Designation: F2238 − 16

An American National Standard

Standard Test Method for Performance of Rapid Cook Ovens[1]

This standard is issued under the fixed designation F2238; 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 cooking performance of rapid cook ovens. The food service operator can use this evaluation to select a rapid cook oven and understand its energy consumption.

1.2 This test method is applicable to gas and electric rapid cook ovens.

1.3 The rapid cook oven can be evaluated with respect to the following (where applicable):

1.3.1 Energy input rate (see 10.2),

1.3.2 Preheat energy consumption and time (see 10.3),

1.3.3 Idle energy rate (see 10.4),

1.3.4 Pilot energy rate (if applicable) (see 10.5), and

1.3.5 Cooking-energy efficiency, cooking energy rate, and production capacity (see 10.6).

1.4 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This test method may involve hazardous materials, operations, and equipment. This test method 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 test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels

2.2 *ASHRAE Documents:*[3]

2013 ASHRAE Handbook of Fundamentals Chapter 1, Psychrometrics

2014 ASHRAE Handbook—Refrigeration Chapter 19, Thermal Properties of Foods

ASHRAE Guideline 2-1986 (RA90) Engineering Analysis of Experimental Data[3]

2.3 *AOAC Document:*[4]

AOAC Procedure 984.25 Moisture (Loss of Mass on Drying) in Frozen French Fried Potatoes

3. Terminology

3.1 *Definitions:*

3.1.1 *cooking-energy efficiency, n*—quantity of energy imparted to the specified food product, expressed as a percentage of energy consumed by the rapid cook oven during the cooking event.

3.1.2 *cooking energy rate, n*—average rate of energy consumption (Btu/h or kW) during the cooking-energy efficiency test.

3.1.3 *energy input rate, n*—peak rate at which a rapid cook oven consumes energy (Btu/h or kW).

3.1.4 *idle energy rate, n*—the rapid cook oven's rate of energy consumption (Btu/h or kW), when empty, required to maintain its cavity temperature at the specified thermostat set point or to otherwise maintain the oven in a ready-to-cook condition.

3.1.5 *oven cavity, n*—that portion of the rapid cook oven in which food products are heated or cooked.

3.1.6 *pilot energy rate, n*—rate of energy consumption (Btu/h) by a rapid cook oven's continuous pilot (if applicable).

3.1.7 *preheat energy, n*—amount of energy consumed (Btu or kWh), by the rapid cook oven while preheating its cavity from ambient temperature to the specified thermostat set point

[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 March 15, 2016. Published April 2016. Originally approved in 2003. Last previous edition approved in 2009 as F2238 – 09. DOI: 10.1520/F2238-16.

[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] 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 AOAC International, 2275 Research Blvd., Suite 300, Rockville, MD 20850-3250, http://www.aoac.org.

or while preheating any other component of the oven, for example, an integral heat exchanger, to a ready-to-cook condition.

3.1.8 *preheat time, n*—time (min.) required for the rapid cook oven cavity to preheat from ambient temperature to the specified thermostat set point or for the rapid cook oven to achieve a ready-to-cook condition.

3.1.9 *production capacity, n*—maximum rate (lb/h) at which an rapid cook oven can bring the specified food product to a specified "cooked" condition.

3.1.10 *production rate, n*—rate (lb/h) at which a rapid cook oven brings the specified food product to a specified "cooked" condition. Does not necessarily refer to maximum rate. Production rate varies with the amount of food being cooked.

3.1.11 *rapid cook oven, n*—a cooking appliance that utilizes one or more heat transfer technologies to cook food product within a chamber and which is capable of cooking the food product significantly faster than is possible using solely radiant oven or convection oven technologies. Heat transfer technologies which may be employed include microwave, quartz halogen and high velocity or impingement convection, both gas and electric.

3.1.12 *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 is determined to confirm that the rapid cook oven is operating within 5 % of the nameplate energy input rate. For a gas rapid cook oven, the pilot energy rate and the fan and control energy rates are also determined.

4.2 Preheat energy and time are determined.

4.3 Idle energy rate is determined.

4.4 Cooking-energy efficiency and production capacity are determined during barreling-run cooking tests using pizza as the food product.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the rapid cook oven is operating properly prior to further testing.

5.2 Preheat energy and time can be useful to food service operators to manage power demands and to know how quickly the rapid cook oven can be ready for operation.

5.3 Idle energy rate and pilot energy rate can be used to estimate energy consumption during non-cooking periods.

5.4 Cooking-energy efficiency is a precise indicator of a rapid cook oven's energy performance while cooking a typical food product. If energy performance information is desired using a food product other than the specified test food, the test method could be adapted and applied. Energy performance information allows an end user to better understand the operating characteristics of a rapid cook oven.

5.5 Production capacity information can help an end user to better understand the production capabilities of a rapid cook oven as it is used to cook a typical food product and this could help in specifying the proper size and quantity of equipment. If production information is desired using a food product other than the specified test food, the test method could be adapted and applied.

6. Apparatus

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

6.2 *Barometer,* for measuring absolute atmospheric pressure, to be used for adjustment of measured natural gas volume to standard conditions. Shall have a resolution of 0.2 in. Hg and an uncertainty of 0.2 in. Hg.

6.3 *Canopy Exhaust Hood,* 4 ft in depth, wall-mounted with the lower edge of the hood 6 ft, 6 in. from the floor and with the capacity to operate at a nominal exhaust ventilation rate of 300 cfm per linear foot of active hood length. This hood shall extend a minimum of 6 in. past both sides and the front of the cooking appliance and shall not incorporate side curtains or partitions.

6.4 *Convection Drying Oven,* with temperature controlled at 220 ± 5°F, to be used to determine moisture content of pizza crust, pizza sauce and pizza cheese.

6.5 *Gas Meter,* for measuring the gas consumption of a rapid cook oven, shall be a positive displacement type with a resolution of at least 0.01 ft^3 and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft^3/h. If the meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution of at least 0.01 ft^3 and a maximum uncertainty no greater than 2 % of the measured value.

6.6 *Pressure Gage,* for monitoring natural gas pressure. Shall have a range of zero to 10 in. H_2O, a resolution of 0.5 in. H_2O, and a maximum uncertainty of 1 % of the measured value.

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

6.8 *Temperature Sensor,* for measuring natural gas temperature in the range of 50 to 100°F with an uncertainty of ± 1°F.

6.9 *Thermocouple,* industry-standard, insulated, 24 gage, type T or Type K thermocouple wire, welded and calibrated, with an uncertainty of ±1°F.

6.10 *Thermocouple Probe,* Type T or Type K, micro needle, product probe with a response time from ambient to 200°F of less than 20 s, and an uncertainty of ±1°F.

