Hobart, Model HEC504 Electric Convection Oven Performance Test

Application of ASTM Standard
Test Method F 1496-99

FSTC Report 5011.08.07

Food Service Technology Center
March 2008

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Acknowledgements

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Specific appreciation is extended to Hobart, for supplying the Food Service Technology Center with the HEC504 convection oven for controlled testing in the appliance laboratory.

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Executive Summary

The Hobart HEC504 is an electric, full size convection oven with a rated energy input of 12.5kW. A two-speed fan, powered by a ½-hp motor, circulates hot air throughout the oven cavity and solid-state controls maintain oven temperatures. The two-speed fan allows for delicate food products, and a cool mode provides quicker cool down times.

FSTC researchers tested the oven under the tight specifications of the American Society for Testing and Materials' (ASTM) standard test method.[1] Convection oven performance is characterized by preheat time and energy consumption, idle energy rate, cooking-energy efficiency, production capacity, cooking uniformity, and white sheet cake browning uniformity.

Cooking performance was determined by baking 100-count russet potatoes under three different loading scenarios (heavy—5 full-size sheet pans, medium—3 full-size sheet pans, and light—1 full-size sheet pan). The cook times for the three loading scenarios were 47.9 minutes for the heavy-load test, 43.3 minutes for the medium-load test, and 43.7 minutes for the light-load test.

As specified by the ASTM test method, cooking-energy efficiency is a measure of how much of the energy that an appliance consumes is actually delivered to the food product during the cooking process. Cooking-energy efficiency is therefore defined by the following relationship:

$$\text{Cooking - Energy Efficiency} = \frac{\text{Energy to Food}}{\text{Energy to Appliance}}$$

[1] American Society for Testing and Materials. 1999. *Standard Test Method for the Performance of Convection Ovens.* ASTM Designation F 1496-99, in *Annual Book of ASTM Standards,* West Conshohocken, PA.

Executive Summary

A summary of the ASTM test results for the Hobart, Model HEC504 convection oven is presented in Table ES-1.

Table ES-1. Summary of HEC504 Convection Oven Performance Results.

Rated Energy Input Rate (kW)	12.5
Measured Energy Input Rate (kW)	12.2
Preheat Time to 340°F (min)	7.3
Preheat Energy to 340°F (kWh)	1.48
Idle Energy Rate @ 350°F (kW)	1.9
Heavy-load Cooking-Energy Efficiency (%)	71.0 ± 1.3
Medium-Load Cooking-Energy Efficiency (%)	61.6 ± 1.6
Light-Load Cooking-Energy Efficiency (%)	40.5 ± 1.2
Production Capacity (lb/h)	92.2 ± 3.4
Cooking Uniformity Average Rack Temperatures (°F):	
Rack #1 (Top)	163
Rack #2	151
Rack #3	190
Rack #4	167
Rack #5 (Bottom)	179
Maximum Temperature Difference	39

The energy cost model applied to the HEC504 electric convection oven assumed 100 lbs of food cooked per day, 365 days per year, at an energy rate of $0.10 per kWh. The model showed an annual energy consumption of 12,300 kWh, equaling an annual estimated energy cost of $1,230.

1 Introduction

Background

Convection ovens are the most widely used appliances in the foodservice industry. Operators know that fresh-baked signature desserts, crusty breads, and familiar comfort foods, such as roasted meats and potatoes, are irresistible to their customers. In addition to traditional uses such as roasting and baking, these ovens can be used for nearly all types of food preparation, including foods typically prepared using other types of appliances.

In 1993, the Food Service Technology Center (FSTC) developed a standard test method to quantify the performance of convection ovens. This test method was applicable to both full-size and half-size convection ovens and allowed manufacturers and end users to compare performance indices such as energy efficiency, cooking uniformity, and production capacity.

The draft test procedure was submitted to the American Society for Testing and Materials (ASTM), and in February 1994 was accepted as a standard test method. In 1999, the test method was re-submitted with new temperature endpoints for the cooking tests, and now carries ASTM designation F1496-99.[1] The Food Service Technology Center report, *Development and Application of a Uniform Testing Procedure for Convection Ovens* documents the developmental procedures and preliminary test results for four (two gas and two electric) convection ovens.[2] Other Food Service Technology Center reports document results of applying the ASTM test method to different convection ovens.[3-12]

Hobart's HEC504 electric convection oven incorporates a two-speed, ½-horsepower fan with a solid-state thermostat, and a zero-to-sixty minute timer. The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report and Appendix B includes the full specification sheet for this oven.

