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An American National Standard

Standard Test Method for Performance of Rack Ovens[1]

This standard is issued under the fixed designation F 2093; 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 baking performance of rack ovens. The food service operator can use this evaluation to select a rack oven and understand its energy performance.

1.2 This test method is applicable to thermostatically controlled, gas and electric rack ovens.

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

1.3.1 Energy input rate (10.2),

1.3.2 Thermostat calibration (10.3),

1.3.3 Preheat energy and time (10.4),

1.3.4 Idle energy rate (10.5),

1.3.5 Pilot energy rate, if applicable (10.6),

1.3.6 Oven main cavity vent performance (10.7),

1.3.7 White sheet cake browning (10.8), and

1.3.8 Baking uniformity and bread production capacity (10.9),

1.3.9 Steam performance (10.9), and

1.3.10 Baking energy efficiency and production capacity (10.10).

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

1.5 *This test method may involve hazardous materials, operations, and equipment. 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 *ASTM Standards:*

D 3588 Practice for Calculating Heat Value, Compressbility Factor, and Relative Density (Specific Gravity) of Gaseous Fuels[2]

2.2 *ANSI Documents:*[3]

ANSI Standard Z83 American National Standard for Gas Food Service Equipment

2.3 *ASHRAE Documents:*[4]

ASHRAE Fundamentals 1997

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bake time*, *n*—time required to bake the frozen berry pies specified 7.3 to an internal temperature of 185 ± 5°F during a baking energy efficiency test.

3.1.2 *baking cavity*, *n*—that portion of the appliance in which food products are heated or cooked.

3.1.3 *baking energy*, *n*—energy consumed by the rack oven as it is used to bake frozen berry pies under heavy- medium-, and light-load conditions.

3.1.4 *baking energy efficiency*, *n*—quantity of energy imparted to the pies, expressed as a percentage of energy consumed by the rack oven during the baking event.

3.1.5 *baking energy rate*, *n*—average rate of energy consumption (Btu/h or kW) during the baking energy efficiency tests.

3.1.6 *idle energy rate*, *n*—the rate of energy consumed (Btu/h or kW) by the rack oven while "holding" or "idling" the baking cavity at the thermostat set point.

3.1.7 *measured energy input rate*, *n*—peak rate at which a rack oven consumes energy (Btu/h or kW), typically reflected during preheat.

3.1.8 *nameplate energy input rate*, *n*—the maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

3.1.9 *pilot energy rate*, *n*—average rate of energy consumption (Btu/h) by a rack oven's continuous pilot (if applicable).

3.1.10 *preheat energy*, *n*—amount of energy consumed by the rack oven while preheating the baking cavity from ambient room temperature (75 ± 5°F) to the 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.

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[2] *Annual Book of ASTM Standards* Vol 05.06.

[3] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036

[4] Available from the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329.

3.1.11 *preheat rate*, *n*—average rate (°F/min) at which the rack oven's baking cavity is heated from ambient temperature (75 ± 5°F) to the thermostat set point.

3.1.12 *preheat time*, *n*—time required for the rack oven to preheat from ambient room temperature (75 ± 5°F) to the thermostat set point.

3.1.13 *production capacity*, *n*—maximum rate (lb/h) at which the rack oven can bring the frozen berry pies specified in 7.3 to an internal temperature of 185 ± 5°F.

3.1.14 *production rate*, *n*—rate (lb/h) at which the rack oven brings the frozen berry pies specified in 7.3 to an internal temperature of 185 ± 5°F during the medium- and light-load tests. Does not necessarily refer to maximum rate. Production rate varies with the amount of food being cooked.

3.1.15 *rack*, *n*—a device which is used to hold pans within a rack oven.

3.1.16 *rack oven*, *n*—an appliance that cooks by forcing hot air over the food within a closed cavity, fitted with a mechanism for rotating one or more racks within the cavity.

