



Standard Guide for Laboratory Requirements Necessary to Test Commercial Cooking and Warming Appliances to ASTM Test Methods¹

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1. Scope

1.1 The scope of this guide includes the laboratory and organizational requirements to test commercial cooking and warming appliances (for example, griddles, fryers, ovens, steam cookers, and hot food holding cabinets) for preheat energy consumption and time, idle energy rate, cooking-energy efficiency, and production capacity, in accordance with the appropriate ASTM test methods under the jurisdiction of Committee F26, including the following:

Test Method	F1275
Test Method	F1361
Test Methods	F1484
Test Method	F1496
Test Methods	F1521
Test Method	F1605
Test Method	F1639
Test Method	F1695
Test Method	F1784
Test Method	F1785
Test Method	F1786
Test Method	F1787
Test Method	F1817
Test Method	F1964
Test Method	F1965
Test Method	F1991
Test Method	F2093
Test Method	F2140
Test Method	F2142
Test Method	F2144
Test Method	F2237
Test Method	F2238
Test Method	F2239
Test Method	F2380
Test Method	F2473

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

1.3 *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 appro-*

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

2. Referenced Documents

2.1 ASTM Standards:²

- F1275 Test Method for Performance of Griddles
- F1361 Test Method for Performance of Open Deep Fat Fryers
- F1484 Test Methods for Performance of Steam Cookers
- F1496 Test Method for Performance of Convection Ovens
- F1521 Test Methods for Performance of Range Tops
- F1605 Test Method for Performance of Double-Sided Griddles
- F1639 Test Method for Performance of Combination Ovens (Withdrawn 2012)³
- F1695 Test Method for Performance of Underfired Broilers
- F1784 Test Method for Performance of a Pasta Cooker
- F1785 Test Method for Performance of Steam Kettles
- F1786 Test Method for Performance of Braising Pans
- F1787 Test Method for Performance of Rotisserie Ovens
- F1817 Test Method for Performance of Conveyor Ovens
- F1964 Test Method for Performance of Pressure Fryers
- F1965 Test Method for Performance of Deck Ovens
- F1991 Test Method for Performance of Chinese (Wok) Ranges
- F2093 Test Method for Performance of Rack Ovens
- F2140 Test Method for Performance of Hot Food Holding Cabinets
- F2142 Test Method for Performance of Drawer Warmers
- F2144 Test Method for Performance of Large Open Vat Fryers
- F2237 Test Method for Performance of Upright Overfired Broilers
- F2238 Test Method for Performance of Rapid Cook Ovens
- F2239 Test Method for Performance of Conveyor Broilers
- F2380 Test Method for Performance of Conveyor Toasters

¹ This guide 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 The last approved version of this historical standard is referenced on www.astm.org.

F2473 Test Method for Performance of Water-Bath Rethermalizers**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 appliance during the cooking event.

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

3.1.3 *energy input rate, n*—peak rate at which an appliance consumes energy, Btu/h (kJ/h) or kW.

3.1.4 *idle energy rate, n*—an appliance's rate of energy consumption while maintaining a ready-to-cook or hold state at a specified thermostat set point, Btu/h (kJ/h) or kW, .

3.1.5 *pilot energy rate, n*—rate of energy consumption by an appliance's continuous pilot (if applicable), Btu/h (kJ/h).

3.1.6 *preheat energy, n*—amount of energy consumed by the appliance while warming the cooking or holding area from ambient temperature to the specified thermostat set point, Btu (kJ) or kWh.

3.1.7 *preheat time, n*—time required for the appliance to warm the cooking or holding area from ambient temperature to the specified thermostat set point, min.

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

3.1.9 *production rate, n*—rate at which an appliance brings the specified food product to a specified "cooked" condition, lb/h (kg/h).

NOTE 1— Does not necessarily refer to maximum rate.

NOTE 2—Production rate varies with the amount of food being cooked.

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

4. Summary of Guide

4.1 Guide to outline requirements for laboratories to test to ASTM performance specifications for commercial cooking appliances that include the necessary organizational structure, facility, equipment, instrumentation, procedures, reporting and proficiency testing.

