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An American National Standard

Standard Test Method for Performance of Large Open Vat Fryers[1]

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ε[1] NOTE—Sections 2.2 and 9.3 were editorially corrected in February 2005.

1. Scope

1.1 This test method evaluates the energy consumption and cooking performance of large-vat open, deep fat fryers. The food service operator can use this evaluation to select a fryer and understand its energy efficiency and production capacity.

1.2 This test method is applicable to floor model gas and electric fryers with 50 lbs and greater fat capacity and an 18-in. and larger vat size.

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

1.3.1 Energy input rate (10.2),

1.3.2 Preheat energy and time (10.4),

1.3.3 Idle energy rate (10.5),

1.3.4 Pilot energy rate (10.6, if applicable),

1.3.5 Cooking energy rate and efficiency (10.9), and

1.3.6 Production capacity and frying medium temperature recovery time (10.9).

1.4 This test method is not intended to answer all performance criteria in the evaluation and selection of a fryer, such as the significance of a high energy input design on maintenance of temperature within the cooking zone of the fryer.

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

1.6 *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:* [2]

F 1361 Test Method for Performance of Open Deep Fat Fryers

2.2 *ANSI Document:*[3]

ANSI Z83.11 American National Standard for Gas Food Service Equipment

2.3 *AOAC Document:*[4]

AOAC Official Action 950.46, Air Drying to Determine Moisture Content of Meat and Meat Products

2.4 *ASHRAE Document:*[5]

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

3. Terminology

3.1 *Definitions:*

3.1.1 *large vat fryer*, *n*—(hereafter referred to as fryer) an appliance designed for cooking large quantities of fish or chicken, in which oils are placed in the cooking vessel to such a depth that the cooking food is essentially supported by displacement of the cooking fluid rather than by the bottom of the vessel. Often referred to as chicken or fish fryers.

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cold zone*, *n*—the volume in the fryer below the heating elements or heat exchanger surface designed to remain cooler than the cook zone.

3.2.2 *cooking energy*, *n*—total energy consumed by the fryer as it is used to cook breaded chicken product under heavy- and light-load conditions.

3.2.3 *cooking energy efficiency*, *n*—quantity of energy imparted to the chicken during the cooking process expressed as a percentage of the quantity of energy consumed by the fryer during the heavy- and light-load tests.

3.2.4 *cooking energy rate*, *n*—average rate of energy consumed by the fryer while "cooking" a heavy or light load of chicken.

[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] 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 National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[4] Available from the Association of Official Analytical Chemists, 1111 N. 19th Street, Arlington, VA 22209.

[5] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

3.2.5 *cook zone*, *n*—the volume of oil in which food is cooked.

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

3.2.7 *idle energy rate*, *n*—average rate of energy consumed (Btu/h or kW) by the fryer while "holding" or "idling" the frying medium at the thermostat(s) set point.

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

3.2.9 *preheat energy*, *n*—amount of energy consumed (Btu or kWh) by the fryer while preheating the frying medium from ambient room temperature to the calibrated thermostat(s) set point.

3.2.10 *preheat rate*, *n*—the average rate (°F/min) at which the frying medium temperature is heated from ambient temperature to the fryer's calibrated thermostat(s) set point.

3.2.11 *preheat time*, *n*—time required for the frying medium to preheat from ambient room temperature to the calibrated thermostat(s) set point.

3.2.12 *production capacity*, *n*—maximum rate (lb/h) at which a fryer can bring the specified food product to a specified "cooked" condition.

3.2.13 *production rate*, *n*—average rate (lb/h) at which a fryer brings the specified food product to a specified "cooked" condition. Production rate does not necessarily refer to maximum rate (production capacity). but varies with the amount of food being cooked.

3.2.14 *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

NOTE 1—All of the fryer tests shall be conducted with the fryer installed under a wall-mounted canopy exhaust ventilation hood that shall operate at an air flow rate based on 300 cfm per linear foot (460 L/s per linear metre) of hood length. Additionally, an energy supply meeting the manufacturer's specifications shall be provided for the gas or electric fryer under test.

4.1 The fryer under test is connected to the appropriate, metered energy source. The measured energy input rate is determined and checked against the rated input before continuing with testing.

