



Standard Test Method for Performance of Self-Serve Hot Deli Cases¹

This standard is issued under the fixed designation F2141; 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 energy consumption and performance of self-serve hot deli cases. The food service operator can use this evaluation to select a deli case and understand its energy consumption and performance.

1.2 This test method is applicable to electric, fully open or partially open, hot deli cases that have been designed to hold and merchandise prepackaged hot food. For staff-serve hot deli cases, refer to Test Method F2472.

1.3 The deli case can be evaluated with respect to the following (where applicable):

- 1.3.1 Energy input rate (10.2),
- 1.3.2 Energy and temperature at the minimum setting (10.3),
- 1.3.3 Energy and temperature at the maximum setting (10.3),
- 1.3.4 Energy and temperature at the manufacturer's recommended setting (10.3),
- 1.3.5 Holding capacity (10.4),
- 1.3.6 Holding temperature calibration (10.4),
- 1.3.7 Preheat energy rate (10.5),
- 1.3.8 Idle energy rate (10.6), and
- 1.3.9 Holding energy rate (10.7).

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 *ASTM Standards:*²

- A36/A36M Specification for Carbon Structural Steel
- F2472 Test Method for Performance of Staff-Serve Hot Deli Cases

3. Terminology

3.1 *calibrated temperature, n*—temperature setting at which the lowest temperature of the water in the holding pans is at $142 \pm 2^\circ\text{F}$ ($61 \pm 1^\circ\text{C}$).

3.2 *capacity, n*—the amount of $\frac{1}{6}$ size containers the deli case will hold in a single layer at one time.

3.3 *deli case, n*—an appliance designed for the display of hot food product.

3.4 *energy input rate, n*—peak rate at which a deli case consumes energy (kW), typically reflected during preheat.

3.5 *factory setting, n*—recommended control setting by the manufacturer.

3.6 *holding energy, n*—energy consumed by the deli case as it is used to hold cooked food product under full load conditions.

3.7 *holding energy rate, n*—average rate of energy consumption (kW) during the holding energy tests.

3.8 *idle energy rate, n*—the rate of energy consumed (kW) by the deli case while “holding” or maintaining the heated surface at the thermostat set point.

3.9 *maximum setting, n*—setting at which maximum surface temperature is achieved.

3.10 *minimum setting, n*—setting at which minimum surface temperature is achieved.

3.11 *preheat energy, n*—amount of energy consumed by the deli case while preheating the heated surface from ambient room temperature ($75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$)) to a temperature at the calibrated setting.

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.

Current edition approved May 1, 2019. Published June 2019. Originally approved in 2001. Last previous edition approved in 2013 as F2141 – 07 (2013). DOI: 10.1520/F2141-07R19.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.12 *preheat rate, n*—average rate (°F/min (°C/min)) at which the deli case's holding surface is heated from ambient temperature ($75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$)) to holding temperature with the thermostat set to the calibrated setting.

3.13 *preheat time, n*—time required for the deli case to preheat from ambient room temperature ($75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$)) to the calibrated setting.

3.14 *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 The deli case 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 deli case holding surface is monitored at maximum, minimum, and factory recommended (if provided) settings using a predetermined number of 5-in. (127-mm) metal discs distributed equally over the heating surface of the deli case.

4.3 Capacity is determined by loading the deli case full of ½ size containers.

4.4 The calibrated setting is determined by using ½ size plastic pans filled with water and setting the surface temperature of the deli case such that lowest temperature in the water containers is $142 \pm 2^\circ\text{F}$ ($61 \pm 1^\circ\text{C}$).

4.5 The amount of energy and time required to preheat the deli case to calibrated setting is determined.

4.6 The idle energy rate is determined with the deli case set at calibrated setting.

4.7 The deli case is used to hold ½ size containers filled with hot food for 3 h. Food temperature and deli case energy consumption are monitored during this testing.

5. Significance and Use

5.1 The energy input rate is used to confirm that the deli case is operating properly prior to further testing.

5.2 Holding temperature range is useful for food service operators in selecting a unit that matches their holding requirements.

5.3 Capacity is used by food service operators to choose a deli case that matches their food holding requirements.

5.4 Preheat energy and time can be useful to food service operators to manage energy demands and to know how quickly the deli case can be ready for operation.

5.5 Holding energy rate and idle energy rate can be used by the food service operator to estimate deli case energy consumption.

6. Apparatus

6.1 *Analytical Balance Scale*, for measuring weights up to 20 lb (9 kg), with a resolution of 0.01 lb (0.004 kg) and an uncertainty of 0.01 lb (0.004 kg).

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

6.3 *Metal Discs*, (one for each hexagonal section of the deli case or one for each square foot of the deli case) composed of structural-grade carbon steel in accordance to Specification **A36/A36M**, free of rust or corrosion, 5 in. (127 mm) in diameter, and ¼ in. (6 mm) thick. The discs shall be flat to within 0.010 in. (0.2 mm) over the diameter.

6.4 *Strain Gage Welder*, capable of welding thermocouples to steel.

