



Standard Test Method for Performance of Combination Ovens¹

This standard is issued under the fixed designation F1639; 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 covers the evaluation of the energy consumption and cooking performance of combination ovens. The food service operator can use this evaluation to select a combination oven and understand its energy consumption.

1.2 This test method is applicable to gas and electric combination ovens that are operated in the combination mode only. For evaluation of a combination oven operated in either convection only mode or steam only mode, apply either Test Method F1496 or Test Method F1484, respectively.

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

1.3.1 Energy input rate and thermostat calibration (10.2).

1.3.2 Preheat energy consumption and time (10.3).

1.3.3 Idle energy rate (10.4).

1.3.4 Pilot energy rate (if applicable) (10.5).

1.3.5 Cooking-energy efficiency, cooking energy rate, and production capacity (10.7).

1.3.6 Water consumption and condensate temperature (10.7).

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

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety 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

F1484 Test Methods for Performance of Steam Cookers

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 Sept. 1, 2005. Published September 2005. Originally approved in 1995. Last previous edition approved in 2001 as F1639 – 95 (2001). DOI: 10.1520/F1639-05.

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.

F1495 Specification for Combination Oven Electric or Gas Fired

F1496 Test Method for Performance of Convection Ovens

2.2 *ASHRAE Documents:*³

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

ASHRAE Guideline 2-1986 (RA90) Thermal and Related Properties of Food and Food Materials

3. Terminology

3.1 *Definitions:*

3.1.1 *combination oven, n*—device that combines the function of hot air convection (oven mode) and saturated and superheated steam heating (steam mode), or both, to perform steaming, baking, roasting, rethermalizing, and proofing of various food products. In general, the term combination oven is used to describe this type of equipment, which is self contained. The combination oven is also referred to as a combination oven/steamer, combi or combo.

3.1.2 *condensate, n*—mixture of condensed steam and cooling water, exiting the combination oven and directed to a drain.

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

3.1.4 *cooking energy rate, n*—average rate of energy consumption (Btu/h (kJ/h) or kW) during the cooking-energy efficiency tests. Refers to all loading scenarios (heavy, medium, light).

3.1.5 *energy input rate, n*—peak rate at which a combination oven consumes energy (Btu/h (kJ/h) or kW).

3.1.6 *idle energy rate, n*—combination oven's rate of energy consumption (Btu/h (kJ/h) or kW), when empty, required to maintain its cavity temperature at the specified thermostat set point.

3.1.7 *oven cavity, n*—that portion of the combination oven in which food products are heated or cooked.

3.1.8 *pilot energy rate, n*—rate of energy consumption (Btu/h (kJ/h)) by a combination oven's continuous pilot (if applicable).

³ See the *ASHRAE Handbook of Fundamentals*, available from the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329.

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

3.1.10 *preheat time, n*—time (in min) required for the combination oven cavity to preheat from ambient temperature to the specified thermostat set point.

3.1.11 *production capacity, n*—maximum rate (lb/h (kg/h)) at which a combination oven can bring the specified food product to a specified “cooked” condition.

3.1.12 *production rate, n*—rate (lb/h (kg/h)) at which a combination 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.

3.1.13 *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 Accuracy of the combination oven thermostat is checked at a setting of 350°F (177°C). This is accomplished by comparing the oven’s temperature control setting with the temperature at the center of the oven’s cavity. If necessary, the control is adjusted so that the maximum difference between its reading and the temperature at the center of the cavity is no more than $\pm 5^\circ\text{F}$ ($\pm 2.8^\circ\text{C}$).

4.2 Energy input rate is determined to confirm that the combination oven is operating within 5 % of the nameplate energy input rate. For gas combination ovens, the pilot energy rate and the fan and control energy rates are also determined.

4.3 The time and energy required to preheat the oven from room temperature ($75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{C}$)) to a ready-to-cook state (350°F (177°C)) is determined.

4.4 Idle energy rate is determined the combination oven set to maintain a ready-to-cook state (for example, $350 \pm 5^\circ\text{F}$ ($177 \pm 2.8^\circ\text{C}$)).