6.11 *Watt-Hour Meter,* for measuring the electrical energy consumption of a rapid cook oven, 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 *Pizza Crust*—Shall be a nominal 11.5 ± 0.5 in. diameter, prebaked or parbaked (self-rising) crust, enriched

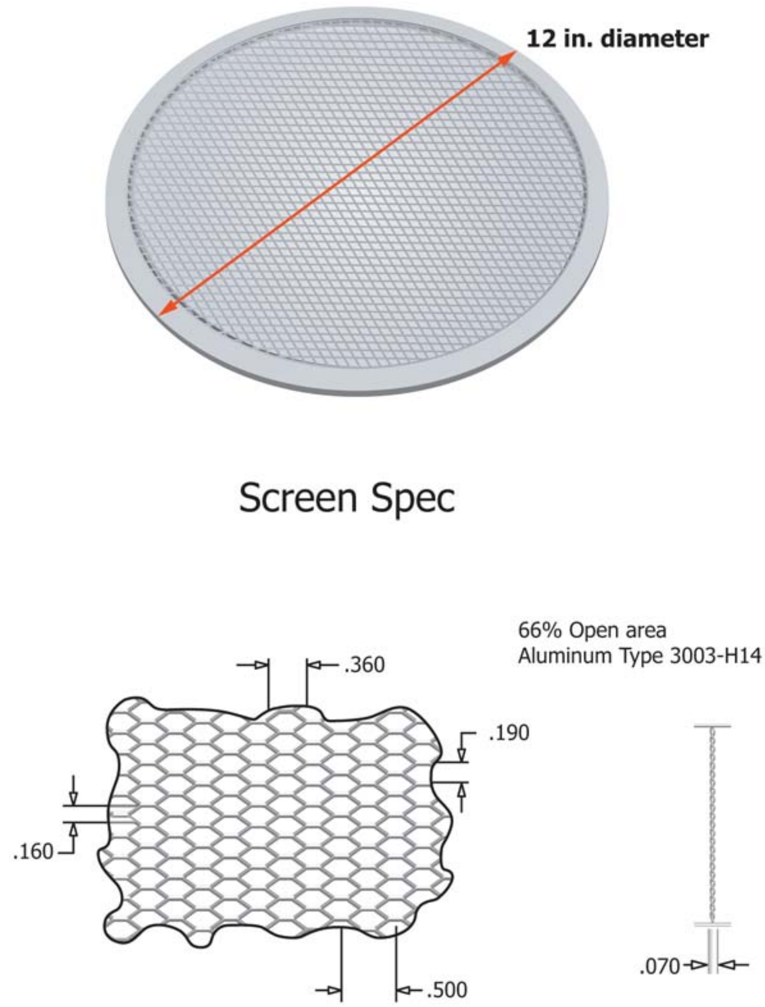

FIG. 1 Pizza Screen

flour (wheat flour, malted barley flour, niacin, reduced iron, thiamine mononitrated riboflavin, rolic acid). Refrigerate to 38 ± 2°F.

7.2 *Pizza Sauce*—Shall be a simple, tomato based sauce with tomatoes, water, tomato paste. A moisture content of 90 ± 2 % by weight, based on a gravimetric moisture analysis. Refrigerate to 38 ± 2°F.

7.3 *Pizza Cheese*—Shall be a part skim, low moisture, shredded mozzarella cheese, parmesan cheese (pasteurized cultured part-skim milk, salt, enzymes), provolone cheese (pasteurized milk, cheese cultures, salt, enzymes), white cheddar cheese (pasteurized milk, cheese cultures, salt, enzymes). Refrigerate to 38 ± 2°F.

7.4 *Pizza*—Shall be comprised of a pizza crust, pizza sauce, and pizza cheese. Each uncooked pizza should have a weight of 1.7 ± 0.1 lb. Moisture content of the uncooked pizza shall be 48 ± 3 % by weight, based on a gravimetric analysis.[5]

7.5 *Pizza Screen*—Shall be a 12 in. diameter, aluminum pizza screen. Refrigerate to 38 ± 2°F. (See Fig. 1.)

7.6 Gravimetric moisture analysis shall be performed as follows: to determine moisture content, place a thawed, refrigerated 38 ± 2°F pizza sample of the test food on a dry, aluminum sheet pan and place the pan in a convection drying

[5] The Food Service Technology Center has found that Freschetta – Frozen (25.85 oz), 4 Cheese Pizza, Item # 73184 – complies with the pizza specification requirements for this test method. The sole source of supply of the pizza known to the committee at this time is Schwan's Food Company Inc., Marshall, MN, 56258. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

oven at a temperature of 220 ± 5°F (104 ± –15°C) for a period of 24 h. Weigh the sample before it is placed in the oven and after it is removed and determine the percent moisture content based on the percent weight loss of the sample. The sample must be thoroughly chopped (⅛ in. or smaller squares) and spread evenly over the surface of the sheet pan in order for all of the moisture to evaporate during drying and it is permissible to spread the sample on top of baking paper in order to protect the sheet pan and simplify cleanup. Typically moisture loss of 47 ± 1 %.

NOTE 1—The moisture content of pizza crust, pizza sauce, and pizza cheese can be determined by a qualified chemistry lab using the AOAC Procedure 984.25.

8. Sampling and Test Units

8.1 *Rapid Cook Oven*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the appliance in a properly ventilated area in accordance with the manufacturer's instructions. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 5°F within the testing environment.

NOTE 2—The ambient temperature requirements are designed to simulate real world kitchen temperatures and are meant to provide a reasonable guideline for the temperature requirements during testing. If a facility is not able to maintain the required temperatures, then it is reasonable to expect that the application of the procedure may deviate from the specified requirements (if it cannot be avoided) as long as those deviations are noted on the Results Reporting Sheets.

9.2 Connect the rapid cook oven to a calibrated energy test meter. For gas installations, install a pressure regulator downstream from the meter to maintain a constant pressure of gas for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the rapid cook oven and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, 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 For an electric rapid cook oven, confirm (while the rapid cook oven 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 3—It is the intent of the testing procedure herein to evaluate the performance of a rapid cook oven at its rated gas pressure or electric voltage. If an electric 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 or tester, or both, shall be reported. If a rapid cook oven 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 For a gas rapid cook oven, adjust (during maximum energy input) the gas supply pressure downstream from the appliance's pressure regulator to within ± 2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the appliance following the manufacturer's recommendations for optimizing combustion.

10. Procedure

10.1 *General:*

10.1.1 For gas appliances, record the following for each test run:

10.1.1.1 Higher heating value,

10.1.1.2 Standard gas pressure and temperature used to correct measured gas volume to standard conditions,

10.1.1.3 Measured gas temperature,

10.1.1.4 Measured gas pressure,

10.1.1.5 Barometric pressure, and

10.1.1.6 Energy input rate during or immediately prior to test (for example, during the preheat for that days testing).

NOTE 4—Using a calorimeter or gas chromatograph in accordance with accepted laboratory procedures is the preferred method for determining the higher heating value of gas supplied to the rapid cook oven under test. It is recommended that all testing be performed with gas having a higher heating value of 1000 to 1075 Btu/ft^3.