3.1.17 *steam energy*, *n*—amount of energy consumed by the rack oven while returning the steam generator to 450°F after a steam injection cycle, with the thermostat set to a calibrated 450°F.

3.1.18 *steam injection cycle*, *n*—a period whereby steam is introduced into the baking cavity during baking.

3.1.19 *steam-ready preheat energy*, *n*—amount of energy consumed by the rack oven while preheating the steam generation unit from ambient room temperature (75 ± 5°F) to 450°F.

3.1.20 *steam-ready preheat rate*, *n*—average rate (°F/min) at which the rack oven's steam generation unit is heated from ambient temperature (75 ± 5°F) to 450°F.

3.1.21 *steam-ready preheat time*, *n*—time required to preheat the rack oven's steam generation unit from ambient room temperature (75 ± 5°F) to 450°F.

3.1.22 *steam recovery rate*, *n*—average rate (°F/min) at which the rack oven's steam generator returns to 450°F after a steam injection cycle, with the thermostat set to a calibrated 450°F.

3.1.23 *steam recovery time*, *n*—time required for the rack oven steam generator to return to 450°F after a steam injection cycle, with the thermostat set to a calibrated 450°F.

3.1.24 *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 rack oven is connected to the appropriate metered energy source, and energy input rate is determined to confirm that the appliance is operating within 5 % of the nameplate energy input rate.

4.2 The accuracy of the oven's thermostat is checked at 375°F and 450°F (the set point for the steam performance test) and adjusted as necessary.

4.3 The amount of energy and time required to preheat the rack oven to 375°F and 450°F are determined. The steam-ready preheat time is also determined at a calibrated 450°F setting, based on the temperature of the steam generation unit.

4.4 The idle energy rate is determined with the rack oven set to maintain 375°F and 450°F in the baking cavity.

4.5 Pilot energy rate is determined, when applicable, for gas rack ovens.

4.6 The oven's main cavity vent performance is evaluated with the oven operating at 375°F.

4.7 The rack oven is used to bake a heavy-load of white sheet cakes (15 cakes in a single-rack oven and 30 cakes in a double-rack oven) to assess the browning uniformity of the oven.

4.8 The rack oven is used to bake a heavy-load of French bread (60 loaves in a single-rack oven and 120 loaves in a double-rack oven) to determine the oven's baking uniformity and bread production capacity.

4.9 The rack oven's steam performance is characterized by assessing the amount of time and energy required for the oven to recover to 450°F after a baking cycle and measuring the amount of steam produced during the steam cycle.

4.10 The rack oven is used to bake heavy-, medium-, and light-loads of frozen, berry pies. Baking energy efficiency, baking energy rate, and production rate are determined from these tests.

5. Significance and Use

5.1 The energy input rate and thermostat calibration tests are used to confirm that the rack oven is operating properly prior to further testing.

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

5.3 Idle energy rate and pilot energy rate can be used by the food service operator to estimate energy consumption during non-baking periods.

5.4 The oven's main cavity vent performance is a direct indicator of how effectively a rack oven will vent any residual steam in the baking cavity, thereby producing the desired crust on a product.

5.5 The oven's browning and baking uniformity can be used by an operator to select an oven that bakes a variety of products evenly.

5.6 Steam performance can be useful for a food service operator interested in the oven's ability to create steam and recover rapidly and repeatedly produce the desired crust on a product.

5.7 Baking energy efficiency is a precise indicator of rack oven energy performance under various loading conditions. This information enables the food service operator to consider energy performance when selecting a rack oven.

5.8 Production capacity is used by food service operators to choose a rack oven that matches their food output requirements.

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 gas volume to standard conditions. Shall have a resolution of 0.2 in. Hg and an uncertainty of 0.2 in. Hg.

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

6.4 *Flow Meter*, for measuring total water consumption of the oven, having a resolution of 0.01 gal and an uncertainty of 0.01 gal for flows of 0.2 gpm and higher.