4.5 Cooking-energy efficiency, cooking energy rate and production rate are determined during heavy and light-load cooking tests using whole chickens.

5. Significance and Use

5.1 The energy input rate test and thermostat calibration are used to confirm that the combination oven is operating properly prior to further testing and to ensure that all test results are determined at the same temperature.

5.2 Preheat energy and time can be useful to food service operators to manage power demands and to know how quickly the combination 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 combination oven energy performance under various loading conditions. This information enables the food service operator to consider energy performance when selecting a combination oven.

5.5 Production capacity can be used by food service operators to choose a combination oven that matches their food output requirements.

5.6 Water consumption characterization is useful for estimating water and sewage costs associated with combination oven operation.

5.7 Condensate temperature measurement is useful to verify that the condensate temperature does not violate applicable building codes.

6. Apparatus

6.1 *Analytical Balance Scale*, for measuring weights up to 20 lb (9.0 kg), with a resolution of 0.01 lb (0.005 kg) and an uncertainty of 0.01 lb (0.005 kg).

6.2 *Barometer*, for measuring absolute atmospheric pressure, to be used for adjustment of measured natural gas volume to standard conditions, having a resolution of 0.2 in. Hg (670 Pa) and an uncertainty of 0.2 in. Hg (670 Pa).

6.3 *Canopy Exhaust Hood*, 4-ft (1.2-m) in depth, wall-mounted with the lower edge of the hood 72 in. (2.0 m) from the floor and with the capacity to operate at a nominal exhaust ventilation rate of 300 cfm per linear foot (360 L/s per linear meter) of active hood length. This hood shall extend a minimum of 6 in. (150 mm) past both sides and the front of the cooking appliance and shall not incorporate side curtains or partitions.

6.4 *Flowmeter*, for measuring total water consumption of the appliance, having a resolution of 0.01 gal (40 mL) and an uncertainty of 0.01 gal (40 mL) at a flow rate as low as 0.2 gpm (13 mL/s).

6.5 *Gas Meter*, for measuring the gas consumption of a combination oven, shall be a positive displacement type with a resolution of at least 0.01 ft³ (0.0003 m³) and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft³/h (0.06 m³/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 ft³ (0.0003 m³) and a maximum uncertainty no greater than 2 % of the measured value.

6.6 *Pressure Gage*, for monitoring natural gas pressure, having a range from 0 to 15 in. H₂O (0 to 3.7 kPa), a resolution of 0.5 in. H₂O (125 Pa), and a maximum uncertainty of 1 % of the measured value.

6.7 *Stopwatch*, with a 1-s resolution.

6.8 *Temperature Sensor*, for measuring natural gas temperature in the range from 50 to 100°F (10 to 40°C), with an uncertainty of $\pm 1^\circ\text{F}$ (0.3°C).

6.9 *Thermocouple Probes*, with a range from 0 to 450°F (−18 to 232°C), with a resolution of 0.2°F (0.1°C), and an uncertainty of 0.5°F (0.3°C), for measuring temperature of the combination oven cavity, food product, and condensate water.

6.10 *Watt-hour Meter*, for measuring the electrical energy consumption of a combination oven, having 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 *Water*, shall have a maximum hardness of three grains per gallon. If the tester's water supply does not meet the specification, a water softener may be required.

7.2 *Chickens*, shall be fresh, ready to cook, whole chickens without giblets (WOG), with a nominal weight of 2½ to 2¾-lb (1.1 to 1.2-kg) per chicken.

7.3 *Chicken Racks*, for holding whole chickens, shall be of manufacturer's design or specification.

7.4 *Hotel Pans*, for capturing chicken juices, solid 12 by 20 by 2½ in. (300 by 500 by 65 mm) stainless steel weighing 2.8 ± 0.5 lb (1.3 ± 0.2 kg).