10.1.2 For gas rapid cook ovens, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (see 10.3).

10.1.3 For electric rapid cook ovens, record the following for each test run:

10.1.3.1 Voltage while elements are energized, and

10.1.3.2 Energy input rate during or immediately prior to test (for example, during the preheat for that days testing).

10.1.4 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 rapid cook oven.

10.2 *Energy Input:*

10.2.1 Set the rapid cook oven controls so that the oven will operate at the maximum input rate and turn the oven on.

10.2.2 Record the time and energy consumption starting as soon as the elements or burners cycle on and continuing over a period that is long enough to accurately determine the energy input rate of the oven. The oven must be fully on over the entire period and the test period must end when any of the burners or elements first cycle off.

NOTE 5—The rapid cook oven may be equipped with a high temperature limit control which prematurely cycles the oven off if no food load is present in the oven cavity. In this case, the researcher may select an appropriate food load which will allow the oven to operate for the duration of the test period.

10.2.3 Calculate and record the rapid cook oven's energy input rate and compare the result to the rated nameplate input. For gas rapid cook ovens, the burner energy consumption is used to compare the calculated energy input rate with the rated gas input and any electrical energy consumption shall be used to compare the calculated energy input rate with the rated electrical input.

10.2.4 In accordance with 11.4, calculate and report the rapid cook oven energy input rate and rated nameplate input.

10.3 *Preheat Energy Consumption and Time:*

10.3.1 Determine whether the rapid cook oven requires preheating in order to achieve a ready-to-cook state. If the oven requires preheating, verify that the oven cavity temperature is 75 ± 5°F and turn the rapid cook oven on.

10.3.2 Record the time and energy consumption required to preheat the rapid cook oven, from the time when the unit is turned on until the time when the rapid cook oven achieves a ready-to-cook state.

10.3.3 In accordance with 11.5, calculate and report the preheat energy consumption and time.

10.4 *Idle Energy Rate:*

10.4.1 Turn the rapid cook oven on and allow it to achieve a ready-to-cook state. If the oven requires preheating in order to achieve a ready-to-cook state then allow the oven to idle for 60 min after it is fully preheated.

10.4.2 Begin recording the rapid cook oven's idle energy consumption for a minimum of 2 h. Record the length of the idle period.

10.4.3 In accordance with 11.6, calculate and report the rapid cook oven's idle energy rate.

NOTE 6—For a rapid cook oven that does not require preheat, the idle energy rate will consist of the computer controls, control circuits, fans, and any other energy consumption that is required to keep the unit in a standby or ready-to-cook state.

10.5 *Pilot Energy Rate (if applicable):*

10.5.1 For a gas rapid cook oven with a standing pilot, set the gas valve at the "pilot" position and set the rapid cook oven's temperature control to the "off" position.

10.5.2 Light and adjust the pilot according to the manufacturer's instructions.

10.5.3 Monitor gas consumption for a minimum of 8 h of pilot operation.

10.5.4 In accordance with 11.7, calculate and report the pilot energy rate.

10.6 *Pizza Preparation:*

10.6.1 Prepare 24 pizzas in accordance with 7.3. Cover the pizzas with plastic wrap (to inhibit moisture loss), place in a refrigerator and chill the pizzas until they stabilize at 38 ± 2°F. Do not test with pizzas that have been in the refrigerator more than 48 h. Each pizza will comprise a pizza test load.

NOTE 7—The test pizzas should not be stored in the refrigerator for long periods, more than 48 h, because the pizza crust may absorb excessive moisture from the sauce and evaporation may reduce the moisture content of the sauce, changing the thermal characteristics of the pizza. The 48-h period is a practical "time" specification that allows the preparation of test pizzas on day one, overnight chilling and stabilization and application of the procedure within two days.

NOTE 8—In order to easily handle and store the pizzas, it is recommended that the prepared pizzas be placed on a pizza screen and placed on full size (18 by 26 in.) sheet pans, two pizzas per pan. The entire pan can then be covered with food grade plastic wrap. When stacking multiple pans in the refrigerator, spacers are necessary between the pans in order to protect the pizzas from damage. Researchers at Pacific Gas and Electric Company's Food Service Technology Center have found that sauce cups can be used as spacers.

NOTE 9—A minimum of 3 test runs is specified, however, more test runs may be necessary if the results do not meet the uncertainty criteria specified in Annex A1.

10.6.2 Prepare a minimum of 4 additional pizzas for use in cook time determination. The actual number of pizzas needed for the cook time determination will vary with the number of trials needed to establish a cooking time that demonstrates a 195 ± 3°F final pizza temperature after cooking.

10.7 *Cook Time Determination:*

10.7.1 Turn the rapid cook oven on and allow it to achieve a ready-to-cook state. If the oven requires preheating in order to achieve a ready-to-cook state then allow the oven to idle for 60 min after it is fully preheated. Set the rapid cook oven controls to the manufacturer's recommended setting for cooking a parbaked pizza as specified in 7.3. Estimate a cook time for pizza.

NOTE 10—The rapid cook oven may allow for several different recipes or programs which will all cook the test pizza to an adequate doneness. The researcher should choose the recipe or program that cooks the pizza in the shortest amount of time and with the lowest energy consumption while maintaining the highest quality of the finished pizza. The manufacturer can be a valuable resource in optimizing this cooking process and should be consulted where possible.

10.7.2 Remove a single pizza from the refrigerator and place the pizza directly on the manufacturer's recommended cooking surface or cooking container in the center of the oven. If the manufacturer does not recommend a cooking surface or cooking container for cooking parbaked pizza then place the pizza directly on the oven deck. Do not allow more than 1 min to elapse from the time a pizza is removed from the refrigerator until it is placed in the oven.

10.7.3 Allow the pizza to cook for the duration of the estimated cook time and then remove the pizza from the rapid cook oven and place the pizza on an insulated, non-metallic surface such as corrugated cardboard. A standard cardboard pizza box is acceptable.

10.7.4 Determine the final temperature of the pizza by placing six thermocouple probes on the surface of the pizza. Locate the probes 3 in. from the center of the pizza and spaced equidistant from each other as shown in Fig. 2. The probes should penetrate the cheese and rest on the sauce-crust interface directly beneath the cheese. Allow no more than 10 s from the time the pizza is removed from the oven to the time the probes are placed on the pizza. Leave the probes in place on the pizza and record and average the temperatures of all six probes every five seconds over a one-minute period (for a total of 12 readings). The final pizza temperature is the highest average temperature of the six probes during the one-minute period. If the final pizza temperature is not 195 ± 3°F, adjust the cook time and repeat the cook time determination test as necessary to produce a 195 ± 3°F final temperature.