Introduction

Objectives

The objective of this report is to examine the operation and performance of the Hobart HEC504 electric full-size convection oven under the controlled conditions of the ASTM standard test method. The scope of this testing is as follows:

1. Verify that the appliance is operating at the manufacturer's rated energy input.
2. Determine the time and energy required to preheat the oven from room temperature to 340°F.
3. Characterize the oven's idle energy use with the thermostat set at a calibrated 350°F.
4. Document the cooking energy consumption and efficiency under three different scenarios: heavy, medium, and light.
5. Determine the oven's production capacity when baking potatoes.
6. Document the oven's frozen-load cooking-energy efficiency, production capacity, and cooking uniformity using macaroni and cheese.
7. Document the oven's browning uniformity using white sheet cakes.
8. Estimate the annual energy cost for this oven based on the test results.

Appliance Description

The Hobart HEC504 is an electric, full size convection oven with a rated energy input of 12.5kW. A two-speed fan, located in the rear of the oven, is used to circulate hot air throughout the cavity. A switch changes the fan between low and high speeds. The fan is typically operated in high speed, but may be set to low speed when cooking delicate food products. A solid-state control maintains oven temperature by means of a dial control. There is a cool down mode that runs the fan while the oven doors are open to speed up the cooling off period. The oven is also equipped with electronic ignition, eliminating the need for a standing pilot.

Appliance specifications are listed in Table 1-1, and the manufacturer's literature is included in Appendix B.

Figure 1-1.
HEC504 oven.

Table 1-1. Appliance Specifications.

Manufacturer	Hobart
Model	HEC504
Generic Appliance Type	Full-size electric convection oven
Rated Input	12.5 kW
Oven Cavity Dimensions	29"W x 22$^1/_8$"D x 20"H
Overall Dimensions	40"W x 41 ½"D x 56 ¾"H (Legs are 25 ¾")
Controls	Single thermostat adjustable from 150 to 500°F, 0 to 60 minute cook timer, two-speed fan switch, cool switch, and moisture vent damper.

2 Methods

Setup and Instrumentation

FSTC researchers installed the convection oven on a tiled floor under a 4-foot-deep canopy hood that was 6 feet, 6 inches above the floor. The hood operated at a nominal exhaust rate of 300 cfm per linear foot of hood. There was at least 6 inches of clearance between the vertical plane of the convection oven and the edge of the hood. All test apparatus were installed in accordance with Section 9 of the ASTM test method.[1]

Researchers used 24 gauge, type-K, Teflon sheathed thermocouples to monitor oven and food product temperatures. Energy was measured with a Watt-hour transducer that generated a pulse for every 10 Watt-hours. The transducer and thermocouples were connected to an automated data acquisition unit that recorded data every 5 seconds.

As per the operating instructions, the HEC504 oven was operated in high fan mode for all phases of testing.

Energy Input Rate and Thermostat Calibration

Researchers determined the energy input rate by measuring the energy consumption during the preheat test, while the oven was operating at full power. The peak input recorded during this period was reported as the measured energy input rate.

The thermostat calibration verified that the oven cavity temperature averaged 350°F ± 5°F when the temperature control was set to 350°F. This was accomplished by allowing the oven to stabilize at the 350°F setting for one hour, then monitoring oven cavity temperature for an additional hour.

This procedure is repeated at the 300°F setting to facilitate the white sheet cake browning uniformity test.

Methods

Preheat and Idle Energy Rate Tests

The preheat test measured the time and energy the HEC504 oven required to heat from a start at room temperature (75 ± 5°F) to a temperature of 340°F. This test was conducted as the first test of the day, after the oven had been sitting overnight.

The idle energy rate test determined the amount of energy the oven consumed while operating at a temperature of 350°F, with no food in the oven. This was accomplished by allowing the oven to stabilize at 350°F for one hour, then monitoring time and energy for at least two additional hours.

Cooking-Energy Efficiency Tests

The cooking-energy efficiency and production capacity tests consisted of baking 100-count russet potatoes on full-size sheet pans. The cooking-energy efficiency tests were conducted for three distinct loading scenarios: heavy (five sheet pans), medium (three sheet pans) and light (single sheet pan).