8. Sampling, Test Units

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

9. Preparation of Apparatus

9.1 Install the appliance according to the manufacturer's instructions under a canopy exhaust hood. Position the combination oven so that a minimum of 6 in. is maintained between the edge of the hood and the vertical plane of the front and sides of the appliance. In addition, both sides of the combination oven shall be a minimum of 3 ft (1.1 m) from any side wall, side partition, or other operating appliance. The exhaust ventilation rate shall be 300 cfm per linear foot (360 L/s per linear meter) of hood length. The associated heating or cooling system shall be capable of maintaining an ambient temperature of 75 ± 5°F (24 ± 3°C) within the testing environment when the exhaust ventilation system is operating.

9.2 Connect the combination 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 combination 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 combination oven, confirm (while the combination 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 1—If an electric combination oven is rated for dual voltage (for example, 208/240 V), the voltage selected by the manufacturer or tester, or both, shall be reported. If an oven is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the oven (for example, preheat time) may differ at the two voltages.

9.4 For a gas combination 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.

9.5 Install a flowmeter to the combination oven water inlet such that total water flow to the appliance is measured.

9.6 Install temperature sensors at the point where the drain water exits the combination oven and in the drain line such that the sensor is immersed in the condensate water path just as it enters the drain.

10. Procedure

NOTE 2—Prior to starting these tests, the tester should read the operating manual and fully understand the operation of the appliance.

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 3—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 combination oven under test. It is recommended that all testing be performed with gas having a higher heating value of 1000 to 1075 Btu/ft³.

10.1.2 For gas combination 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 combination 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 combination oven.

10.2 Energy Input Rate and Thermostat Calibration:

10.2.1 Install a thermocouple at the geometric center (top to bottom, side to side, and front to back) of the combination oven cooking cavity.

10.2.2 Set the temperature control to 350°F (177°C); set the controls to operate in the combination mode; and turn the combination oven on. Record the time and energy consumption from the time when the unit is turned on until the time when any of the burners or elements (combination oven) first cycle off.

10.2.3 Calculate and record the combination oven's energy input rate and compare the result to the rated nameplate input. For gas combination ovens, only the burner energy consumption is used to compare the calculated energy input rate with the rated gas input; any electrical energy use shall be calculated and recorded separately as the fan/control energy rate.

10.2.4 Allow the combination oven to idle for 60 min after the burners or elements commence cycling at the thermostat set point.

10.2.5 After the 60-min idle period, start monitoring the combination oven cavity temperature, and record the average

temperature over a 15-min period. If this recorded temperature is $350 \pm 5^\circ\text{F}$ ($177 \pm 3^\circ\text{C}$), then the combination oven's thermostat is calibrated.

10.2.6 If the average temperature is not $350 \pm 5^\circ\text{F}$ ($177 \pm 3^\circ\text{C}$), adjust the combination oven's temperature control following the manufacturer's instructions and repeat 10.2.5 until it is within this range. Record the corrections made to the controls during calibration.

10.2.7 In accordance with 11.4, calculate and report the combination oven energy input rate, fan/control energy rate where applicable, and rated nameplate input.

10.3 *Preheat Energy Consumption and Time:*

10.3.1 Verify that the combination oven cavity temperature is $75 \pm 5^\circ\text{F}$ ($24 \pm 3^\circ\text{F}$). Set the calibrated temperature control to 350°F ; set the controls to operate in the combination mode; and turn the combination oven on.

10.3.2 Record the time, temperature, and energy consumption required to preheat the combination oven, from the time when the unit is turned on until the time when the combination oven cavity reaches a temperature of $350 \pm 2^\circ\text{F}$ ($177 \pm 1^\circ\text{C}$).

10.3.3 In accordance with 11.5, calculate and report the preheat energy consumption and time, and generate a preheat temperature versus time graph.

10.4 *Idle Energy Rate:*

10.4.1 With the temperature controls set to maintain the average cavity air temperature at $350 \pm 5^\circ\text{F}$ ($177 \pm 2.8^\circ\text{C}$) and the oven set to operate in full combination mode (maximum humidity), turn the combination oven on.

10.4.2 Allow the combination oven to stabilize at these settings for 60 min after the burners or elements commence cycling.

10.4.3 At the end of 60 min stabilization period, begin recording the elapsed time, oven cavity temperature, and combination oven energy and water consumption for a minimum of 3 h.