NOTE 11—It is recommended that the six thermocouple probes be attached to a simple, lightweight, rigid structure which will maintain the proper spacing and upright position of the probes and will therefore help maintain the consistency of the temperature readings. Fig. 3 shows a thermocouple structure that is made of Plexiglas and includes a simple handle for easy placement of the structure on the pizza. This structure can be gently set on top of the pizza during cook time determination with just enough force to penetrate the cheese but not enough to push the probes beyond the sauce-crust interface. Because the sauce migrates into the crust during cooking, it is relatively easy to remain in the sauce-crust interface during temperature measurement.

10.7.5 Record the determined cook time and the recipe or program for optimized cooking of a pizza test load for use during the cooking-energy efficiency and production capacity tests.

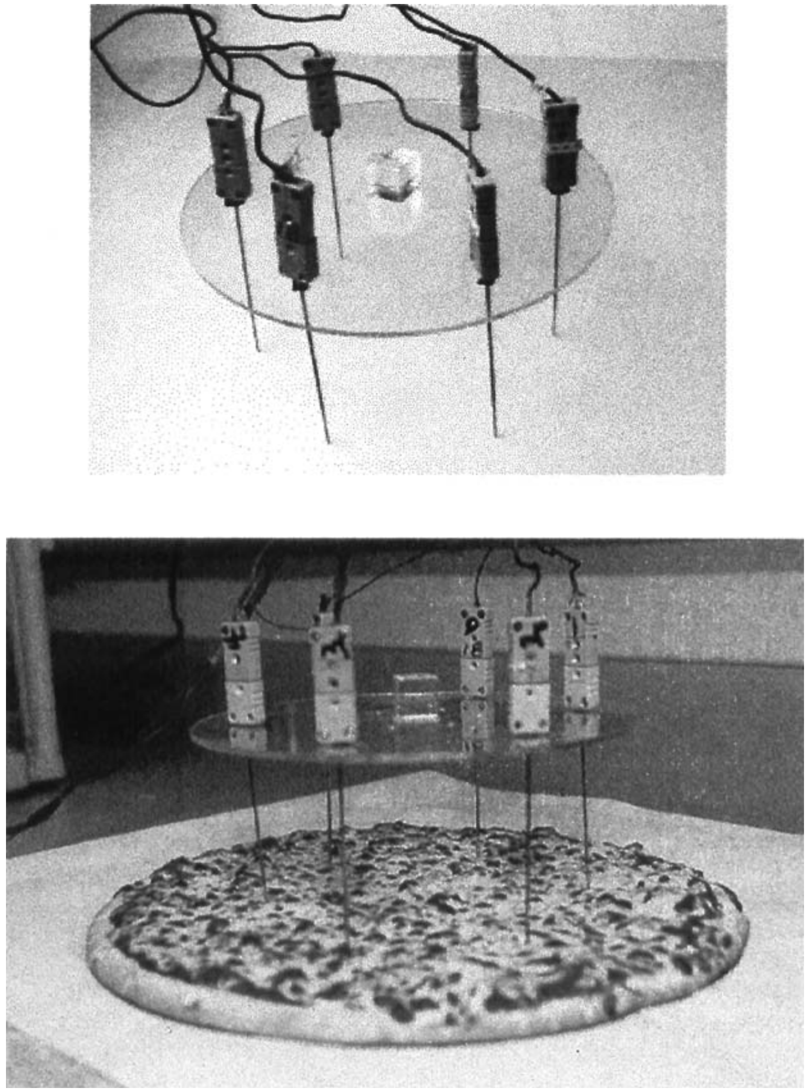

FIG. 2 Location of Thermocouple Probes on Pizza Surface

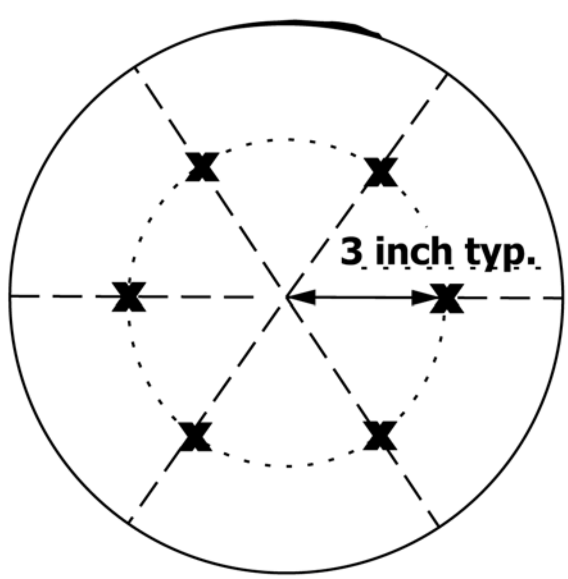

FIG. 3 Thermocouple Structure

10.8 *Cooking-Energy Efficiency and Production Capacity*—The cooking-energy efficiency and production capacity tests are to be run a minimum of three times. Allow a minimum of 15 min between each test run. Additional test runs may be necessary to obtain the required precision for the reported test results (see Annex A1). The cooking-energy efficiency tests shall be performed in the following sequence:

10.8.1 Turn the rapid cook oven on and allow it to achieve a ready-to-cook state. If the oven requires preheating in order to achieve a ready-to-cook state then allow the oven to idle for 60 min after it is fully preheated.

10.8.2 Set the rapid cook oven controls to the recipe or program for optimized cooking of a pizza as determined in 10.7. If the manufacturer recommends cooking parbaked pizza using a cooking surface or container that is separate from the oven deck, then weigh the recommended surface or container and record the weight.

10.8.3 After the oven has stabilized, wait for the heaters to cycle on then off again (if applicable).

NOTE 12—It is the intent of this procedure to begin with the oven in a maximum state of stored energy.

10.8.4 Remove a single pizza from the refrigerator, weigh the uncooked pizza, record the weight and place the pizza directly on the manufacturer's recommended cooking surface or cooking container in the center of the oven. If the manufacturer does not recommend a separate cooking surface or cooking container for cooking parbaked pizza; then place the pizza directly on the oven deck. Do not allow more than 1 min to elapse from the time a pizza is removed from the refrigerator until it is placed in the oven. Commence monitoring time and energy consumption.

10.8.5 Close the rapid cook oven door and immediately start the program to initiate the cook cycle. Cook the pizza for the time determined in 10.7.

10.8.6 Approximately 15 s before removing the cooking load, take the next pizza out of the refrigerator, weigh and record the weight of the pizza. The pizza shall not be out of the refrigerator for more than 1 min before loading into the oven.