5. Significance and Use

5.1 This guide provides criteria for evaluating the capability of a laboratory to properly perform commercial cooking appliance energy consumption and cooking-energy efficiency evaluations, and to establish essential characteristics pertaining to the organization, personnel, facilities, and quality systems of the laboratory.

6. Organization of the Laboratory

6.1 The following information concerning the organization of the laboratory shall be provided by documentation:

6.1.1 A description of the organization including:

6.1.1.1 The complete legal name and address of the main office,

6.1.1.2 The names and positions of the principal officers and directors,

6.1.1.3 The laboratory's ownership, managerial structure, and principal members,

6.1.1.4 The functional description of the laboratory's organizational structure, operational departments, and support departments and services. This may be demonstrated in the form of charts that depict all the divisions, departments, sections, and units and their relationships,

6.1.1.5 All relevant organizational affiliates of the laboratory and the principal officers of affiliates and directors of the affiliates, where applicable,

6.1.1.6 External organizations and organizational components, and their functions, that are utilized for significant technical support services, and

6.1.1.7 A brief history of the laboratory including its relationship with its organizational component affiliations and other supporting information.

6.1.2 A general description of the type of users of the laboratory's services.

6.1.3 A listing of the relevant technical services offered.

6.2 Independence:

6.2.1 If the testing laboratory is part of an organization performing activities other than testing or calibration, or both, the laboratory shall define the responsibilities of key personnel in the organization that have an involvement or influence on the testing, equipment purchase, test data, reports, and calibration activities, or combination thereof, of the laboratory in order to identify potential conflicts of interest.

6.2.2 When a laboratory is part of a larger organization, the organizational arrangements shall be such that departments having conflicting interests, such as design engineering, production, commercial marketing, or finance do not adversely influence the laboratory's compliance with the requirements of this guide.

6.2.3 If the laboratory wishes to be recognized as a third-party laboratory, it shall demonstrate that it is impartial and that it and its personnel are free from any undue commercial and financial pressures and job performance evaluations that might influence their technical judgment. The third-party testing or calibration laboratory shall not engage in any activities that may endanger trust in its independence of judgment and integrity in relation to its testing or calibration activities.

7. Responsibilities and Duties

7.1 An appliance testing laboratory's capabilities shall include, but not be limited to, the following (where applicable): preheat energy consumption and time, idle energy rate, cooking-energy efficiency, and production capacity, as defined in the appropriate ASTM test methods.

7.2 It is the responsibility of the laboratory to ensure the following:

7.2.1 It performs only examinations for which it is adequately equipped and staffed,

7.2.2 Its employees perform only examinations for which they are adequately qualified,

7.2.3 Its equipment is calibrated and its personnel are qualified, and

7.2.4 All equipment, equipment calibrations, and personnel qualifications are properly maintained in accordance with this guide.

7.3 The following duties are those usually performed by the laboratory:

7.3.1 Performance of all testing in accordance with the specified ASTM test methods, and

7.3.2 Preparation of formal reports of all the results of the testing defined in 7.3.1. The laboratory shall be prepared to substantiate examination results when required.

7.4 The laboratory shall maintain a records retention policy that is compatible with its mission.

8. Personnel

8.1 The laboratory shall document and maintain a record of the following:

8.1.1 Written outline or chart defining operational personnel positions and their lines of responsibility and authority,

8.1.2 Job description for each professional, scientific, supervisory, and technical position category, documenting the required education, training, or experience, or a combination thereof.

8.1.3 Records or resumes that document the qualifications, work experience, and training history of each person in a position described in 8.1.2.

8.1.4 The laboratory shall make available a description of its means of ensuring the continued competence of its personnel to perform commercial cooking appliance testing, including the maintenance of written records to document the results.

9. Personnel Qualification

9.1 Commercial cooking appliance testing personnel, including contracted personnel, shall be qualified with a minimum of two years post-secondary education or equivalent work experience, be proficient in data acquisition and recording of energy measurement, water measurement, and temperature systems, and be able to operate data acquisition hardware and related software.