6.5 *Gas Meter*, for measuring the gas consumption of a rack 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 *Heavy-Duty Chef's Thermometers*, capable of withstanding 400°F temperatures for monitoring food temperature while baking. A 2-in. or larger dial is recommended for enhanced visibility.

6.7 *Hot Wire Anemometer*, for measuring air flow from the oven's vent, with a range of 0 to 100 ft/min, a resolution of at least 1 ft/min, and an uncertainty no greater than ±3 % of the measured value.

6.8 *Platform Balance Scale*, or appropriate load cells, for measuring weights up to 500 lb with a resolution of 0.2 lb and an uncertainty of 0.2 lb.

6.9 *Pressure Gauge*, for monitoring gas pressure. Shall have a range of zero to 15 in. H_2O, a resolution of 0.5 in. H_2O, and a maximum uncertainty of 1 % of the measured value.

6.10 *Proofing Cabinet*, for proofing bread dough. Shall be capable of maintaining between 70 and 95 % RH at temperatures between 70 and 110°F, and have the capacity to hold a minimum of two full-loads bread dough.

6.11 *Retarder*, or refrigerator, for retarding frozen bread dough. Shall be capable of maintaining between 34 and 40°F and have the capacity to hold a minimum of four full-loads of bread dough.

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

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

6.14 *Thermocouple(s)*, industry standard type K thermocouple wire with a range of 0°F to 600°F and an uncertainty of ± 1°F.

6.15 *Thermocouple Probe*, "fast response" type T or type K thermocouple probe, 1⁄16 in. or smaller diameter, with a 3-s or faster response time, capable of immersion with a range of 30°F to 300°F and an uncertainty of ± 1°F. The thermocouple probe's active zone shall be at the tip of the probe.

6.16 *Watt-Hour Meter*, for measuring the electrical energy consumption of a rack 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 *Aluminum Sheet Pans*, measuring 18 by 26 by 1 in. for the baking energy efficiency and sheet cake browning tests.

7.2 *Baking Screens*, for bread tests shall be standard flat screens measuring 18 by 26 in.

7.3 *Cake Mix*, Pillsbury Deluxe White, 5 lb per box. A minimum 50 lb is required for single-rack ovens and 100 lb for double-rack ovens.

7.4 *Frozen Berry Pies*, 10-in. frozen, commercial-grade, ready-to-bake blueberry and blackberry pies, weighing 3.10 ± 0.15 lb, with a moisture content of 54 ± 2 %, by weight for baking energy efficiency and production capacity tests. The pie crust shall be made with 100 % vegetable shortening.

NOTE 1—Sysco Classic fruit pies have been shown to be an acceptable product for testing by Pacific Gas and Electric Company.

7.5 *Frozen French Bread Dough*, pre-formed, 19.5 ± 1 oz per loaf.

NOTE 2—Rich's® French bread dough has been shown to be an acceptable product for testing by Pacific Gas and Electric Company.

7.6 *Hotel Pan*, to be used to collect water runoff during testing, solid 12 by 20 by 2½ in. stainless steel.

7.7 *Paper Baking Liners*, to line sheet pans for browning uniformity tests.

7.8 *Plastic Wrap*, commercial grade, 18-in. wide.

7.9 *Rack*, supplied by the oven manufacturer shall have a nominal 4-in. spacing between pan positions, with a minimum of 4-in. between the top pan and the top of the top of the rack and a minimum of 4-in. between the bottom pan and the floor.

7.10 *Rack Covers*, disposable Polythene covers, or equivalent, to fit standard 30" × 18" tray racks.

7.11 *Water*, supplied to the rack oven shall be 65 ± 5°F. If outside this range, hot and cold water supplies may be mixed to achieve the required inlet temperature.