10.8.7 When the programmed cook cycle is complete, or the pizza test load has been in the oven the same amount of time as the cook time determined in 10.7, open the oven door and remove the pizza.

NOTE 13—It is recommended that a pizza peel be used to safely remove hot pizzas from inside the oven. A pizza peel consists of a flat metal or wood blade connected to a handle. Sized to lift a single pizza, the peel allows the operator to load and remove a pizza from the oven without having to touch the pizza or extend an arm into the oven.

10.8.8 Determine the final temperature of the pizza by placing six thermocouple probes on the surface of the pizza. Locate the probes 3 in. from the center of the pizza and spaced equidistant from each other as shown in Fig. 2. The probes should penetrate the cheese and rest on the sauce-crust interface directly beneath the cheese. Allow no more than 10 s from the time the pizza is removed from the oven to the time the probes are placed on the pizza. Leave the probes in place on the pizza and record and average the temperatures of all six probes every five seconds over a one-minute period (for a total of 12 readings). The final pizza temperature is the highest average temperature of the six probes during the one-minute period.

10.8.9 Remove any cheese that may stick to the thermocouple probes during temperature measurement and place the cheese back on the pizza. Weigh the cooked pizza and record the weight.

10.8.10 Load the next pizza into the oven within 15 s or when the oven indicates that it is ready to cook, whichever is longer. Repeat 10.8.6 – 10.8.10 until all eight pizza loads have been cooked.

10.8.11 Terminate the test after removing the last pizza load and either allowing 15 s to pass or waiting until the oven has indicated that it has recovered to a ready to cook state. Record the total elapsed time and consumption of energy for the last seven loads of each eight-load cooking test.

10.8.12 Confirm that the average final temperature for the seven pizza loads is 195 ± 3°F. If the 7-run average final pizza temperature is not 195 ± 3°F, then the test is invalid and must be repeated. Adjust the cook time or oven recipe and repeat 10.8.4 – 10.8.12.

10.8.13 Replicate each cooking test using the order detailed above, allowing a minimum of 1 h to elapse between replications. The reported cooking-energy efficiency and production capacity shall be an average of at least three tests (see Annex A1).

10.8.14 In accordance with 11.8, calculate and report the cooking-energy efficiency, cooking energy rate, electric energy rate (if applicable for gas rapid cook ovens), and production capacity.

11. Calculation and Report

11.1 *Test Rapid Cook Oven:*

11.1.1 Summarize the physical and operating characteristics of the rapid cook oven. 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 For electric rapid cook ovens, report the voltage for each test.

11.2.3 For gas rapid cook ovens, report the higher heating value of the gas supplied to the rapid cook oven during each test.

11.3 *Gas Energy Calculations:*

11.3.1 For gas rapid cook ovens, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (see 10.2).

11.3.2 Calculate the energy consumed based on:

$$E_{gas} = V \times HV \quad (1)$$

where:

E_{gas} = energy consumed by the appliance,
HV = higher heating value,
= energy content of gas measured at standard conditions, Btu/ft^3, and

V = actual volume of gas corrected for temperature and pressure at standard conditions, ft^3,
= $V_{meas} \times T_{cf} \times P_{cf}$

where:

V_{meas} = measured volume of gas, ft^3,
T_{cf} = temperature correction factor,
= *absolute standard gas temperature* °R / *absolute actual gas temperature* °R,
= *absolute standard gas temperature* °R / [*gas temperature* °F + 459.67] °R,
P_{cf} = pressure correction factor,
= *absolute actual gas pressure* psia / *absolute standard pressure* psia, and
= *gas gage pressure* psig + *barometric pressure* psia / *absolute standard pressure* psia.

NOTE 14—Absolute standard gas temperature and pressure used in this calculation should be the same values used for determining the higher heating value. Standard conditions using Practice D3588 are 14.696 psia (101.33 kPA) and 60°F (519.67 °R, (288.71 °K)).

11.4 *Energy Input Rate:*

11.4.1 Report the manufacturer's nameplate energy input rate in Btu/h for gas rapid cook ovens and in kW for an electric rapid cook oven.

11.4.2 For gas or electric rapid cook ovens, calculate and report the measured energy input rate (Btu/h or kW) based on the energy consumed by the rapid cook oven during the period of peak energy input according to the following relationship:

$$q_{input} = \frac{E \times 60}{t} \quad (2)$$

where:

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

11.5 *Preheat Energy and Time:*

11.5.1 Report the preheat energy consumption (Btu or kWh) and preheat time (min).

11.6 *Idle Energy Rate:*

11.6.1 Calculate and report the pilot energy rate (Btu/h or kW) based on:

$$q_{idle\ rate} = \frac{E \times 60}{t} \quad (3)$$

where:

$q_{idle\ rate}$ = idle energy rate, Btu/h or kW,
E = energy consumed during the test period, Btu or kW, and
t = test period, min.

11.7 *Pilot Energy Rate (if applicable):*

11.7.1 Calculate and report the pilot energy rate (Btu/h) based on:

$$q_{pilot\ rate} = \frac{E \times 60}{t} \quad (4)$$

where:

$q_{pilot\ rate}$ = pilot energy rate, Btu/h,
E = energy consumed during the test period, Btu, and
t = test period, min.

11.8 *Cooking-Energy Efficiency, Cooking Energy Rate, and Production Capacity:*

11.8.1 Calculate the cooking-energy efficiency, η_{pizza}, for pizza test load cooking tests based on:

$$\eta_{pizza} = \frac{E_{food} + E_{pan}}{E_{oven}} \times 100 \quad (5)$$

where:

η_{pizza} = pizza test load cooking-energy efficiency, %,
E_{food} = energy into food, Btu,
= $(W_{uncooked} \times Cp\ (Pizza) \times (T_2 - T_1)) + ((W_{uncooked} - W_{cooked})^* Hfgt2)$,
E_{pan} = energy into the manufacturer's recommended cooking surface or cooking container, Btu,
= $W_{pan} \times Cp\ (Pan) \times (T_2 - T_1)$,
$W_{uncooked}$ = weight of pizza test load before it is cooked,
W_{cooked} = weight of cooked pizza test load,
W_{pan} = weight of the manufacturer's recommended cooking surface or cooking container,
Cp (Pizza) = the specific heat of pizzas based on the average specified pizza,
= 0.593 Btu/lb·°F,
Cp (Pan) = the specific heat of the manufacturer's recommended cooking surface or cooking container,
Hfgt2 = the heat of vaporization of water (Btu/lb) as found from a table of thermodynamic properties of water at saturation (see 2013 ASHRAE Handbook of Fundamentals, Chapter 1, Table 3),
= 970 Btu/lb,
T_2 = the average final temperature of the pizza test load,
T_1 = the initial temperature of the pizza test load,
= 40°F, and
E_{oven} = energy into the appliance including electric energy consumed by a gas rapid cook oven, Btu.