4.2 The frying medium temperature in the cook zone is monitored at a location chosen to represent the average temperature of the frying medium while the fryer is "idled" at 325°F. Fryer temperature calibration to 325°F is achieved at the location representing the average temperature of the frying medium.

4.3 The preheat energy and time and idle energy rate are determined while the fryer is operating with the thermostat(s) set at a calibrated 325°F. The rate of pilot energy consumption also is determined, when applicable, to the fryer under test.

4.4 Energy consumption and time are monitored while the fryer is used to cook breaded, 8-piece-cut frying chicken to a 27 ± 2 % weight loss with the thermostats set at a calibrated 325°F. Cooking energy efficiency, cooking energy rate, and production rate are determined for heavy-, medium-, and light-load tests. Production capacity is based on the heavy-load test.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the fryer under test is operating in accordance with its nameplate rating.

5.2 Fryer temperature calibration is used to ensure that the fryer being tested is operating at the specified temperature. Temperature calibration also can be used to evaluate and calibrate the thermostat control dial.

5.3 Preheat energy and time can be used by food service operators to manage their restaurants' energy demands, and to estimate the amount of time required for preheating a fryer.

5.4 Idle energy rate and pilot energy rate can be used to estimate energy consumption during noncooking periods.

5.5 Preheat energy, idle energy rate, pilot energy rate, and heavy-, medium-, and light-load cooking energy rates can be used to estimate the fryer's energy consumption in an actual food service operation.

5.6 Cooking energy efficiency is a direct measurement of fryer efficiency at different loading scenarios. This information can be used by food service operators in the selection of fryers, as well as for the management of a restaurant's energy demands.

5.7 Production capacity is used by food service operators to choose a fryer that matches their food output requirements.

6. Apparatus

6.1 *Analytical Balance Scale*, for measuring weights up to 50 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 *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. Makeup air shall be delivered through the face registers and/or from the space.

6.4 *Convection Drying Oven*, with temperature controlled at 215 to 220°F, used to determine moisture content of both the raw and cooked food product.

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

6.6 *Fry Baskets*, chrome-plated steel construction, supplied by the manufacturer of the fryer under test. At least four baskets are required to test each fryer according to this protocol.

6.7 *Gas Meter*, for measuring the gas consumption of a fryer, 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.

6.8 *Pressure Gage*, 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.

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

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

6.11 *Thermocouple(s)*, Polytetrafluoroethylene-insulated, 24 gauge, type T or type K thermocouples capable of immersion with a range of 50° to 400°F and an uncertainty of ± 1°F.

6.12 *Thermocouple Probe(s)*, "fast response" type T or type K thermocouple probe, 1⁄16 in. or smaller diameter, with a 3-s response time, capable of immersion with a range of 30° to 250°F and an uncertainty of ± 1°F.

6.13 *Watt-Hour Meter*, for measuring the electrical energy consumption of a fryer, 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 *Enriched Flour*—Order a sufficient quantity of all-purpose, enriched white flour to conduct the heavy-, medium-, and light-load tests.

7.2 *Chicken Pieces*—Order sufficient quantity of eight-piece-cut 2¾-pound individually quick-frozen (IQF) frying chickens to conduct the heavy-, medium-, and light-load cooking tests.

7.3 *Cooling Racks*—Stainless steel construction, measuring 18 by 26 in. with 1-in. high feet. Used for draining thawed chicken.

7.4 *Dipping Solution*—8 % (by weight) salt water solution at 75°F.

7.5 *Bucket*—Food grade, 5-gallon bucket for coating the chicken pieces in a dipping solution.

7.6 *Breading Bin*—or food storage box, made from food-grade plastic, measuring 18 by 26 by 9 in. for coating the chicken pieces in flour breading.

7.7 *Frying Medium*—Shall be partially hydrogenated, 100 % pure vegetable oil. New frying medium shall be used for each fryer tested in accordance with this test method. The new frying medium that has been added to the fryer for the first time shall be heated to 325°F at least once before any test is conducted.

NOTE 2—Mel-fry[6] partially hydrogenated all vegetable oil (soybean oil) has been shown to be an acceptable product for testing by PG&E

7.8 *Sheet Pans*—Measuring 18 by 26 by 1 in., for holding the thawed chicken.