8. Sampling, Test Units

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

9. Preparation of Apparatus

9.1 Install the oven according to the manufacturer's instructions in an appropriate space. All sides of the oven shall be a minimum of 3 ft from any side wall, side partition, or other operating appliance. The oven, moisture vent, and hood assembly, as furnished, shall be vented to the exterior of the testing space, using the manufacturer's specified ventilation rate(s). The associated heating or cooling system for the space shall be capable of maintaining an ambient temperature of 75 ± 5°F within the testing environment (outside the vertical area of the rack oven) when the combined oven exhaust ventilation system is operating.

9.2 Install a test duct section on the oven's main cavity vent outlet with the following specifications: the ductwork shall have a 24-in. vertical rise from the outlet of the main cavity vent, followed by a 90° elbow and a horizontal run equal to a minimum of 10 times the diameter of the duct. If the vent outlet is not round, then install a rectangular-to-round transition immediately downstream from the 90° elbow and ensure that the horizontal run of round duct is a minimum of 10 times the diameter of the test duct.

9.2.1 To facilitate further testing, measure 7 duct-diameters from the transition (or 90° elbow if no transition is used). Using a permanent marker, mark this point on the test duct, then mark 2 other points, each 60° along the circumference of the duct from the initial point.

9.2.2 Drill small access holes at each of the three marked locations. Ensure that the access holes are just large enough to accommodate the wire anemometer. Cover these holes with duct tape.

9.3 With the oven at room temperature (75 ± 5°F), run water through the steam generator. Measure and record the volume of any water that accumulates in steam generator compartment and on the oven floor.

9.4 Instrument the steam-producing mass with a minimum of three thermocouples (one in the geometric center, one at the top, and one at the bottom) for monitoring temperature. The thermocouples sensing points shall be embedded in the center of the mass, so as to reflect the core temperature of the mass.

9.5 Install a thermocouple at the vertical center of the oven's pressure panel in the air outlet, with the sensing tip 1.0 ± 0.25-in. away from the vertical plane of the panel to record the oven cavity temperature. Make certain that the thermocouple sensing tip is not touching the pressure panel nor any of its components.

9.6 Adjust the air baffles inside the oven cavity to the manufacturer's recommended gap settings. Follow the manufacturer's recommendation for fine adjustments.

9.7 Connect the rack 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 rack 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.

9.8 For a gas rack 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. Proper combustion may be verified by measuring air-free CO in accordance with ANSI standard Z83.

9.9 For an electric rack oven, confirm (while the elements are energized) that the supply voltage is within ± 2.5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test.

NOTE 3—It is the intent of the testing procedure herein to evaluate the performance of a rack oven at its rated gas pressure or electric voltage. If an electric unit is rated dual voltage (this 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 rack 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.

9.10 Install a flow meter to the rack oven water inlet such that total water flow to the appliance is measured and a pressure regulator downstream from the meter to maintain a constant pressure of water for the steam performance tests. Also install a thermocouple probe in the inlet water line to the rack oven for monitoring inlet water temperature.

9.11 Adjust the water pressure to the manufacturer's recommended operating water pressure.

9.12 Assure that the oven cavity vent is closed for all tests.

9.13 For the baking energy efficiency and production capacity tests, affix a stop or piece of colored tape 0.75 ± 0.05 in. from the sensing tip of the thermocouple probe used for measuring food temperature. This is used to indicate when the thermocouple probe has reached the approximate center of the pies being probed.

NOTE 4—A disc made from paper or plastic may serve as a stop, so long as its position along the thermocouple probe is fixed.

10. Procedure

10.1 *General*:

10.1.1 For gas rack ovens, 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,

10.1.1.6 Ambient temperature, and

10.1.1.7 Energy input rate during or immediately prior to test.

NOTE 5—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 rack oven under test. It is recommended that all testing be performed with natural gas having a higher heating value of 1,000 to 1,075 Btu/ft^3.