The conversion factor for electric energy is 3413 Btu/kWh.

11.8.2 Calculate the cooking energy rate for pizza tests based on:

$$q_{pizza} = \frac{E \times 60}{t} \quad (6)$$

where:

q_{pizza} = cooking energy rate, Btu/h or kW,
E = energy consumed during cooking-energy efficiency test, Btu or kWh, and
t = Total time of the cooking-energy efficiency test, min.

For gas appliances, report separately a gas cooking energy rate and an electric cooking energy rate.

11.8.3 Calculate production capacity, PC_{pizza} (lb/h), based on:

$$PC_{pizza} = \frac{W \times 60}{t} \quad (7)$$

where:

PC_{pizza} = production capacity of the rapid cook oven cooking pizza, lb/h,
W = total weight of the pizzas cooked during cooking-energy efficiency test, lb, and
t = total time of the cooking-energy efficiency test, min.

11.8.4 Report the cook time and the three run average value of the cooking-energy efficiency, cooking energy rate, and production capacity.

12. Precision and Bias

12.1 *Precision:*

12.1.1 *Repeatability (within laboratory, same operator and equipment):*

12.1.1.1 For the cooking-energy efficiency and production capacity results, the percent uncertainty in each result has been specified to be no greater than ±10 % based on at least three test runs.

12.1.1.2 The repeatability of each reported parameter is being determined.

12.1.2 *Reproducibility (multiple laboratories)*—The interlaboratory precision of the procedure in this test method for measuring each reported parameter is being determined.

12.2 *Bias*—No statement can be made concerning the bias of the procedures in this test method because there are no accepted reference values for the parameters reported.

13. Keywords

13.1 cooking-energy efficiency; efficiency; energy; performance; pizza oven; production capacity; rapid cook oven; test method; throughput

ANNEX

(Mandatory Information)

A1. PROCEDURE FOR DETERMINING THE UNCERTAINTY IN REPORTED TEST RESULTS

NOTE A1.1—The procedure described below is based on the method for determining the confidence interval for the average of several test results discussed in Section 6.4.3, ASHRAE Guideline 2-1986(RA90). It should only be applied to test results that have been obtained within the tolerances prescribed in this method (for example, thermocouples calibrated, range was operating within 5 % of rated input during the test run).

A1.1 For the cooking-energy efficiency and production capacity procedures, results are reported for the cooking-energy efficiency (η_{cook}) and the production capacity (*PC*). For the barreling energy performance procedure, the total reduction in the cooking energy rate from the first barreling test run to the sixth is reported ($q_{total\ rate\ reduction}$). Each reported result is the average of results from at least three test runs. In addition, the uncertainty in these averages is reported. For each cooking-energy efficiency test (pizza test load and chicken test load), the uncertainty of η_{cook} must be no greater than ±10 % before η_{cook} for that test can be reported and the uncertainty of *PC* must also be no greater than ±10 % before *PC* for that test can be reported. For the barreling test, the uncertainty of the total cooking energy rate reduction $q_{total\ rate\ reduction}$ must be no greater than ±10 % before $q_{total\ rate\ reduction}$ for that test can be reported.

A1.2 The uncertainty in a reported result is a measure of its precision. If, for example, the η_{cook} is 40 %, the uncertainty must not be larger than ± 4 %. This means that the true η_{cook} is within the interval between 36 and 44 %. This interval is determined at the 95 % confidence level, which means that there is only a 1 in 20 chance that the true η_{cook} could be outside of this interval.

A1.3 Calculating the uncertainty not only guarantees the maximum uncertainty in the reported results, but also is used to determine how many test runs are needed to satisfy this requirement. The uncertainty is calculated from the standard deviation of three or more test results and a factor from Table A1.1, which depends on the number of test results used to calculate the average. The percent uncertainty is the ratio of the uncertainty to the average expressed as a percent.

A1.4 *Procedure:*

NOTE A1.2—See A1.5 for example of applying this procedure.

A1.4.1 *Step 1*—Calculate the average and the standard deviation for the η_{cook} , *PC*, and $q_{total\ rate\ reduction}$ using the results of the first three test runs:

NOTE A1.3—The formulas below may be used to calculate the average and sample standard deviation. However, it is recommended that a calculator with statistical function be used. If one is used, be sure to use the sample standard deviation function. Using the population standard deviation function will result in an error in the uncertainty.

TABLE A1.1 Uncertainty Factors

Test Results, *n*	Uncertainty Factor, *Cn*
3	2.48
4	1.59
5	1.24
6	1.05
7	0.92
8	0.84
9	0.77
10	0.72

A1.4.1.1 The formula for the average (3 test runs) is as follows:

$$Xa_3 = (1/3) \times (X_1 + X_2 + X_3) \quad \text{(A1.1)}$$

where:

Xa_3 = average of results for η_{cook}, PC, $q_{total\ rate\ reduction}$, and
X_1, X_2, X_3 = results for η_{cook}, PC, $q_{total\ rate\ reduction}$.

A1.4.1.2 The formula for the sample standard deviation (3 test runs) is as follows:

$$S_3 = \left(1/\sqrt{2}\right) \times \sqrt{(A_3 - B_3)} \quad \text{(A1.2)}$$

where:

S_3 = standard deviation of results for η_{cook}, PC, $q_{total\ rate\ reduction}$,
A_3 = $(X_1)^2 + (X_2)^2 + (X_3)^2$, and
B_3 = $(1/3) \times (X_1 + X_2 + X_3)^2$.

NOTE A1.4—The "A" quantity is the sum of the squares of each test result, while the "B" quantity is the square of the sum of all test results multiplied by a constant (1/3 in this case).

A1.4.2 *Step 2*—Calculate the absolute uncertainty in the average for each parameter listed in Step 1. Multiply the standard deviation calculated in Step 1 by the Uncertainty Factor corresponding to three test results from Table A1.1.

A1.4.2.1 The formula for the absolute uncertainty (3 test runs) is as follows:

$$U_3 = C_3 \times S_3, \quad \text{(A1.3)}$$

$$U_3 = 2.48 \times S_3$$

where:

U_3 = absolute uncertainty in average for η_{cook}, PC, $q_{total\ rate\ reduction}$, and
C_3 = uncertainty factor for 3 test runs (see Table A1.1).

A1.4.3 *Step 3*—Calculate the percent uncertainty each parameter average using the average from Step 1 and the absolute uncertainty from Step 2.

A1.4.3.1 The formula for the percent uncertainty (3 test runs) is as follows:

$$\%U_3 = (U_3/Xa_3) \times 100\,\% \quad \text{(A1.4)}$$

where:

$\%U_3$ = percent uncertainty in average for η_{cook}, PC, $q_{total\ rate\ reduction}$,
U_3 = absolute uncertainty in average for η_{cook}, PC, $q_{total\ rate\ reduction}$,
Xa_3 = average η_{cook}, PC, $q_{total\ rate\ reduction}$.

