which a refrigerated buffet and preparation table consumes energy (kW).~~

~~3.1.3 *lid down energy rate, n*—average rate of buffet/preparation table energy consumption (kW) with the upper lid closed over the refrigerated rail containing pans of synthetic food.~~

~~3.1.4 *lid up energy rate, n*—average rate of buffet/preparation table energy consumption (kW) while it maintains the temperature of pans of synthetic food in the refrigerated rail with the upper lid open and the cabinet doors closed.~~

3.1.1 *production capacity, n*—maximum volumetric storage capacity (ft^3 (m^3)) at which the refrigerated buffet and preparation table's open display area can hold using a specified container filled to ½ in. of the container rim.

3.1.2 *refrigerated buffet and preparation table, n*—buffet/preparation table herein, equipment designed with a refrigerated open top or open condiment rail.

3.1.3 *refrigerated buffet table or unit, n*—equipment designed with mechanical refrigeration that is intended to receive refrigerated food and maintain food product temperatures and is intended for customer service such as a salad bar. A unit may or may not be equipped with a lower refrigerated compartment.[6]

3.1.4 *refrigerated food preparation unit, n*—equipment designed with a refrigerated open top or open condiment rail such as refrigerated sandwich units, pizza preparation tables, and similar equipment. The unit may or may not be equipped with a lower refrigerated compartment.[6]

3.1.5 *self-contained refrigerator, n*—a refrigerator whose condensing unit is attached as an integral component of the unit.[6]

3.1.6 *storage refrigerator or freezer, n*—a refrigerator or freezer designed for cold storage of nonfrozen or frozen foods.

3.1.7 *storage capacity, n*—maximum volumetric storage capacity (ft^3 (m^3)) as determined by the manufacturer at which the refrigerated buffet or preparation table's storage component can hold food.

3.1.8 *test method, n*—a definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces test results.

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

4. Summary of Test Method

4.1 ~~Energy input rate~~ Power is determined to confirm that the buffet/preparation table is operating within 5 % of the ~~nameplate energy input rate.~~manufacturer's rated power.

4.2 ~~2~~ Buffet/preparation table energy ~~rate~~consumption is determined with the upper lid in the raised ~~and lowered positions~~ position while the unit is used to maintain the temperature of ~~a synthetic food product~~ water being held in the refrigerated rail and with the upper lid in the lowered position without any pans in the refrigerated rail.

4.3 Production capacity is determined by measuring the amount of ~~synthetic food~~ water that the refrigerated rail can hold, using a specified container filled to ½ in. of the container rim.

5. Significance and Use

5.1 The ~~energy input rate~~ power test is used to confirm that the buffet/preparation table is operating properly prior to further testing.

5.2 ~~Lid up~~Buffet/preparation table energy ~~rate~~consumption is a precise indicator of buffet/preparation table energy performance under the test loading ~~condition. Lid down energy rate is a precise indicator of buffet/preparation table energy performance~~ condition and under a simulated overnight operating condition. This information enables the food service operator to consider energy performance when selecting a buffet/preparation table.

5.3 Production capacity is used by food service operators to choose a buffet/preparation table that matches their food output requirements.

6. Apparatus

6.1 *Analytical Balance Scale,* for measuring weights up to 25 lb, with a resolution of 0.01 lb and an uncertainty of 0.01 lb.

~~6.2 *Electric Mixer,* for mixing ingredients of the synthetic food. Mixer can be handheld or stand mounted. The synthetic food is used to evaluate the performance of the open top section of the refrigeration equipment.~~

[6] ~~Based on ANSI/NSF 7, available from NSF International, P.O. Box 130140, Ann Arbor, MI 48113-0140.~~Available from National Technical Information Service (NTIS), 5301 Shawnee Rd., Alexandria, VA 22312, http://www.ntis.gov.