9.2 *LEVEL I*—Qualified to perform specific calibrations, specific examinations and specific evaluations (with specific written instructions).

9.3 *LEVEL II*—Qualified to set-up and calibrate equipment and to interpret and evaluate results with respect to codes, standards, and specifications. Shall be able to prepare written instructions and be qualified to provide on-the-job training, guidance to trainees, and to report examination results.

9.4 *LEVEL III*—Capable and responsible for establishing techniques, interpreting codes, and designating the test method and technique to be used. Capable of training Level I and II personnel. Shall have a practical background in the technology and be familiar with other commonly used methods.

10. Procedures Manual

10.1 The laboratory shall prepare a written or electronic procedures manual for the type of work for which the labora-

tory is contracted. Additional requirements or clarifications are contained in 10.2 through 10.6. The Procedures Manual shall be of sufficient detail to provide complete guidance on its use to the laboratory personnel.

NOTE 3—The procedures manual may include multiple volumes for each type of work conducted by the testing laboratory.

10.1.1 The laboratory management shall designate a person or persons within the laboratory who shall have responsibility for maintaining the laboratory's quality system. This person or persons shall have direct access to top management. This person or persons shall ensure that an internal audit is conducted at least once every year to verify that the quality system is functioning properly as documented in the Procedures Manual.

10.1.2 The laboratory shall maintain a record of changes to the Procedures Manual.

10.2 *Operational Procedures*—This section shall contain the information necessary to control the various activities necessary for testing appliances. Items covered shall include receiving and preparing samples, identification and marking, test procedures and specifications to be used, reports, and return of samples.

10.3 *Personnel Qualification*—This section shall contain the requirements and procedures for training, as outlined in Section 9.1.

10.4 *Equipment Maintenance and Calibration*—All test equipment shall be calibrated and traceable to the National Institute of Standards and Technology (NIST) or equivalent. This section shall contain all of the following:

10.4.1 *Inventory Listing*—All available equipment shall be listed with the following information noted:

10.4.1.1 Name of the manufacturer,

10.4.1.2 Equipment model and serial number,

10.4.1.3 Characteristics subject to calibration,

10.4.1.4 Range of operation and range of calibration,

10.4.1.5 Reference to recognized standardization procedures acceptable to the authority, if applicable,

10.4.1.6 Frequency of calibration,

10.4.1.7 Allowable tolerances or maximum sensitivity, and

10.4.1.8 Source of verification,

10.4.2 *Calibration*—Each instrument, when calibration is required, shall have either a calibration sticker affixed or record of certification on file, containing the following:

10.4.2.1 Instrument calibrated,

10.4.2.2 Serial number,

10.4.2.3 Calibration date,

10.4.2.4 Calibration next due date, and

10.4.2.5 Name of individual who performed last calibration.

If calibration is not required, a sticker stating “no calibration is necessary” shall be affixed, or a record shall be on file to this effect.

10.4.2.6 Equipment that has been subjected to overloading or mishandling, gives suspect results, or has been shown to be defective or outside specified limits, shall be taken out of service. It shall be isolated to prevent its use or clearly labeled or marked as being out of service until it has been repaired and shown by calibration or testing to perform correctly. The

laboratory shall examine the effect of the defect or departure from specified limits on previous tests or calibrations, or both, and shall institute the following measures:

(1) The laboratory shall have a procedure that shall be implemented when any aspect of its testing or calibration work, or both, or the results of this work, do not conform to its own procedure or the agreed requirements of the customer. The procedure shall ensure that:

(a) The laboratory shall demonstrate a means by which any tests determined to be in error due to calibration issues or malfunctions can be traced back to specific test programs that may have been affected by the malfunctioning equipment,

(b) The laboratory shall demonstrate a means to notify the certifying body when the laboratory determines the tests may have been in error in such a way as to present results that are considered more favorable from a consumer perspective than the required minimum values,

(c) Correction is taken immediately, together with any decision about the acceptability of the nonconforming work,

(d) Where necessary, the customer is notified and work is recalled, and

(e) The responsibility for authorizing the resumption of work is defined.