6.5 *Thermocouple(s)*, industry standard type T or type K thermocouple wire with a range of 0 to 250°F (−18 to 121°C) and an uncertainty of $\pm 1^\circ\text{F}$ ($\pm 0.56^\circ\text{C}$).

6.6 *Thermocouple Probe*, “fast response” type T or type K thermocouple probe, ¼-in. or smaller diameter, with a 3-s or faster response time, capable of immersion with a range of 0 to 250°F (−18 to 121°C) and an uncertainty of $\pm 1^\circ\text{F}$ ($\pm 0.56^\circ\text{C}$). The thermocouple probe's active zone shall be at the tip of the probe.

6.7 *Watt-Hour Meter*, for measuring the electrical energy consumption of a deli case, shall have a resolution of at least 10 Wh 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 Wh and a maximum uncertainty no greater than 10 %.

7. Reagents and Materials

7.1 *Binder Clips*, ¾ in. (19 mm) size.

7.2 *Macaroni and Cheese*, a sufficient quantity of frozen, ready-to-cook, traditional macaroni and cheese, in ½ size pans weighting approximately 4 lb (1.8 kg) obtained from a food distributor.

7.3 *Pans with Covers*, Cambro ½ size, $6\frac{3}{8} \times 6\frac{15}{16}$ in. (162×176 mm) black plastic pans with $6\frac{3}{8} \times 6\frac{15}{16}$ in. (162×176 mm) plastic amber colored cover able to accommodate temperatures up to 375°F (191°C).

7.4 *Water*, with a maximum hardness of less than 3 grains/gal.

8. Sampling, Test Units

8.1 *Deli Case*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the deli case according to the manufacturer's instructions in an appropriate space. All sides of the deli case shall be a minimum of 3 ft (0.9 m) 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 $75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$) within the testing environment.

9.2 Connect the deli case 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 $\pm 2.5\%$ 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 deli case at its rated electric voltage. If the unit is rated dual voltage (that is, designed to operate at either 240 or 480 V with no change in components), the voltage selected by the manufacturer and/or tester shall be reported. If a deli case 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.

10. Procedure

10.1 *General:*

10.1.1 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 test.

10.1.2 For each test run, confirm that the peak input rate is within $\pm 5\%$ 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 deli case.

10.2 *Energy Input Rate:*

10.2.1 Set the temperature controls to the maximum setting.

10.2.2 Start recording time and energy consumption when the elements are energized and stop recording when the elements commence cycling.

10.2.3 Confirm that the measured input rate or power (kW) is within 5% of the rated nameplate input or power. (It is the intent of the testing procedures herein to evaluate the performance of a deli case at its rated energy input rate.) If the difference is greater than 5% , terminate testing and contact the manufacturer. The manufacturer may make appropriate changes or adjustments to the deli case or supply another deli case for testing.

10.3 *Holding Temperature Range:*

10.3.1 Using a strain gauge welder, attach one thermocouple to the center of one side of each 5-in. (127-mm), 1/4-in. (6-mm) thick steel disc. Add a strain relief to each disc to facilitate handling of the discs (see Fig. 1).

10.3.2 Place a thermocoupled disc in the center of each section (See Fig. 2).

10.3.3 Set the controls to the lowest possible setting without being turned off.

10.3.4 Allow the unit to stabilize for 1 h, then monitor temperature and energy consumption for an additional 2 h, recording the temperatures at least once every minute.

10.3.5 Repeat 10.3.4 with the controls set to their maximum setting.

10.3.6 Repeat 10.3.4 with the controls set to the manufacturer’s recommended settings (if applicable).

10.4 *Holding Temperature Calibration:*

10.4.1 Remove the thermocoupled discs from the deli case and determine the number of 1/6-size pans that will fit on the surface of the deli case. This is the capacity of the deli case.

10.4.2 Place a thermocouple in the center of each pan 5/8 in. above the bottom of the pan. Secure the thermocouple on one side of the plastic pan by using a 3/4-in. (19-mm) binder clip.

10.4.3 Fill the pans with 1.3 ± 0.01 lb (0.6 ± 0.004 kg) of water and cover.

10.4.4 Evenly distribute the filled pans around the surface of the deli case.

10.4.5 Set the controls to the manufacturer’s recommended settings. If not specified by the manufacturer, then set the controls halfway between the minimum and maximum settings.

10.4.6 Allow the unit and water pans to stabilize for a minimum of 3 h.

10.4.7 Check the temperature of the water pans.

10.4.8 If the lowest temperature is not $142 \pm 2^\circ\text{F}$ ($61 \pm 1^\circ\text{C}$), then adjust the controls as appropriate and repeat 10.4.6 and 10.4.7 until the lowest pan temperature is $142 \pm 2^\circ\text{F}$ ($61 \pm 1^\circ\text{C}$).

10.4.9 To facilitate further testing, make a mark on the dial or a notation of this setting. Record the settings. This will be referred to as the calibrated settings.

10.5 *Preheat Energy Consumption and Time:*

NOTE 2—The preheat test should be conducted as the first appliance operation on the day of the test, starting with the appliance at room temperature ($75 \pm 5^\circ\text{F}$).