6.2 *Pans,* for holding ~~synthetic food and water loads.~~ water. Standard 4-in. (102-mm) deep 1/6-size steam table pans ~~or manufacturer specified pans~~ are used in this test method. Pans shall have nominal dimensions of 6 × 6 15/16 × 4 in. (162 × 176 × 102 mm). ~~The~~ Metal pans shall be used. The weight of the pan shall be 0.70 ± 0.07 lb. The buffet/preparation table manufacturer may provide alternative pans if the unit is designed specifically to only be used with ~~alternative pans. Pans~~ the alternative pans. If alternative pans are used, they shall have nominal dimensions as close to that of the standard pans as is available. All pans must be equipped with thermocouples for temperature measurement. An example of a typical setup is shown in Fig. 1. The thermocouple lead ~~is~~ shall be long enough to allow connection to the monitoring device while the pans are in the storage refrigerator.

6.3 ~~*Hydrometer,*~~ *Electronic Humidity Sensor,* for measuring the ~~atmospheric~~relative humidity within the test ~~environment.~~environment with a range of 25 to 45 % and an uncertainty of ±2 %.

~~6.5 *Stop Watch,* with a 1-s resolution.~~

6.4 *Thermocouple Probe,* capable of immersion with a range of 30° to 50°F and an uncertainty of ±1°F. Preferably industry standard type T or type K thermocouples.

6.5 ~~*Watt-Hour*~~*Power Meter,* for measuring the electrical energy consumption of a buffet/preparation table, shall have a resolution of at least 1 ~~W·h~~W 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 1 ~~W·h~~W and a maximum uncertainty no greater than 10 %.

6.6 *Air Velocity Meter,* for measuring air velocity around the buffet/preparation ~~table.~~ table with an uncertainty of ±10 % at 100 ft/min (0.51 m/s) and capable of measuring air velocities at 50 ft/min (0.25 m/s).

~~NOTE 1—Food Service Technology Center researchers found 10-ft (3-m) sensor leads allowed for flexibility in test equipment setup while still being manageable (tangle free).~~

7. Reagents and Materials

7.1 ~~*Water,*~~ *Water*—~~used shall have a maximum hardness of 3 grains per gallon. Distilled water may~~Distilled water shall be used.

~~7.2 Sodium chloride (salt).~~

~~7.3 *Gelatin,* shall be industry-grade, granulated, non-flavored gelatin.~~

~~NOTE 2—Knox brand unflavored gelatin was found by the Food Service Technology Center to be an acceptable test product.~~

8. Sampling, Test Units

8.1 *Buffet/Preparation Table*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the buffet/preparation table according to the manufacturer's instructions. Position the buffet/preparation table so that there is 6 in. clearance maintained between a back wall and the back vertical plane of the buffet/preparation table. In addition, both sides of the buffet/preparation table shall be a minimum of 12 in. from any side wall, ~~side partition, or other operating buffet/preparation table~~ or side partition (see Fig. 2). Walls can be portable or suspended from ceiling. There shall be a minimum of 3 ft of clearance between the front vertical plane of the buffet/preparation table and any wall or partition. ~~If manufacturer's instructions require additional clearance between buffet/preparation table and walls, then use the manufacturer's clearance recommendations in place of clearances listed above.~~ Report appliance placement relative to test room walls in results reporting section. ~~The associated heating or cooling system shall be capable of maintaining an ambient temperature of 73 ± 3°F (22 ± 2°C) during preconditioning of the buffet/preparation table and 86 ± 2°F (30 ± 1°C) during energy tests within the testing environment.~~