7.9 *Tongs*—Heavy duty, 15-in. tongs for holding hot pieces of chicken.

[6] Available from Van Den Berg Foods, 3701 Southwestern Blvd., Baltimore, MD 21229.

8. Sampling, Test Units

8.1 *Fryer*—A representative production model shall be selected for performance testing.

9. Preparation of Apparatus

9.1 Install the appliance according to the manufacturer's instructions under a 4-ft–deep canopy exhaust hood mounted against the wall with the lower edge of the hood 6 ft, 6 in. from the floor. Position the fryer with the front edge of frying medium inset 6 in. from the front edge of the hood at the manufacturer's recommended working height. The length of the exhaust hood and active filter area shall extend a minimum of 6 in. past the vertical plane of both sides of the fryer. In addition, both sides of the fryer shall be a minimum of 3 ft from any side wall, side partition, or other operating appliance. A "drip" station positioned next to the fryer is recommended. The exhaust ventilation rate shall be based on 300 cfm per linear foot of hood length. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 5°F within the testing environment when the exhaust system is operating.

9.2 Connect the fryer to a calibrated energy test meter. For gas installations, a pressure regulator shall be installed downstream from the meter to maintain a constant pressure of gas for all tests. Both the pressure and temperature of the gas supplied to a fryer, as well as the barometric pressure, shall be recorded during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, a voltage regulator may be required to maintain a constant "nameplate" voltage during tests if the voltage supply is not within ± 2.5 % of the manufacturer's "nameplate" voltage.

9.3 For a gas fryer, adjust (during maximum energy input) the gas supply pressure downstream from the fryer's pressure regulator to within ± 2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the fryer following the manufacturer's recommendations for optimizing combustion. Proper combustion may be verified by measuring air-free CO in accordance with ANSI Z83.11.

9.4 For an electric fryer, confirm (while the fryer 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 fryer at its rated gas pressure or electric voltage. If an electric fryer is rated dual voltage (that is, designed to operate at either 208 or 240 V with no change in components), the voltage selected by the manufacturer and/or tester shall be reported. If a fryer is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the fryer (for example, preheat time) may differ at the two voltages.

9.5 Make fryer ready for use in accordance with the manufacturer's instructions. Clean fryer by "boiling" with the manufacturer's recommended cleaner and water and then rinsing the inside of the fry-pot thoroughly.

9.6 To prepare the fryer for temperature calibration, attach an immersion type thermocouple in the fry pot before beginning any tests. The thermocouple used to calibrate the fryer shall be located within 1-in. of the tip of the thermostat probe. If it is not possible to locate a thermocouple near the thermostat

probe, position the thermocouple at the rear of the fry pot, 2 in. below the oil fill line and ½ in. from rear wall of the fry pot.

9.7 Cook zone temperature shall be measured using an immersion type thermocouple in the fry vat before beginning any tests. The thermocouple shall be placed in the center of the fry vat, about 1 in. (25 mm) up from the platform the fry baskets rest on.

NOTE 4—For single-basket or split-vat fryers, the thermocouple may be placed at about ⅛ in. (3 mm) up from the platform the fry baskets rest on.

9.8 Cold zone temperature shall be measured using an immersion-type thermocouple placed 0.5 in. (12 mm) above the bottom and 1 in. (25 mm) away from the rear wall of the fry vat. The portion of the rear wall not immersed in oil may be used for thermocouple support.

10. Procedure

10.1 *General*:

10.1.1 For gas fryers, 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.

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 fryer 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 fryers, add electric energy consumption to gas energy for all tests, with the exception of the energy input rate test (10.2).

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

10.1.3.1 Voltage while elements are energized.

10.1.3.2 Ambient temperature.

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 fryer.

10.2 *Energy Input Rate*:

10.2.1 Load fryer with water to the indicated fill line and turn the fryer on with the temperature controls set to the maximum setting possible.

10.2.2 For gas fryers, operate the unit for a period of 15 min, then monitor the time required for the fryer to consume 5 ft^3 of gas. Adjustments to input rate may be made by adjusting gas manifold pressure.