10.4.4 Repeat 10.4.1 through 10.4.3 with the oven set to operate at the lowest humidity setting, while still in combination mode. If additional humidity settings are possible, the combination oven may be characterized at these settings by repeating 10.4.1 through 10.4.4.

10.4.5 In accordance with 11.6, calculate and report the combination oven's idle energy rate and water consumption rate.

10.5 *Pilot Energy Rate:*

10.5.1 For a gas combination oven with a standing pilot, set the gas valve at the "pilot" position, and set the combination 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 *Chicken Preparation:*

10.6.1 Determine the number of chicken racks required to fill the oven to maximum capacity (or the manufacturer's recommended maximum capacity) while maintaining a minimum of 1/2-in. (13 mm) clearance around each loaded chicken

rack. If the chicken racks are not designed to be placed inside standard hotel pans, then space must be reserved at the bottom of the oven for a standard 2 1/2-in. (64-mm) deep hotel pan to catch the drippings.

NOTE 4—It is the intent of this procedure to load the oven to maximum capacity without having the chickens contacting each other, the oven walls, or adjacent racks. The number of chicken racks required to fill the oven to maximum capacity will vary depending on oven size and the manufacturer's design of the chicken racks.

10.6.2 Prepare enough chickens for a minimum of three runs each of both heavy- and light-load tests. For the heavy-load tests, use the maximum number of chicken racks allowable. For the light-load tests, use one rack of chickens.

10.6.3 If necessary, the chickens may be thawed by immersing them in cold running water. Thoroughly rinse the thawed chickens and then place them onto a drip rack on a sheet pan and cover with plastic wrap. Place the wrapped chickens into the refrigerator.

NOTE 5—It is important that the raw whole chickens be properly and consistently thawed and drained. Excess moisture in the pans will make it difficult to accurately determine the amount of product shrinkage.

10.6.4 Monitor the internal temperature of a sample chicken with a thermocouple probe. Its internal temperature must reach $37 \pm 2^\circ\text{F}$ ($3 \pm 1^\circ\text{C}$) before the chickens can be removed from the refrigerator and loaded onto the appropriate chicken racks. If necessary, adjust the refrigerator temperature to achieve this required internal temperature.

10.6.5 Trim any loose fat and skin from the bottom of each chicken.

10.6.6 Weigh and record the weight of each rack. If the chicken racks are designed to be held inside standard hotel pans, then weigh and record the weight of the individual hotel pans. To facilitate the testing, label the racks (and pans) for identification.

10.6.7 Load the chickens onto the appropriate racks, following the manufacturer's recommendations for orientation. Weigh and record the weight of each full-loaded rack (and pan).

10.6.8 Choose two chickens near the center of each rack for temperature measurement. Each chicken shall be instrumented with four thermocouples: one thermocouple in each thigh and one thermocouple in each breast.

NOTE 6—Each pair of thermocouples in the breasts and thighs can be mechanically averaged by joining two equal lengths of thermocouple wire into one wire, which is attached to the temperature measuring device. This method simplifies the procedure by reducing the number of thermocouple wires leaving the combination oven.

NOTE 7—It is recommended that the thermocouple wires be attached to the side of the chicken racks with clips or some other form of strain relief to ensure that the thermocouples remain in the same spot in the chickens during handling and loading of the racks.

NOTE 8—It was determined by the Food Service Technology Center that four thermocouple pairs for each chicken rack were sufficient to produce accurate and repeatable test results. Limiting the number of thermocouples simplifies the handling of the pans and reduces the chance that the wires will become tangled.

10.6.9 Cover the chickens with plastic wrap. Return the chickens to the refrigerator and allow them to remain at 37°F

$\pm 2^{\circ}\text{F}$ ($3 \pm 1^{\circ}\text{C}$) refrigerator temperature. Do not store the thawed chickens in the refrigerator for more than one week.

10.7 Cooking-Energy Efficiency and Production Capacity:

10.7.1 This procedure applies to two possible loading scenarios: heavy and light. Each loading scenario shall be repeated a minimum of three times. Additional test runs may be necessary to obtain the required precision for the reported test results (**Annex A1**). The reported values of cooking-energy efficiency, cooking energy rate, production capacity, condensate temperature, and water consumption shall be the average of the replications (runs).