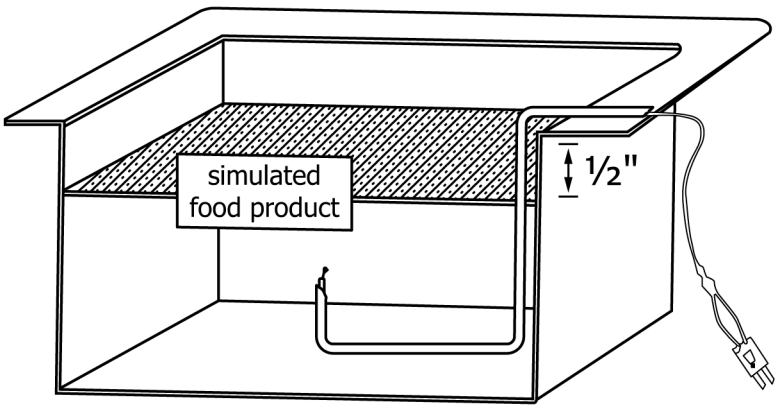

FIG. 1 Pan With Thermocouple ~~Probes~~Probe

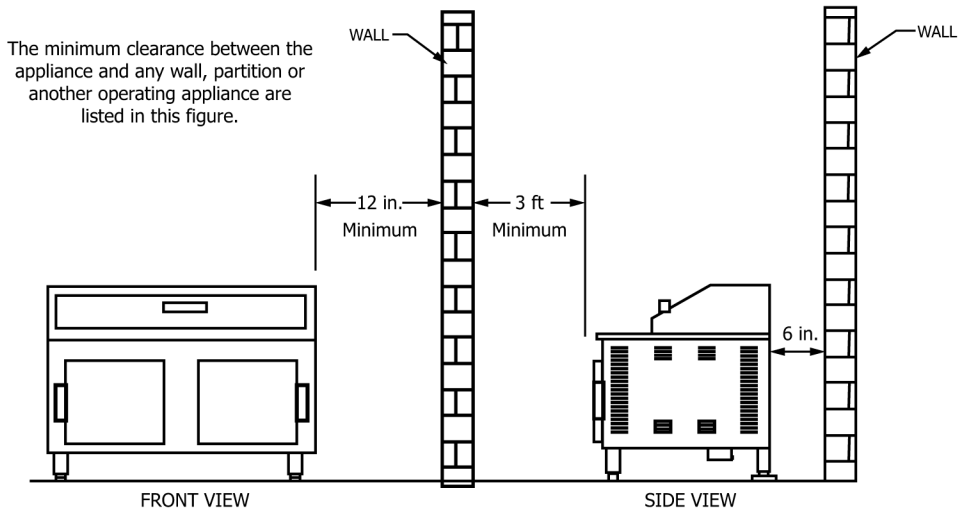

FIG. 2 Example of Appliance Placement

9.2 The testing environment during energy tests shall be maintained as ~~per ANSI/NSF 7 standard section on performance for refrigerated buffet units and refrigerated food preparation units room (test chamber) specifications. ANSI/NSF 7 test room conditions are~~ follows: ambient temperature of 86 ± 2°F (30 ± 1°C), no vertical temperature gradient exceeding 1.5°F/ft (2.5°C/m), ~~maximum~~ relative humidity of ~~50 %~~ 35 ± 5 % and maximum air current velocity of 50 ft/min (0.25 m/s) across the surfaces of the test ~~pans.~~pans while the buffet/preparation table is not operating.

9.3 Ambient temperatures shall be measured at two locations along a vertical line at the center line of the buffet/preparation table. The first shall be 5.9 ± 2 in. (150 ± 50 mm) above the highest point on the buffet/preparation table. The second shall be at the geometric center of the buffet/preparation table. Both points shall be located 36 ± 2 in. (914 ± 50 mm) out from the front face of the buffet/preparation table. It shall be verified that no location around the perimeter of the buffet/preparation table at the same heights as the two points has an average temperature lower than that specified for the test conditions.

9.4 Connect the buffet/preparation table 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~~manufacturer's rated voltage.

9.5 Confirm (while the buffet/preparation table compressor(s) are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the ~~manufacturer.~~ manufacturer during the entire test period. Record the test voltage ~~for~~throughout each test.

NOTE 1—It is the intent of the testing procedure herein to evaluate the performance of a buffet/preparation table at its rated voltage. If a unit is rated for 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 buffet/preparation table is designed to operate at two voltages without a change in components, the performance of the unit (for example, holding energy rate) may differ at the two voltages.

9.6 If the buffet/preparation table is equipped with a refrigerated compartment, the compartment air temperature shall be monitored to evaluate the buffet/preparation table's ability to maintain the air temperature between 33°F (1°C) and ~~40°F (4°C).~~41°F (5°C). The compartment shall be empty, and three thermocouples shall be used to monitor air temperatures. If the buffet/preparation table is not equipped with a refrigerated compartment then skip steps ~~9.5.1~~9.6.1 – ~~9.5.3~~9.6.3.