10.2.3 For electric fryers, monitor the energy consumption for 15 min with the controls set to achieve maximum input. If the unit begins cycling during the 15 min interval, record the time and energy consumed for the time from when the unit was first turned on until it begins cycling.

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

10.3 *Calibration*:

10.3.1 Ensure that frying medium is loaded to the indicated fryer fill line. Preheat to 325°F and allow the fryer to stabilize for 30 min before beginning temperature calibration.

10.3.2 The frying medium temperature shall be measured by attaching a calibrated immersion type thermocouple in the cook zone as detailed in 9.7. The median temperature recorded over three complete thermostat cycles at this point shall be considered as the average temperature for the frying medium.

10.3.3 Where required, adjust the fryer temperature control(s) to calibrate the fryer at an average frying medium temperature of 325 ± 5°F. Record the frying medium temperature over three cycles and average the temperatures over the three cycles to verify that the average measured temperature at the frying medium sensor location is 325 ± 5°F.

10.4 *Preheat Energy and Time*:

10.4.1 Ensure that frying medium is loaded to the indicated fryer fill line. Record frying medium temperature and ambient kitchen temperature at the start of the test. Frying medium temperature shall be 75 ± 5°F at the start of the test.

10.4.2 With the fry pot uncovered, turn the fryer on with the temperature controls set to attain a temperature within the frying medium of a calibrated 325°F.

10.4.3 Begin monitoring energy consumption, time, and temperature as soon as the fryer is turned on. For a gas fryer, the preheat time shall include any delay between the time the unit is turned on and the burners actually ignite. Preheat is judged complete when the temperature at the monitored location reaches 325°F.

10.5 *Idle Energy Rate*:

10.5.1 Ensure that frying medium is loaded to the indicated fryer fill line.

10.5.2 Preheat to 325°F and allow frying medium to stabilize at 325°F for at least 30 min after the last thermostat has commenced cycling at the thermostat set point.

10.5.3 Monitor the elapsed time, temperature, and energy consumption of the fryer while it is operated under this "idle" condition for a minimum of 2 h. The fryer shall remain uncovered throughout this idle test.

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

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

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

10.6.3 Record gas reading, electric energy consumed and time before and after a minimum of 8 h of pilot operation.

10.7 *Test Product Preparation*:

10.7.1 Prepare enough chicken for a minimum of 4 runs each for heavy-, medium-, and light-load tests. Table 1 lists the heavy-load sizes, based on nominal fryer size. Each heavy-load shall have an equal number of breasts, thighs, legs and wings. If the manufacturer's recommended load size is less than that determined by Table 1, the manufacturer's recommendations should be followed. For example, a fryer with a nominal tank size of 18 × 14 in. will require 48 pieces for a heavy load. For the medium-load tests, use half of the number of pieces comprising a heavy-load. Ensure that equal amounts of breast, thighs, legs, and wings comprise the medium-load. For the light-load tests, use 8 pieces (2 of each type of piece).

10.7.2 The chicken may be thawed by immersing it in cold running water. Place the thawed chicken on a drip rack on a sheet pan and cover with plastic wrap. Place the covered chicken in the refrigerator.

NOTE 6—Unless the chicken has been continuously held below 40°F, it may be unsafe and should not be eaten.

10.7.3 Monitor the internal temperature of a sample piece of chicken with a thermocouple probe. Its internal temperature must reach 38 to 40°F before the chicken can be removed from the refrigerator and breaded. If necessary, adjust the refrigerator temperature to achieve this required internal temperature.

10.7.4 Prepare the dipping solution by dissolving salt in 2½ gal tap water to achieve an 8 % (by weight) salt-water solution. Pour the solution in a food grade bucket and allow to stabilize at room temperature (75 ± 5°F).

10.7.5 Pour enough flour to fill the breading bin half-way. Allow to stabilize at room temperature.

10.7.6 Remove the chicken pieces from the refrigerator and immerse briefly in the dipping solution. Remove the chicken pieces from the solution and allow to drip briefly over the dipping container. Transfer the dipped pieces of chicken to the breading bin. Assure that each piece is evenly coated on all sides.