A1.4.4 *Step 4*—If the percent uncertainty, $\%U_3$, is not greater than ± 10 % for η_{cook}, PC, $q_{total\ rate\ reduction}$, then report the average for η_{cook}, PC, and $q_{total\ rate\ reduction}$ along with their corresponding absolute uncertainty, U_3 in the following format:

$$Xa_3 \pm U_3$$

If the percent uncertainty is greater than ± 10 % for η_{cook} , PC, or $q_{total\ rate\ reduction}$, then proceed to Step 5.

A1.4.5 *Step 5*—Run a fourth test for each η_{cook}, PC, or $q_{total\ rate\ reduction}$ which resulted in the percent uncertainty being greater than ± 10 %.

A1.4.6 *Step 6*—When a fourth test is run for a given η_{cook}, calculate the average and standard deviation for η_{cook} and PC using a calculator or the following formulas:

A1.4.6.1 The formula for the average (4 test runs) is as follows:

$$Xa_4 = (1/4) \times (X_1 + X_2 + X_3 + X_4) \quad \text{(A1.5)}$$

where:

Xa_4 = average of results for η_{cook}, PC, $q_{total\ rate\ reduction}$, and
X_1, X_2, X_3, X_4 = results for η_{cook}, PC, $q_{total\ rate\ reduction}$.

A1.4.6.2 The formula for the standard deviation (4 test runs) is as follows:

$$S_4 = \left(1/\sqrt{3}\right) \times \sqrt{(A_4 - B_4)} \quad \text{(A1.6)}$$

where:

S_4 = standard deviation of results for η_{cook}, PC, $q_{total\ rate\ reduction}$ (4 test runs),
A_4 = $(X_1)^2 + (X_2)^2 + (X_3)^2 + (X_4)^2$, and
B_4 = $(1/4) \times (X_1 + X_2 + X_3 + X_4)^2$.

A1.4.7 *Step 7*—Calculate the absolute uncertainty in the average for each parameter listed in Step 1. Multiply the standard deviation calculated in Step 6 by the Uncertainty Factor for four test results from Table A1.1.

A1.4.7.1 The formula for the absolute uncertainty (4 test runs) is as follows:

$$U_4 = C_4 \times S_4, \quad \text{(A1.7)}$$

$$U_4 = 1.59 \times S_4$$

where:

U_4 = absolute uncertainty in average for η_{cook}, PC, $q_{total\ rate\ reduction}$, and
C_4 = the uncertainty factor for 4 test runs (Table A1.1).

A1.4.8 *Step 8*—Calculate the percent uncertainty in the parameter averages using the averages from Step 6 and the absolute uncertainties from Step 7.

A1.4.8.1 The formula for the percent uncertainty (4 test runs) is as follows:

$$\%U_4 = (U_4/Xa_4) \times 100\,\% \quad \text{(A1.8)}$$

where:

$\%U_4$ = percent uncertainty in average for η_{cook}, PC, $q_{total\ rate\ reduction}$,
U_4 = absolute uncertainty in average for η_{cook}, PC, $q_{total\ rate\ reduction}$, and
Xa_4 = average η_{cook}, PC, $q_{total\ rate\ reduction}$.

A1.4.9 *Step 9*—If the percent uncertainty, $\%U_4$, is no greater than ± 10 % for η_{cook}, PC, or $q_{total\ rate\ reduction}$, then report the average for η_{cook}, PC, and $q_{total\ rate\ reduction}$ along with their corresponding absolute uncertainty, U_4 in the following format:

$$Xa_4 \pm U_4$$

If the percent uncertainty is greater than ± 10 % for η_{cook}, *PC*, or $q_{total\ rate\ reduction}$ proceed to Step 10.

A1.4.10 *Step 10*—The step required for five or more test runs are the same as those described above. More general formulas are listed below for calculating the average, standard deviation, absolute uncertainty and percent uncertainty.

A1.4.10.1 The formula for the average (*n* test runs) is as follows:

$$Xa_n = n \times (X_1 + X_2 + X_3 + X_4 + \ldots + X_n) \quad (A1.9)$$

where:

n = number of test runs,
Xa_n = average of results for η_{cook}, *PC*, $q_{total\ rate\ reduction}$, and
$X_1, X_1, X_2, X_3, X_4, \ldots X_n$ = results for η_{cook}, *PC*, $q_{total\ rate\ reduction}$.

A1.4.10.2 The formula for the standard deviation (*n* test runs) is as follows:

$$S_n = \left(1/\sqrt{(n-1)}\right) \times \left(\sqrt{(An - Bn)}\right) \quad (A1.10)$$

where:

S_n = standard deviation of results for η_{cook}, *PC*, $q_{total\ rate\ reduction}$ (*n* test runs)
A_n = $(X_1)^2 + (X_2)^2 + (X_3)^2 + (X_4)^2 + \ldots + (X_n)^2$, and
B_n = $(1/n) \times (X_1 + X_2 + X_3 + X_4 + \ldots + X_n)^2$.

A1.4.10.3 The formula for the absolute uncertainty (*n* test runs) is as follows:

$$U_n = C_n \times S_n \quad (A1.11)$$

where:

U_n = absolute uncertainty in average for η_{cook}, *PC*, $q_{total\ rate\ reduction}$, and
C_n = uncertainty factor for *n* test runs (see Table A1.1).

A1.4.10.4 The formula for the percent uncertainty (*n* test runs) is as follows:

$$\%U_n = (U_n/Xa_n) \times 100\,\% \quad (A1.12)$$

where:

$\%U_n$ = percent uncertainty in average for η_{cook}, *PC*, $q_{total\ rate\ reduction}$.

When the specified uncertainty, $\%U_n$, is less than or equal to ±10 %; report the average for η_{cook}, *PC*, and $q_{total\ rate\ reduction}$ along with their corresponding absolute uncertainty, U_n, in the following format:

$$Xa_n \pm U_n$$

NOTE A1.5—In the course of running these tests, the tester may compute a test result that deviates significantly from the other test results. It may be tempting to discard such a result in an attempt to meet the ± 10 % uncertainty requirement. This should be done only if there is some physical evidence that the test run from which that particular result was obtained was not performed according to the conditions specified in this method. For example, a thermocouple was out of calibration or the oven's input rate was not within 5 % of the rated input. To be sure all results were obtained under approximately the same conditions, it is good practice to monitor those test conditions specified in this method.