10.7.2 Set the temperature control to 350°F (177°C); set the controls to operate in full combi mode; preheat the combination oven; and then allow the combination oven to idle in full combi mode for 60 min.

10.7.3 If the manufacturer offers a recommended program for cooking whole chickens, then that program may be used, provided that the cooking time, temperature, and humidity settings are noted in the results reporting sheets. If no recommended cooking program is provided, then the chickens shall be cooked in full combi mode (temperature plus maximum humidity) at 350°F (177°C).

NOTE 9—Some oven manufacturers recommend cooking whole chickens using a staged or stepped program, using varying temperature and humidity settings. It is the intent of this test procedure to characterize the cooking performance of the combination oven as the manufacturer intends it to be used.

10.7.4 Remove the chickens from the refrigerator and remove the plastic wrap. Open the door of the combination oven and commence loading the racks of chickens into the oven. If the racks are designed to be loaded directly into the oven without pans, then place a standard 2½-in. (64-mm) deep hotel pan at the bottom rack position to catch any chicken drippings. For the light-load test, the rack shall be placed as close to the center of the oven cavity as possible. For the heavy-load test, the racks shall be loaded from bottom to top. Allow 20 s to load each rack into the combination oven (for example, a heavy load of 3 racks times 20 s = 1-min maximum loading time). The initial average temperature of the chickens (all the racks together) when the test is started (the combination oven door is closed) shall be $40 \pm 2^{\circ}\text{F}$ ($4 \pm 1^{\circ}\text{C}$). Keep the door open for the entire load time, even if the loading is accomplished in less time.

10.7.5 Shut the door and start the oven cooking cycle to begin the test. Start monitoring time, temperature, energy consumption, water consumption, and condensate temperature.

10.7.6 End the test when the average temperature of the whole chickens (all the racks together) reaches 200°F (93°C). Stop monitoring time, temperature, energy, water consumption, and condensate temperature.

10.7.7 Remove the racks of chickens and hotel pan(s) from the combination oven and close the oven door. Remove the thermocouples from the chickens, and immediately weigh each rack of chickens while still in the hotel pans, including the juice in the pans (racks in pans). For stand-alone racks, include the weight of the hotel pan with drippings in the final chicken weight.

10.7.8 Subtract the weight of the chicken racks and the hotel pans to determine the total cooked weight of the whole chickens with the juices. Record the final temperature, the test time, the total cooked weight of the whole chickens, and the energy and water consumed during the test.

10.7.9 To quantify product shrinkage, remove the chickens from the racks, leaving any juice in the drip pans and shaking off any excess moisture that may have condensed on the chickens, then weigh and record the net weight of the whole chickens.

NOTE 10—The total cooked weight of the whole chickens will be subtracted from the total uncooked weight of the whole chickens in order to determine the amount of moisture evaporated during the test. It is crucial to include all of the moisture that is remaining in the drip pans when determining the total cooked weight so that the evaporation will not be exaggerated.

NOTE 11—The net weight of the whole chickens will be subtracted from the total uncooked weight of the whole chickens in order to determine the product shrinkage. The net weight is representative of the final product or the quantity of product that would be available to be served.

10.7.10 Perform runs No. 2 and No. 3 by repeating **10.7.3-10.7.9**. Allow a minimum of 10 min for the oven to re-stabilize at its operating temperature (for example, 350°F (177°C) at full-combi mode) between subsequent tests. Follow the procedure in Annex A1 to determine whether more than three test runs are required.

10.7.11 In accordance with **11.8**, calculate and report the cooking-energy efficiency, cooking energy rate, electric energy rate (if applicable for gas combination ovens), production capacity, product shrinkage, water consumption, and condensate temperature.

11. Calculation and Report

11.1 *Test Combination Oven*—Summarize the physical and operating characteristics of the combination oven, including method of steam generation, oven controls and different operating modes. 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 combination ovens, report the voltage for each test.

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

11.3 Gas Energy Calculations:

11.3.1 For gas combination 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 the following:

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

where:

E_{gas} = energy consumed by the appliance.