10.7.7 Place the breaded pieces uncovered on a sheet pan and place the sheet pan in the refrigerator. Allow the chicken to stabilize at the 38 to 40°F refrigerator temperature.

NOTE 7—If the breaded chicken is not cooked within 24 hours, it should be covered with plastic wrap. Thawed chicken should not be stored in the refrigerator for more than 1 week.

10.8 *Cook Time Determination*:

NOTE 8—This is a trial and error procedure and may take several iterations to obtain the correct cook time.

TABLE 1 Sample Heavy-Load Sizes Based on Nominal Tank Size

Fryer Nominal Tank Size	Heavy-Load Size
18 × 14	48 pieces
18 × 18	64 pieces
18 × 20	72 pieces
18 × 24	84 pieces
20 × 20	80 pieces
20 × 24	92 pieces
24 × 24	112 pieces
34 × 24	160 pieces

10.8.1 Ensure that frying medium is loaded to the indicated fryer fill line. Confirm that the frying medium temperature is 325 ± 5°F as calibrated in 10.3. Allow the fryer to stabilize for 30 min at 325°F.

10.8.2 After the 30 min stabilization, vigorously stir the cold zone with a long spoon or equivalent for 5 min ± 30 s (fryers with cold zones).

NOTE 9—While it is recognized that stirring the cold zone is not practiced in industry, it is included in this procedure because stirring provides a simple way to eliminate the variations in cold zone temperature that could cause a significant fluctuation in the measured cooking energy efficiency. To make the cooking energy efficiency test repeatable, the cold zone must be at the same temperature when beginning each test. This is accomplished with minimal time and effort through manual stirring.

10.8.3 Ten ± 1 min after stirring the cold zone, begin the initial cook time determinations. Estimate a cook time for the first heavy-, medium-, and light-load cooking tests. A separate cook time determination shall be done for each loading scenario. Do not assume the same cook time for the heavy-, medium-, and light-loads.

10.8.4 Measure and record the initial temperature of 8 (2 of each type of piece) randomly selected pieces by inserting a fast response thermocouple probe into a thick (meaty) portion of each piece.

10.8.5 Place the chicken pieces into the fry baskets (equal amounts of pieces in each basket), starting with the largest pieces (thighs and breasts). Record the initial weight of the chicken pieces.

10.8.6 When the fryer has cycled off, place the loaded baskets into the fry pot and commence monitoring the cook time. To minimize product clumping, vigorously stir the chicken pieces for 5 s.

10.8.7 When the estimated cook time has elapsed (as determined by a stopwatch or computer), cancel the cooking cycle.

10.8.8 Lift the baskets and allow to drain over the fryer for approximately 15 s. Then pour the contents of the baskets onto a sheet pan.

10.8.9 Measure and record the final temperature of 8 (2 of each type of piece) randomly selected pieces by inserting a fast response thermocouple probe into a thick (meaty) portion of each piece.

10.8.10 Weigh and record the weight of the cooked load. The weight loss shall be 27 ± 2 %.

10.8.11 Wash and dry the fry basket between loads, making sure to remove any food product that may have stuck to the inside of the basket. Allow the basket to return to room temperature (75 ± 5°F) prior to reloading it with chicken pieces.

10.8.12 If the percent weight loss is not 27 ± 2 %, repeat 10.8.4-10.8.12, adjusting the total cooking time to attain the 27 ± 2 % weight loss. Subsequent loads may be inserted into the fryer when the oil temperature has returned to 325 ± 5°F.

10.8.13 Use the cooking times established for heavy-, medium-, and light-load conditions for the cooking energy efficiency determination and production capacity tests (10.9).

10.9 *Cooking Energy Efficiency and Production Capacity for Heavy-, Medium- and Light-Load Fry Tests*:

NOTE 10—Section 10.10 of Test Method F 1361 can be applied for determining cooking energy efficiency and production capacity for heavy-, medium-, and light-load french fry tests.

10.9.1 The cooking energy efficiency and production capacity tests are to be run a minimum of three times. Additional test runs may be necessary to obtain the required precision for the reported test results (see Annex A1). The minimum three test runs for each loading scenario shall be run on the same day.