A1.5 *Example of Determining Uncertainty in Average Test Result:*

A1.5.1 Three test runs for the full-energy input rate cooking efficiency test yielded the following η_{cook} results:

Test	η_{cook}
Run #1	33.8 %
Run #2	34.1 %
Run #3	31.0 %

A1.5.2 *Step 1*—Calculate the average and standard deviation of the three test results for the η_{cook}.

A1.5.2.1 The average of the three test results is as follows:

$$Xa_3 = (1/3) \times (X_1 + X_2 + X_3), \quad (A1.13)$$

$$Xa_3 = (1/3) \times (33.8 + 31.3 + 30.5),$$

$$Xa_3 = 31.9\,\%$$

A1.5.2.2 The standard deviation of the three test results is as follows. First calculate "A_3" and "B_3:"

$$A_3 = (X_1)^2 + (X_2)^2 + (X_3)^2, \quad (A1.14)$$

$$A_3 = (33.8)^2 + (31.3)^2 + (30.5)^2,$$

$$A_3 = 3{,}052$$

$$B_3 = (1/3) \times [(X_1 + X_2 + X_3)^2],$$

$$B_3 = (1/3) \times [(33.8 + 31.3 + 30.5)^2],$$

$$B_3 = 3{,}046$$

A1.5.2.3 The new standard deviation for the η_{cook} is as follows:

$$S_3 = \left(1/\sqrt{2}\right) \times \sqrt{(3{,}052 - 3{,}046)}, \quad (A1.15)$$

$$S_3 = 1.73\,\%$$

A1.5.3 *Step 2*—Calculate the uncertainty in average.

$$U_3 = 2.48 \times S3, \quad (A1.16)$$

$$U_3 = 2.48 \times 1.73,$$

$$U_3 = 4.29\,\%$$

A1.5.4 *Step 3*—Calculate percent uncertainty.

$$\%U_3 = (U_3/Xa_3) \times 100\,\%, \quad (A1.17)$$

$$\%U_3 = (4.29/31.9) \times 100\,\%,$$

$$\%U_3 = 13.5\,\%$$

A1.5.5 *Step 4*—Run a fourth test. Since the percent uncertainty for the η_{cook} is greater than ± 10 %, the precision requirement has not been satisfied. An additional test is run in an attempt to reduce the uncertainty. The η_{cook} from the fourth test run was 31.8 %.

A1.5.6 *Step 5*—Recalculate the average and standard deviation for the η_{cook} using the fourth test result:

A1.5.6.1 The new average η_{cook} is as follows:

$$Xa_4 = (1/4) \times (X_1 + X_2 + X_3 + X_4), \quad (A1.18)$$

$$Xa_4 = (1/4) \times (33.8 + 31.3 + 30.5 + 31.8),$$

$$Xa_4 = 31.9\,\%$$

A1.5.6.2 The new standard deviation: First calculate "A_4" and "B_4:"

$$A_4 = (X_1)^2 + (X_2)^2 + (X_3)^2 + (X_4)^2, \quad (A1.19)$$

$$A_4 = (33.8)^2 + (31.3)^2 + (30.5)^2 + (31.8),$$

$$A_4 = 4{,}064$$

$$B_4 = (1/4) \times [(X_1 + X_2 + X_3 + X_4)^2],$$

$$B_4 = (1/4) \times [(33.8 + 31.3 + 30.5 + 31.8)^2],$$

$$B_4 = 4{,}058$$

A1.5.6.3 The new standard deviation for the η_{cook} is as follows:

$$S_4 = \left(1/\sqrt{3}\right) \times \sqrt{(4{,}064 - 4{,}058)}, \quad (A1.20)$$

$$S_4 = 1.41\,\%$$

A1.5.7 *Step 6*—Recalculate the absolute uncertainty using the new average and standard deviation.

$$U_4 = 1.59 \times S_4, \quad (A1.21)$$

$$U_4 = 1.59 \times 1.41,$$

$$U_4 = 2.24\,\%$$

A1.5.8 *Step 7*—Recalculate the percent uncertainty.

$$\%U_4 = (U_4/Xa_4) \times 100\,\%, \quad (A1.22)$$

$$\%U_4 = (2.24/31.9) \times 100\,\%,$$

$$\%U_4 = 7\,\%$$

A1.5.9 *Step 8*—Since the percent uncertainty, $\%U_4$, is less than ±10 %, the average for the η_{cook} is reported along with its corresponding absolute uncertainty, U_4 as follows:

$$\eta_{cook}: 31.9 \pm 2.24\,\% \quad (A1.23)$$

The *PC* and its absolute uncertainty can be calculated and reported following the same steps, assuming the ± 10 % precision requirement has been met for the corresponding η_{cook}.

APPENDIX

(Nonmandatory Information)

X1. RESULTS REPORTING SHEETS

Manufacturer____________________
Model____________________
Serial #____________________
Date____________________
Test Reference Number (optional)____________________

Section 11.1 Test Oven

Description of operational characteristics: ____________________

Physical Dimensions

Size of rapid cook oven: ____ H × ____ W × ____ D in.

Section 11.2 Apparatus

____ Check if testing apparatus conformed to specifications in Section 6.

Deviations:

Section 11.4 Energy Input Rate

Test Voltage (V) ____________
Gas Heating Value (Btu/ft^3) ____________
Heat Source (microwave, halogen, convection, etc.) ____________
Rated (Btu/h or kW) ____________
Measured (Btu/h or kW)

Percent Difference between Measured and Rated (%) ________
Second Heat Source (if applicable) ________
Rated (Btu/h or kW) ________
Measured (Btu/h or kW) ________
Percent Difference between Measured and Rated (%) ________
Fan / Control Energy Rate (kW, gas ovens only) ________

Section 11.5 Preheat Energy and Time

Test Voltage (V) ________
Gas Heating Value (Btu/ft^3) ________
Energy Consumption (Btu or kWh) ________
Time ________

Section 11.6 Idle Energy Rate

Test Voltage (V) ________
Gas Heating Value (Btu/ft^3) ________
Idle Energy Rate (Btu/h or kW) ________

Section 11.7 Pilot Energy Rate (if applicable)

Gas Heating Value (Btu/ft^3) ________
Pilot Energy Rate (Btu/h) ________

Section 11.8 Cooking-Energy Efficiency, Cooking Energy Rate, and Production Capacity

Cook Time Determination for Pizza:
Cook time: _____ Min
Oven recipe: ________
Type of cooking container: ________

Test Voltage (V) ________
Gas Heating Value (Btu/ft^3) ________
Cooking-Energy Efficiency (%) ________
Cooking Energy Rate (Btu/h or kW) ________
Electric Energy Rate (kW, gas ovens only) ________
Energy into food—E_{food} (Btu) ________
Energy to cooking container—E_{pan} (Btu) ________
Energy into the appliance—E_{oven} (Btu) ________
Energy into the appliance—E_{oven} (Wh) ________
Production Capacity (lb/h)