Each pan contained 30 potatoes that had a combined weight of 14.5 ± 0.3 pounds. Three potatoes per pan were randomly selected and instrumented with thermocouples for monitoring temperature during the test. The potatoes were then baked from a stabilized beginning temperature of 75 ± 5°F to an average temperature of 205°F. Each of the three cooking-energy efficiency tests were replicated a minimum of three times to ensure accuracy in the reported results. Production capacity was determined during the heavy-load test.

Cooking Uniformity Tests

The heavy-load cooking uniformity test was performed with 4.5 lb pans of frozen, prepared, macaroni and cheese to determine how evenly the oven cooked a “stubborn” food product. Before the test, the pans of macaroni and cheese were placed in a freezer and stabilized to a temperature of 0°F. The preheated oven was then loaded with 20 pans of the frozen product, arranged by evenly spacing 4 pans on each of the oven’s 5 racks. The temperature of each pan was monitored during the course of the test. The test was complete when the combined average temperature of all of the macaroni and cheese pans reached 170°F.

Browning Uniformity Tests

The oven's browning uniformity was evaluated by baking white sheet cakes. This test was performed with the oven set to a calibrated 300°F. For this test, the oven was loaded with five full-size sheet pans, each filled with 6 pounds of cake batter. The pans were loaded from the bottom rack to the top rack to minimize the disuniformity between racks. The cakes were considered done when a wood skewer could be inserted into the cakes and removed without any particles adhering to it. The uniformity of each cake was documented with a photograph and written observations.

Appendix C contains the ASTM results reporting sheets for this oven.

Energy Cost Model

The operating energy cost for the HEC504 oven was calculated based on a combination of test data and assumptions about typical oven usage. This provides a standard method for estimating oven energy consumption based on ASTM performance test results. The examples contained in the energy cost model are for informational purposes only, and should not be considered an absolute.

The model assumed a typical twelve-hour day, with two preheats. During the day, 100 pounds of food would be cooked: 50% under heavy-load conditions, 40% under medium-load conditions, and 10% under light-load conditions. The total daily energy usage was calculated based on the oven's energy consumption in each of these cooking scenarios. The cost model assumptions are listed in Table 2-1

Table 2-1: Cost Model Assumptions.

Operating Time per Day	12 h
Operating Days per Year	365 d
Number of Preheats per Day	2
Total Amount of Food Cooked per Day	100 lb
Percentage of Food Cooked Under Heavy-	50 %
Percentage of Food Cooked Under Me-	40 %
Percentage of Food Cooked Under Light-	10 %

3 Results

Energy Input Rate and Thermostat Calibration

The measured energy input rate was 12.2 kW, a difference of 2.7% from the nameplate rating of 12.5 kW. This confirmed the oven was operating properly and testing could proceed without adjustment.

With the temperature control adjusted to 350°F, the oven had an average cavity temperature of 364.1°F. The thermostat was adjusted to an indicated 335°F, which produced an average oven cavity temperature of 349.3°F. The oven was therefore operated at the 335°F setting for all tests, except the sheet cake browning uniformity test, which was performed with the oven set at 285°F, as described below.

With the temperature control adjusted to 300°F, the oven had an average cavity temperature of 315.4°F. The thermostat was adjusted to an indicated 285°F, which produced an average oven cavity temperature of 298.7°F. The oven was therefore operated at a thermostat setting of 285°F for the browning uniformity test.

Preheat and Idle Tests

Preheat Energy and Time

The oven required 7.3 minutes to heat from 70.6°F to 340°F. During this period the oven consumed 1.48 kWh of energy. Figure 3-1 shows the cavity temperature and energy consumption profile during the preheat test.

Idle Energy Rate

During the idle energy rate test, the HEC504 oven consumed electricity at a rate of 1.9 kW.

Test Results

Input, preheat, and idle test results are summarized in Table 3-1.