10.9.2 Set aside four raw, breaded pieces of chicken (one of each type) for moisture content determination in accordance with recognized laboratory procedures (AOAC Official Action 950.46). Place the sample in a self-sealing bag in the freezer unless the moisture content test is run immediately. This will be used for determining the energy of vaporization component of the cooking energy efficiency equation.

10.9.3 Ensure that frying medium is loaded to the indicated fryer fill line. Confirm that the frying medium temperature is 325 ± 5°F as calibrated in 10.3. Allow the fryer to stabilize for 30 min after being turned on.

10.9.4 After the 30 min stabilization, vigorously stir the cold zone with a long spoon or equivalent for 5 min ± 30 s (fryers with cold zones). Allow the fryer to idle for 10 ± 1 min.

10.9.5 Measure and record the initial temperature of 8 (2 of each type of piece) randomly selected pieces by inserting a fast response thermocouple probe into a thick (meaty) portion of each piece.

10.9.6 Place the chicken pieces into the fry baskets (equal amounts of pieces in each basket), starting with the largest pieces (thighs and breasts). Record the initial weight of the chicken pieces.

10.9.7 When the fryer has cycled off, place the loaded baskets into the fry pot and commence monitoring the cook time, oil temperature, and fryer energy consumption. To minimize product clumping, vigorously stir the chicken pieces for 5 s.

10.9.8 When the cook time determined in 10.8 has elapsed, cancel the cooking cycle.

10.9.9 Lift the baskets and allow to drain over the fryer for approximately 15 s.

10.9.10 Measure and record the temperature of 8 (2 of each type of piece) randomly selected pieces by inserting a fast response thermocouple probe into a thick (meaty) portion of each piece.

10.9.11 Weigh and record the weight of the cooked load. The weight loss shall be 27 ± 2 %. If the weight loss is not 27 ± 2 %, the test is invalid and must be repeated.

10.9.12 Terminate the test after removing the load and allowing the cook zone thermocouple to indicate that the oil temperature has recovered to 325 ± 5°F or after 30 s, whichever is longer. Record the elapsed time and energy consumption.

10.9.13 Reserve 4 pieces of cooked chicken (one of each type of piece) for determining the moisture content. Unless the moisture content test is conducted immediately, place the chicken pieces in a self-sealing plastic bag and place the bag in the freezer.

10.9.14 Wash and dry the fry baskets between loads, making sure to remove any food that may be stuck on the inside of the basket. Allow the basket to return to room temperature (75 ± 5°F) prior to reloading them with uncooked chicken pieces.

10.9.15 Immediately perform runs nos. 2 and 3 by repeating 10.9.5-10.9.17, using clean, dry, room-temperature (75 ± 5°F) fry baskets. Follow the procedure in Annex A1 to determine whether more than three test runs are required.

NOTE 11—Replicate test runs should be run immediately after the 30-s preparation time or the frying medium has returned to 325°F ± 5°F.

10.9.16 Determine the moisture content of the previously reserved chicken pieces for each test run in accordance with recognized laboratory procedures (AOAC Official Action 950.46) and calculate the moisture loss based on the initial moisture content of the chicken pieces (10.9.2). This will be used to determine the energy of vaporization component of the cooking energy efficiency equation.

10.9.17 Repeat 10.9.1-10.9.17 for medium- and light-load scenarios.

11. Calculation and Report

11.1 *Test Fryer*:

11.1.1 Summarize the physical and operating characteristics of the fryer. 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 conform to all of the specifications in Section 6. Describe any deviations from those specifications.

11.2.2 For electric fryers, report the voltage for each test.

11.2.3 For gas fryers, report the higher heating value of the gas supplied to the fryer during each test.

11.3 *Gas Energy Calculations*:

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

11.3.2 For all gas measurements calculate the energy consumed based on:

$$E_{gas} = V \times HV \tag{1}$$

where:

E_{gas} = energy consumed by the fryer,
HV = higher heating value,
= energy content of gas measured at standard conditions, Btu/ft^3,
V = actual volume of gas corrected for temperature and pressure at standard conditions, ft^3, and
= $V_{meas} \times T_{cf} \times P_{cf}$

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 temp* °F + 459.67] °R
P_{cf} = pressure correction factor
= *absolute actual gas pressure* psia / *absolute standard pressure* psia