9.6.1 For buffet/preparation tables with refrigerated compartments position thermocouple no. 1 when viewed from the front of the refrigerated table 5 ± 0.25 in (127 ± 6 mm) from the left interior wall. Center the thermocouple in the compartment relative to the front and the back. For refrigerated compartments with overhead cooling, position the thermocouple 2 ± 0.25 in. (51 ± 6 mm) above the bottom horizontal plane of the compartment. For units where the evaporator is not suspended from the ceiling, the thermocouple shall be placed 5 ± 0.25 in. (127 ± 6 mm) down from the ceiling.

9.6.2 Position thermocouple no. 2 centered front-to-back, top-to-bottom, and left-to-right.

9.6.3 Position thermocouple no. 3 when viewed from the front of the refrigerated table 5 ± 0.25 in. (127 ± 6 mm) from the right interior wall and 5 ± 0.25 in. (127 ± 6 mm) above the internal floor of the compartment. Center the thermocouple in the compartment relative to the front and the back.

10. Procedure

NOTE 2—Prior to starting this test, the tester should read the operating manual and fully understand the operation of the appliance.

10.1 *General:*

10.1.1 Record the following for each test run: (*1*) ~~voltage while compressor(s) are energized, and~~ voltage, (*2*) ~~energy input~~current, (*3* ~~rate while~~) power, (*4*) relative humidity, (*5*) ambient temperature, (*6*) pan water temperatures, and (*7*) refrigerated

compartment air temperatures. All data points shall be measured continuously in 1 min intervals or less for each test. For (*1*) voltage, (*2*) current, and (*3*~~the compressor(s) are energized.~~) power the recorded values shall be the average reading over each 1 min or shorter interval.

10.1.2 For each test run, confirm that the peak ~~instantaneous~~ amperage draw rate is below the manufacturer's rated ~~nameplate~~ maximum amperage. If the measured ~~instantaneous~~ amperage is greater than the rated ~~nameplate~~ maximum amperage, terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the buffet/preparation table.

10.2 ~~*Preparation of Synthetic Food:*~~ *Pan Thermocouple Placement:*

10.2.1 Determine whether standard, 4-in. (102-mm) deep ⅙-sized pans or manufacturer specified pans will be used to hold ~~synthetic food~~ water in the display (rail) area of the buffet/preparation table. During the ~~holding energy~~ test, thermocouples will measure the temperature of the ~~synthetic food~~ water in the pans. Place the pans in display area (rail) of the buffet/preparation table to determine thermocouple placement. Later, when the ~~synthetic food~~ water is prepared, the pans will be filled with ~~synthetic food~~ water to within ½ in. (13 mm) of the pan's top rim. Note where ½ in. (13 mm) is from the pan's top rim for determining placement of thermocouples. ~~Determine which pans will be placed in the corners of the display area (rail). Place two thermocouples in each of the corner pans and two thermocouples in the pan located in the center of the display area (rail). The two thermocouples in each corner will be positioned no more than ½ in. (13 mm) from the side walls or end walls of the pan. One of the corner thermocouples shall be 1 in. (25 mm) below the surface of the synthetic food while the other thermocouple will be positioned ⅛ in. (3 mm) above the bottom surface of the pan. Position the two center thermocouples as close to the center of the open display area as possible (in the center pan) with one thermocouple at a depth of 1 in. (25 mm) below the surface of the synthetic food and the other thermocouple positioned ⅛ in. (3 mm) above the bottom surface of the pan. Position each center thermocouple no more than ½ in. (13 mm) from the sidewalls or endwalls of the pan. Thermocouple leads should be firmly attached to the pan to prevent movement. The thermocouple leads should be long enough to allow connection to the monitoring device while the pans are in a cooler for conditioning and while they are in the buffet/preparation table. See Fig. 3 for an example of manufacturer-supplied pans with thermocouple probes.~~

10.2.2 ~~Calculate the test capacity of the pans. The usable test capacity of a pan is the volume measured from the pan bottom to within~~Install a thermocouple at the geometric center of the water in the pans, top to bottom, side to side, and front to back, of every pan in the display area (rail). Thermocouple leads should be firmly attached to the pan to prevent ~~½ in.~~ movement. The thermocouple leads should be long enough to allow connection to the monitoring device while the pans are in the buffet/preparation table. See Fig. 3~~of the rim.~~ for an example of standard pans with thermocouple probes.