10.4.3 Equipment typically required in accordance with referenced ASTM standards to conduct test. See individual test methods (see Section 2) for specific equipment requirements:

10.4.3.1 *Data Acquisition System*, verified to a calibrated instrument for all measurements used in the testing before and after a battery of tests on a specific appliance to ensure accurate data.

10.4.3.2 *Electric Energy Meter*, with a resolution of at least 10 Wh and an uncertainty less than 1.5 % 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 an uncertainty less than 10 %. Calibrate annually.

10.4.3.3 *Gas Consumption Meter*, positive displacement type, with a resolution of at least 0.01 ft³ (0.0003 m³) and an uncertainty less than 1 % for any demand greater than 5 ft³/h (0.06 m³/h). For any demand less than 5 ft³/h (0.06 m³/h), the meter shall have a resolution of at least 0.005 ft³ (0.00015 m³) and an uncertainty less than 5 %. Calibrate annually.

10.4.3.4 *Gas Heat Capacity*—Calorific value measured on-site during testing either by gas calorimeter, bagged sample, or equivalent, with an uncertainty $\pm 1\%$. Calibrate annually.

10.4.3.5 *Surface Temperature Thermometer*—temperature sensor, with a range from -10 to 400°F and an uncertainty of $\pm 1^\circ\text{F}$ (0.56°C), verified prior to testing.

10.4.3.6 *Velometer*—Shall have a minimum reading of 50 ft/min and an accuracy of 2 %. Calibrate annually.

10.4.3.7 *Supply Gas Temperature*—Gas temperature in the range from 50 to 100°F (10 to 93°C) with an uncertainty of $\pm 2^\circ\text{F}$ (1°C). Calibrate annually.

10.4.3.8 *Supply Gas Pressure*—with a range from 0 to 15 in. of water (0 to 3.7 kPa), a resolution of 0.1 in. of water, and a maximum uncertainty of 1 %. Calibrate annually, unless gravity-operated devices (for example, U-Tube manometer) are used. Gravity-operated devices are considered primary standards and do not require annual calibration.

10.4.3.9 *Scale*, with 10 lb capacity, a resolution of 0.01 lb (0.004 kg), and an uncertainty of 0.01 lb. Calibrate annually.

10.4.3.10 *Barometer*, with a resolution of 0.2 in. (670 Pa) Hg and an uncertainty of 0.2 in. (670 Pa) Hg. Calibrate annually, unless gravity-operated devices (for example, a mercury barometer) are used. Gravity-operated devices are considered primary standards and do not require annual calibration.

10.4.3.11 *Refrigerator*, for holding food product, with temperature controlled at $39 \pm 5^\circ\text{F}$. Check monthly for thermostat accuracy.

10.4.3.12 *Freezer*, for holding food product, with internal temperature maintained at $-5 \pm 5^\circ\text{F}$ ($-20 \pm 3^\circ\text{C}$). Check monthly for thermostat accuracy.

10.4.3.13 *Convection Drying Oven*, with temperature controlled at $220 \pm 5^\circ\text{F}$ ($100 \pm 3^\circ\text{C}$), to be used to determine moisture content of both the raw and cooked product. Check monthly for thermostat accuracy.

10.4.3.14 *Water Consumption Meter*, with a resolution of 0.01 gal (40 ml) and an uncertainty of 0.01 gal (40 ml), at flow rate as low as 0.2 gal/min (13 ml/s). Calibrate annually.

10.4.3.15 *Elapsed Time Stopwatch*, with a 1 s resolution. Calibrate biennially.

10.4.3.16 *Product Temperature Sensor*, with a range from -20 to 400°F (-30 to 200°C) and an uncertainty of $\pm 1^\circ\text{F}$ (0.3°C), for measuring temperature of food products. Calibrate annually.

10.4.3.17 *Test Appliance*—A representative production model.