10.5.1 Place a thermocoupled disc at the center of each section (Fig. 2).

10.5.2 Record ambient temperature at the start of the test. The ambient temperature shall be $75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$) at the start of the test.

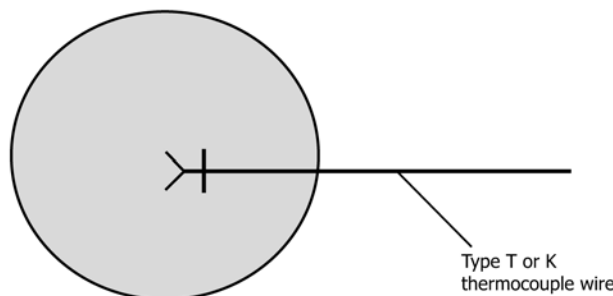


FIG. 1 Thermocoupled Disc With Strain Relief

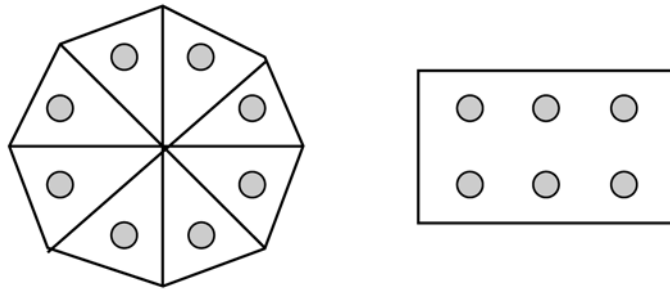


FIG. 2 Thermocoupled Disc Placement on Different Deli Case Configurations

10.5.3 Turn the unit on with controls set to the calibrated setting determined in 10.4.9. Begin recording temperature and energy consumption when the unit is turned on.

10.5.4 Record the surface temperature over a minimum of 5-s intervals during the course of preheat until the temperature of each disc stabilizes. Record the stabilization temperature of each disc. The calibrated temperature of the deli case is the average stabilized disc temperature.

10.5.5 Record the energy and time to preheat the deli case. Preheat is judged complete when the average temperature reaches 95 % of the calibrated temperature, as indicated by the thermocoupled discs.

10.6 Idle Energy Rate:

NOTE 3—The idle test may be conducted immediately following the preheat test (10.5).

10.6.1 Place a thermocoupled disc at the center of each section (Fig. 2).

10.6.2 Set the controls to the calibrated setting.

10.6.3 Allow the unit and the thermocoupled discs to stabilize for a minimum of 1 h.

10.6.4 Monitor deli case temperature and energy consumption for 3 h.

10.7 Holding Energy Rate:

10.7.1 Remove the thermocoupled discs from the deli case and preheat deli case for 1 h at the calibrated setting.

10.7.2 Prepare enough macaroni and cheese to fill the number of containers determined in 10.4.1. by following directions on the packages.

10.7.3 Quickly transfer 1.5 ± 0.01 lb (0.7 ± 0.004 kg) of macaroni and cheese to each container. Evenly distribute the filled containers around the surface of the deli case. Monitor the temperature of at least one container per section.

10.7.4 The temperature for each pan of macaroni and cheese at the beginning of the test shall be 165 ± 5°F (74 ± 3°C).

10.7.5 Monitor temperature and energy consumption for 3 h.

10.7.6 At the end of 3 h, check the temperature of the macaroni and cheese. The temperature in each container shall be greater than 140°F (60°C). If container’s temperature is less than 140°F (60°C), then the test is invalid. Adjust the controls accordingly, note the new settings, and repeat 10.7.1 – 10.7.5.

11. Calculation and Report

11.1 Deli Case:

11.1.1 Summarize the physical and operating characteristics of the deli case. If needed, describe other design or operating characteristics that may facilitate interpretation of the test results.

11.2 Apparatus and Procedure:

11.2.1 Confirm that the testing apparatus conformed to all of the specifications in Section 6. Describe any deviations from those specifications.

11.2.2 Report the voltage for each test.

11.3 Energy Input Rate:

11.3.1 Report the manufacturer’s nameplate energy input rate in kW.

11.3.2 Calculate and report the measured energy input rate (kW) based on the energy consumed by the deli case during the period of peak energy input according to the following relationship:

$$q_{input} = \frac{E \times 60}{t} \tag{1}$$

where:

- q_{input} = measured peak energy input rate, kW,
- E = energy consumed during period of peak energy input, kWh, and
- t = period of peak energy input, min.

11.3.3 Calculate and report the percent difference between the manufacturer’s nameplate energy input rate and the measured energy input rate.

11.4 Holding Temperature Range:

11.4.1 Calculate and report the average surface temperature at the minimum, maximum, and factory settings.

11.4.2 Calculate and report the energy rate at the minimum, maximum, and factory settings (kW) on:

$$q_{setting} = \frac{E \times 60}{t} \tag{2}$$

where:

- $q_{setting}$ = energy rate at setting, kW,
- E = energy consumed during the test period, kWh, and
- t = test period, min.

11.5 Holding Temperature Calibration:

11.5.1 Report the settings used to attain the calibrated setting.