~~10.2.3 Prepare enough synthetic food to fill the test to within ½ in. of the rim. The following steps and material quantities will produce approximately 5 gal (19 L) of synthetic food.~~

~~10.2.3.1 Dissolve 3.0 oz (93 g) of sodium chloride into 1.59 gal (6 L) of water in a stockpot. Heat and maintain the solution between 176°F (80°C) and 194°F (90°C).~~

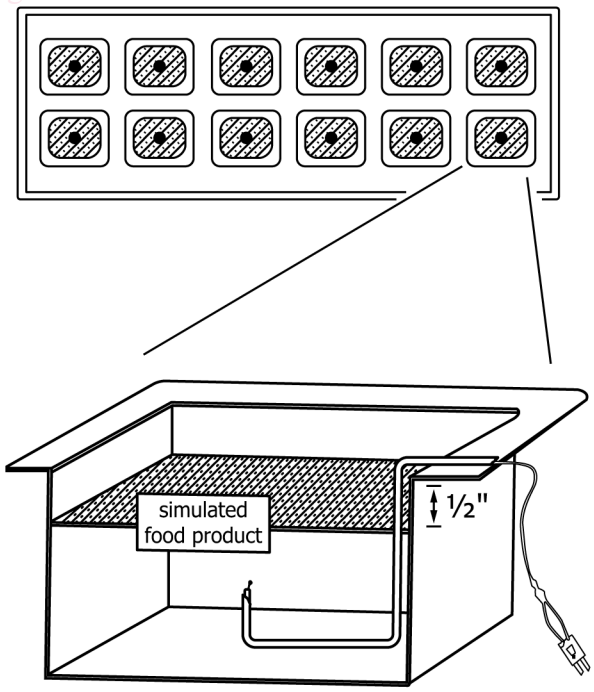

FIG. 3 Example of ~~Manufacturer-Supplied Pan~~Standard Pans With Thermocouple Probes

~~10.2.3.2 Slowly add 17.94 oz (558 g) of gelatin to the salt solution while stirring with a paddle or large spoon. Use an electric hand mixer to disperse any lumps that form.~~

~~10.2.3.3 When all the gelatin is dispersed, slowly add 3.33 gal (12.6 L) of cold water to the suspension and stir until the mixture appears smooth and homogenous. An electric mixer may be used at low speed to mix the synthetic food until it appears smooth and homogenous.~~

~~10.2.3.4 As soon as the synthetic food is finished mixing, pour into the instrumented pans. Fill the pans to ½ in. (13 mm) of the rim. If the pans are to be used in a tilted display, fill the pans so that when tilted, the synthetic food at the bottom of the pan is ½ in. (13 mm) below the rim. Cover each pan and refrigerate. Maintain the synthetic food temperature at 35 ± 2°F (2 ± 1°C) until loading the pans into the test unit.~~

10.3 ~~*Preconditioning Buffet/Preparation Table for the Holding Energy Test*~~*Stabilization/Run-in Time:* ~~:~~

10.3.1 ~~Fill the 4-in. (100 mm) deep~~Establish and maintain the test room ~~½-sized pans at least half full with cold water. Refrigerate and maintain the pans at 35 ± 2°F (2 ± 1°C).~~(test chamber) conditions of 86 ± 2°F (30 ± 1°C) ambient temperature, no vertical temperature gradient exceeding 1.5°F/ft (2.5°C/m), relative humidity of 35 ± 5 % and maximum air current velocity of 50 ft/min (0.25 m/s) across the surfaces of the test pans while the buffet/preparation table is not operating.

10.3.2 Place the buffet/preparation table in ~~a~~ test environment (test ~~chamber) maintained at 73 ± 3°F (22 ± 2°C).~~chamber).