10.4.3.18 Written records of the results of the checks and calibrations are to be maintained at a central location. The above checks are minimum and do not relieve the responsibility of constantly checking and immediately repairing any item that may affect test results. A history of the repairs, modifications, or substitutions shall be maintained.

10.5 *Equipment Operation and Technique File:*

10.5.1 Each type of equipment in use shall have a complete manual that contains all information necessary to operate and maintain the equipment in accordance with applicable codes and specifications. The manual shall include the maintenance procedures and schedules for each type of equipment and the calibration schedule of each type of equipment.

10.5.2 A technique file shall be maintained for each type of equipment. It shall be available as guidance for the technician. The manual shall include:

10.5.2.1 Summary of application of specific ASTM test procedures,

10.5.2.2 Step-by-step preparation of appliance for examination,

10.5.2.3 Reference standard,

10.5.2.4 Control of essential variables, such as the time required for each test step (if applicable), ambient temperature, drafts, airflow rates, etc.,

10.5.2.5 What indications should appear at each step,

10.5.2.6 Indications and their evaluations, and

10.5.2.7 Recording of test results.

10.6 *Records and Documentation:*

10.6.1 *Records*—All applicable records pertaining to 10.2 through 10.5 shall be maintained.

10.6.2 The internal process forms or job record forms shall be filed and become a part of the permanent record for a minimum of 5 years. They shall include the following minimum information:

- 10.6.2.1 Order and reference numbers,
- 10.6.2.2 Specification,
- 10.6.2.3 Type of test and procedure identification,
- 10.6.2.4 Serial or part numbers, as applicable,
- 10.6.2.5 Special instructions from the customer,
- 10.6.2.6 Customer's name,
- 10.6.2.7 Results of the examination, and

10.6.2.8 A notation of all known deviations from any standard test method(s) referenced and all requirements of the test method(s) that were not performed by the laboratory.

10.6.3 All applicable internal reports shall be signed by the technician performing the work and by Level II or Level III personnel. A procedure for the auditing of reports by Level III personnel shall be referenced in the final report.

10.6.4 Personnel qualification records shall be developed in accordance with 8.1 and be available in an active file as long as employment continues. When personnel leave the laboratory, the records may be transferred to an inactive file but shall not be discarded for a period of 5 years or as otherwise specified.

10.6.5 *Specification File*—The company shall maintain an orderly file containing all codes, specifications, and amendments under which it is performing work.

10.7 *Laboratory Facility:*

10.7.1 *Size*—An enclosed or draft-free (less than 75 ft/min at 3 ft above the floor, next to the appliance under test) space

with at least a 3 ft perimeter around the front and sides of a wall-mounted canopy hood located over the appliance.

10.7.2 *Ventilation*—The appliance and space shall be exhausted by a canopy hood, 4 ft (1.2 m) in depth, wall mounted, with the lower edge of the hood located at 78 in. above the floor and with the capacity to operate at a nominal net exhaust ventilation rate of 300 ft³/min per linear foot (460 L/s per linear meter) of hood length, unless otherwise directed by the specific test method. This hood shall extend a minimum of 6 in. (152 mm) past both sides and the front of the cooking appliance and shall not incorporate side curtains or partitions. Makeup air shall be delivered through air outlets at least 4 ft from either side of the hood. Local velocities at the appliance surface shall not exceed 75 ft/min. The makeup air shall maintain a space temperature of 75 ± 1°F.

10.7.2.1 *Food Product*—Including necessary accessories to store, stage, prepare, cook, and dispose of products for test.

10.7.2.2 Raw and cooked food product shall be analyzed for moisture content either by drying or chemical analysis.

10.7.2.3 *Proficiency Testing*—Laboratory proficiency shall be conducted through an ongoing proficiency testing program. The program shall consist of testing a reference appliance for idle energy rate. Laboratories that test both gas and electric appliances shall maintain reference appliances for each respective fuel source. These reference appliances shall be used to validate laboratory proficiency.

11. **Keywords**

11.1 cooking-energy efficiency; efficiency testing; idle energy rate; idle rate; laboratory practices; laboratory qualifications; food service equipment; food service equipment test methods

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