10.1.2 For gas rack ovens, record any electric energy consumption, in addition to gas energy for all tests.

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

10.1.3.1 Voltage while elements are energized,

10.1.3.2 Ambient temperature, and

10.1.3.3 Energy input rate during or immediately prior to test run.

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 rack oven.

10.2 *Energy Input Rate*:

10.2.1 Set the temperature controls 375°F and turn on the oven.

10.2.2 Start recording time and energy consumption when the burners actually ignite or when the elements are energized (not when the oven ready light comes on) and stop recording when the burners or elements commence cycling.

10.2.3 Confirm that the measured input rate or power, (Btu/h for a gas rack oven and kW for an electric rack oven) 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 rack oven 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 rack oven or supply another rack oven for testing.

10.3 *Thermostat Calibration*:

10.3.1 Preheat the baking cavity to a temperature of 375°F as indicated by the temperature control. Stabilize for 4 h after the burners or elements commence cycling at the thermostat set point.

10.3.2 Monitor and record the cavity temperature every 30s for a minimum of 1 h.

10.3.3 As required (as indicated by the average temperature), adjust the temperature control(s) to attain an actual baking cavity temperature of 375 ± 5°F. Repeat 10.3.2 to confirm that the cavity temperature is 375 ± 5°F.

10.3.4 To facilitate further testing, mark on the dial the exact position of the thermostat control(s) that corresponds to an average baking cavity temperature of 375 ± 5°F (analog controls). Record the final thermostat setting.

10.3.5 Repeat 10.3.2-10.3.5 with the controls set to 450°F. This temperature setting is used for the steam performance test (10.6).

10.4 *Preheat Energy Consumption and Time*:

NOTE 6—The preheat test should be conducted as the first appliance operation on the day of the test, starting with the baking cavity at room temperature (75 ± 5°F).

10.4.1 Record oven cavity temperature, steam generator temperature, and ambient temperature at the start of the test. The cavity and steam generator temperature shall be 75 ± 5°F at the start of the test.

10.4.2 Turn the unit on with controls set to maintain an average cavity temperature of 375°F, as determined in 10.3.4.

10.4.3 Record the cavity and steam generator temperatures at least once every 5-s during the course of preheat.

10.4.4 Record the energy and time to preheat the rack oven. Air preheat is judged complete when the temperature at the pressure panel reaches 375°F, as indicated by the thermocouple.

10.4.5 After the oven has cooled for a minimum of 12 h, repeat 10.4.1-10.4.3 with the controls set to maintain an average cavity temperature of 450°F, as determined in 10.3.5.

10.4.6 Record the energy and time to preheat the rack oven. Air preheat is judged complete when the temperature at the pressure panel reaches 450°F, as indicated by the thermocouple.

10.4.7 Continue monitoring time, temperature, and energy consumption until the steam-producing mass has reached 450°F. This is the ready-to-steam preheat.

10.5 *Idle Energy Rate*:

NOTE 7—The idle test may be conducted immediately following the preheat test (10.4).

10.5.1 Preheat the rack oven to 375°F and allow to stabilize for 4 h.

10.5.2 Monitor baking cavity temperature and rack oven energy consumption for an additional 3 h while the rack oven is operated in this condition.

10.5.3 Preheat the rack oven to 450°F and allow to stabilize for 4 h.

10.5.4 Monitor baking cavity temperature and rack oven energy consumption for an additional 3 h while the rack oven is operated in this condition.

10.6 *Pilot Energy Rate (Gas Models with Standing Pilots)*:

10.6.1 Where applicable, set the gas valve that controls gas supply to the appliance at the "pilot" position. Otherwise, set the rack oven temperature controls to the "off" position.

10.6.2 Light and adjust pilots according to the manufacturer's instructions.

10.6.3 Record the gas reading after a minimum of 8 h of pilot operation.

10.7 *Oven Main Cavity Vent Performance*:

NOTE 8—This test is designed to determine the effectiveness of the oven's main cavity vent and does not apply to the overpressure vent.