10.3.3 Place the ~~chilled pans filled with water~~ empty pans into the ~~open~~ display area (rail) of the buffet/preparation table. If the manufacturer's instructions specify pans should not be empty while in the display area (rail) of the buffet/preparation table, follow the manufacturer's instructions for what is acceptable. If the unit is equipped with cover(s) for the display area, the cover(s) shall be ~~closed.~~open.

10.3.4 Allow the unit to ~~cycle on and off at least two full cycles.~~run for not less than 24 h.

10.4 *Thermostat Calibration:*

10.4.1 Establish and maintain the test room (test chamber) conditions of 86 ± 2°F (30 ± 1°C) ambient temperature, no vertical temperature gradient exceeding 1.5°F/ft (2.5°C/m), relative humidity of 35 ± 5 % and maximum air current velocity of 50 ft/min (0.25 m/s) across the surfaces of the test pans while the buffet/preparation table is not operating.

10.4.2 If the unit is equipped with cover(s) for the display area, the cover(s) shall be open.

10.4.3 ~~If the buffet/preparation table has not been preconditioned, then complete 10.3 first; if the table has been preconditioned, then move to step 10.4.2.~~*Pan Loading Procedure:*

10.4.3.1 Determine the weight of water required to fill one pan to within ½ in. (13 mm) of the pan's top rim.

10.4.3.2 Fill a container with enough water to fill every test pan with the determined weight of water.

10.4.3.3 Refrigerate and maintain the container of water at 35 ± 1°F.

10.4.3.4 Place the empty pans in the display area (rail) and ensure that thermocouples in the pans are positioned as described in 10.2. Empty pans must remain in the display area (rail) of the buffet/preparation table for 2 h before continuing.

10.4.3.5 Using the analytical balance scale, weigh the determined weight of water (±0.025 lb) from the refrigerated container of water into a separate container.

10.4.3.6 Carefully pour the measured water into one of the empty pans in the display area (rail) of the buffet/preparation table.

10.4.3.7 Repeat steps 10.4.3.5 and 10.4.3.6 until all test pans are filled with water. The total pan loading time, from removal of container filled with water from storage refrigerator to the last pan filled with water, shall be no longer than 50 s per pan in the display area (rail).

10.4.4 Record the water temperature of the pans placed in the ~~open section~~ display area (rail) and the air temperature of the under cabinet as the unit ~~cycles on and off for two complete cycles. If the highest water temperature during the two cycles is below 41°F (5°C) and above 39°F (3.9°C), then pre-calibration of~~ runs for not less than 4 h. If any temperature reading is below 33°F (1°C) or above 41°F (5°C) for any consecutive 15 min period, then adjust the thermostat accordingly and repeat the calibration. If not, then calibration of the thermostat is done. ~~If the highest water temperature during the two cycles is not between 39°F (3.9°C) and 41°F (5°C), then adjust the thermostat accordingly.~~ Repeat adjustment of the thermostat until ~~the highest water temperature during two consecutive complete cycles is between 39°F (3.9°C) and 41°F (5°C). If the highest water temperature during refrigeration cycling is not between 39°F (3.9°C) and 41°F (5°C)~~ no temperature reading is below 33°F (1°C) or above 41°F (5°C) for any consecutive 15 min period over the 4 h. If this is not achieved after repeated thermostat adjustment, then stop thermostat calibration and contact the manufacturer for assistance.

10.4.5 Indicate in the test report whether or not a defrost cycle occurred during the calibration. Through visual inspection, report if any ice buildup occurred on or inside the buffet/preparation table and if so, at what location(s) and to what degree.

10.5 ~~*Lid Up Energy Test:*~~

10.5.1 Establish and maintain the test room (test chamber) conditions of 86 ± 2°F (30 ± 1°C) ambient temperature, no vertical temperature gradient exceeding 1.5°F/ft (2.5°C/m), ~~maximum~~ relative humidity of ~~50 %~~ 35 ± 5 % and maximum air current velocity of 50 ft/min (0.25 m/s) across the surfaces of the test ~~pans.~~pans while the buffet/preparation table is not operating.

10.5.2 ~~Place the refrigerated pans of synthetic food in the display area (rail) and ensure that thermocouples in the pans are positioned as described in 10.2.~~ If the unit is equipped with cover(s) for the display area, then test the unit with the cover(s) in