10.7.1 Measure the area of the vent outlet.

10.7.2 Preheat the rack oven to 375°F and allow to stabilize for 4 h.

10.7.3 Open damper or enable automatic vent.

10.7.4 Measure the airflow at the outlet of the oven vent using a minimum 6-point traverse for each of the three axes (see Fig. 1). Also measure the temperature of the air at the outlet of the vent.

10.8 *Browning Uniformity (White Sheet Cakes)*:

NOTE 9—The objective of this test is to evaluate the browning uniformity of the oven using white sheet cakes. The oven's browning uniformity is reported by describing the browning pattern of the sheet cake baked on each rack. This test is to be performed so that the variation in

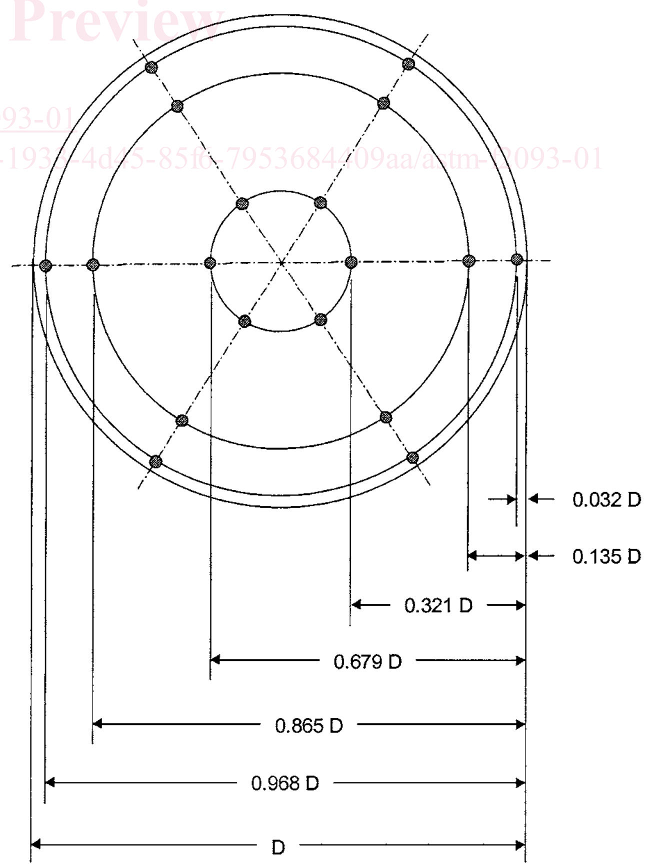

FIG. 1 Measuring Points for Duct Traverse

browning from rack to rack is minimized.

10.8.1 Preheat oven to 375°F and allow to stabilize for 4 h.

10.8.2 Mix cake batter per purveyor's instructions. For single-rack ovens, prepare a minimum of 75 lb of batter; for double-rack ovens, prepare a minimum of 150 lb of batter.

10.8.3 Scale 5.0 ± 0.01 lb of cake batter into each lined, pre-weighed sheet pan. Level the batter in each pan with a spatula. Lightly drop each pan several times to reduce the number of air bubbles in the batter.

10.8.4 Load the filled sheet pans onto the rack(s). Use every pan position available (15 for single-racks and 30 for double-racks).

10.8.5 Record the starting temperature of every other cake.

10.8.6 When the oven cycles off, load the rack(s) into the hot oven. Loading time shall be 45 ± 15 seconds. Begin monitoring time, temperature, and energy consumption when the door is shut.

10.8.7 Test is complete when cakes have turned uniformly brown. Open door and remove the rack(s) within 45 ± 15 seconds.

10.8.8 Determine whether the sheet cakes are done by first inserting a skewer into the center of several cakes. The individual cake is considered done if no moist particles cling to the skewer when it is withdrawn. Whether the cake load is done properly, overdone, or underdone is determined by the color of the cakes. Refer to Fig. 2. If less then 60 % of the cakes are golden or darker in color, the cakes are underdone and the bake time should be lengthened. If 60 % or more of the cakes are dark brown, the cakes are overdone and the bake time should be shortened. If underdone or overdone, the browning uniformity cannot be determined.

10.8.9 If a bake time adjustment is required, repeat 10.8.2-10.8.8 until an acceptable level of doneness is achieved. Record the final bake time.

10.8.10 Record the final temperature of every other cake within 3 minutes ± 15 seconds of removing them from the oven.

10.8.11 Record the final weight of each pan.

10.9 *Steam Performance Frenchand Bread Production Capacity*:

NOTE 10—The objective of this test is to evaluate the steam performance, baking time, and baking uniformity of the oven using French bread. The oven's browning uniformity is reported by describing the browning pattern of the bread baked on each rack. This test is to be performed so that the variation in browning from rack to rack is minimized.

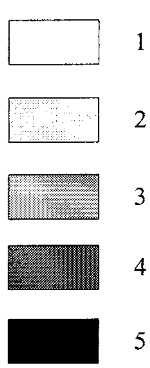

FIG. 2 Color Chart

10.9.1 Pull loaves out of freezer and place 4 loaves on each lined, pre-weighed screen. Place the screens onto proofing racks and cover the racks with rack covers. If the retarder is not large enough to hold the proofing racks, then cover the individual screens with plastic wrap. Load the covered bread dough into the retarder and retard at 35 ± 1°F for a minimum of 12 h.

NOTE 11—The bread dough should not remain in the retarder for more than 24 h as it may begin proofing.

10.9.2 Preheat oven to 450°F and allow to stabilize for 4 h. Set the steam induction timer to 20-s.

10.9.3 Set proof box to attain 90°F and 80 % RH. Preheat proof box for a minimum of 30 min.

10.9.4 Remove one heavy-load of bread dough from the retarder, remove rack covers or plastic wrap, then place on racks and load racks into preheated proof box. Proof bread dough for 60 ± 5 min.

10.9.5 Record the initial weight of the runoff pan.

10.9.6 Remove proofed bread dough from proof box. Using a sharp serrated knife, cut each loaf with four diagonal cuts ¼-in. deep.

10.9.7 Weigh each pan and record the temperature of at least one loaf per every other pan. Allow no more than 10 min to pass from the time the bread dough was removed from the proofer to the time it was placed in the oven.

10.9.8 When the oven cycles off, load the racks into the hot oven. Loading time shall be 45 ± 15 seconds. Begin monitoring time, temperature, water consumption, and energy consumption when the door is shut.

10.9.9 Steam for 20 s, with a 0-s delay.

10.9.10 After 3 min, open damper or enable automatic vent. For manual vents and adjustable automatic venting systems, open the vent for an equivalent of four oven cavity air changes. The required time can be determined by comparing the venting flow rate with the oven cavity volume:

$$t_{vent} = 4 \times V_{cavity}/Q_{vent}$$

where:

t_{vent} = the venting time, min,
V_{cavity} = the measured oven cavity volume, ft^3, and
Q_{vent} = the venting flow rate, as measured in 10.7, cfm.

10.9.11 Bake is complete when bread has turned uniformly dark golden brown (approximately 20 additional minutes—see Fig. 2). Open door and remove the racks within 45 ± 15 seconds.

10.9.12 After removing the racks, shut the oven door and record the time and energy required to return both the cavity and the steam generator to 450°F.

10.9.13 Determine whether the bread is done properly by examining the color of the crust. If less then 60 % of the loaves are golden or darker in color, the bread is underdone and the bake time should be lengthened. If 60 % or more of the loaves are dark brown, the bread is overdone and the bake time should be shortened. If underdone or overdone, the browning uniformity cannot be determined.