Results

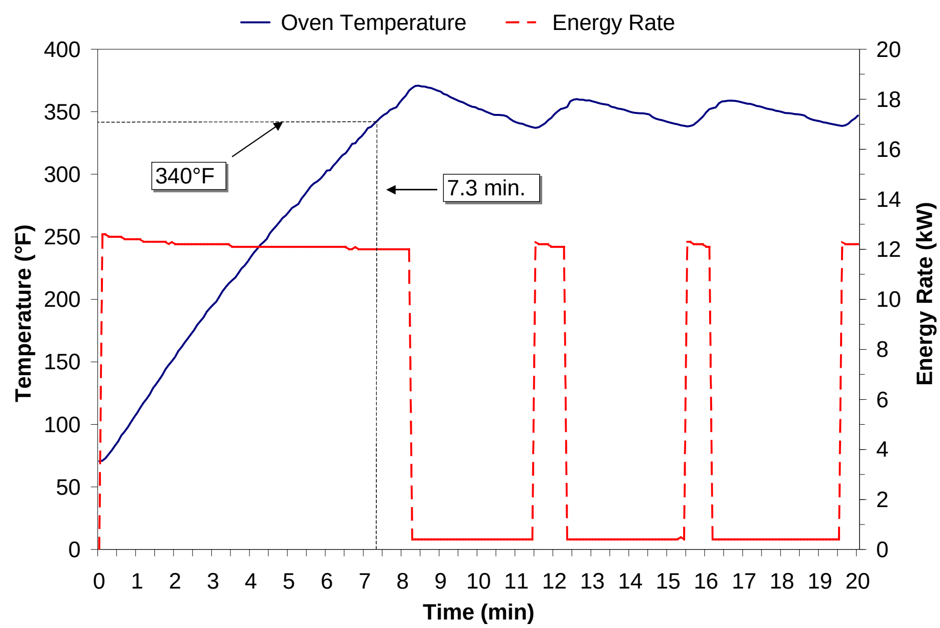


Figure 3-1.
Preheat characteristics.

Table 3-1. Input, Preheat, and Idle Test Results.

Rated Energy Input Rate (kW)	12.5
Measured Energy Input Rate (kW)	12.2
Difference between Rated and Measured (%)	2.7
Preheat	
Starting Temperature (°F)	70.6
Energy Consumption (kWh)	1.48
Duration (min)	7.3
Preheat Rate (°F/min)	37
Idle Energy Rate @ 350°F (kW)	1.9

Cooking-Energy Efficiency Tests

Heavy-load Tests

The oven’s cooking-energy efficiency for a given loading scenario is the amount of energy imparted to the potatoes, expressed as a percentage of the amount of energy consumed by the oven during the cooking process. The heavy-load cooking energy efficiency for the HEC504 oven was 71.0 %. The cook time was 47.9 minutes, giving the oven a production capacity of 92.2 lb/h. During the heavy-load potato tests, the cooking-energy rate was 9.5 kW.

Medium- and Light-Load Tests

During the medium load tests, the HEC504 showed a cooking energy efficiency of 61.6 %. The cook time was 43.3 minutes and the production rate was 61.3 lb/h. The cooking-energy rate for the medium loads was 7.1 kW.

Light-load tests showed a cooking-energy efficiency of 40.5 %, a production rate of 20.3 lb/h, and a cooking-energy rate of 3.7 kW. The cook time for the light load potato tests was 43.7 minutes.

Test Results

Cooking-energy efficiency results for the heavy-load tests were 71.6%, 70.9%, and 70.6%, yielding an uncertainty of 1.8% in the test results. Table 3-2 summarizes the results of the cooking-energy efficiency and production capacity tests, and Figure 3-3 illustrates the relationship between cooking-energy efficiency and production rate for the HEC504 oven.

Figure 3-4 illustrates the relationship between the convection oven’s average energy consumption rate and the production rate. This graph can be used as a tool to estimate the daily energy consumption for the convection oven in a real-world operation. Average energy consumption rates at 15, 30, and 60 pounds per hour are 3.2 kW, 4.4 kW, and 6.9 kW, respectively.

Table 3-2. Cooking-Energy Efficiency and Production Capacity Test Results.

	Heavy-Load	Medium-Load	Light-Load
Cook Time (min)	47.9	43.3	43.7
Production Rate (lb/h)	92.2 ± 3.4	61.3 ± 1.7	20.3 ± 0.4
Energy to Food (Btu/lb)	250	244	252
Cooking Energy Rate (kW)	9.5	7.1	3.7
Energy per Pound of Food Cooked (Btu/lb)	351	396	622
Cooking-Energy Efficiency (%)	71.0 ± 1.3	61.6 ± 1.6	40.5 ± 1.2

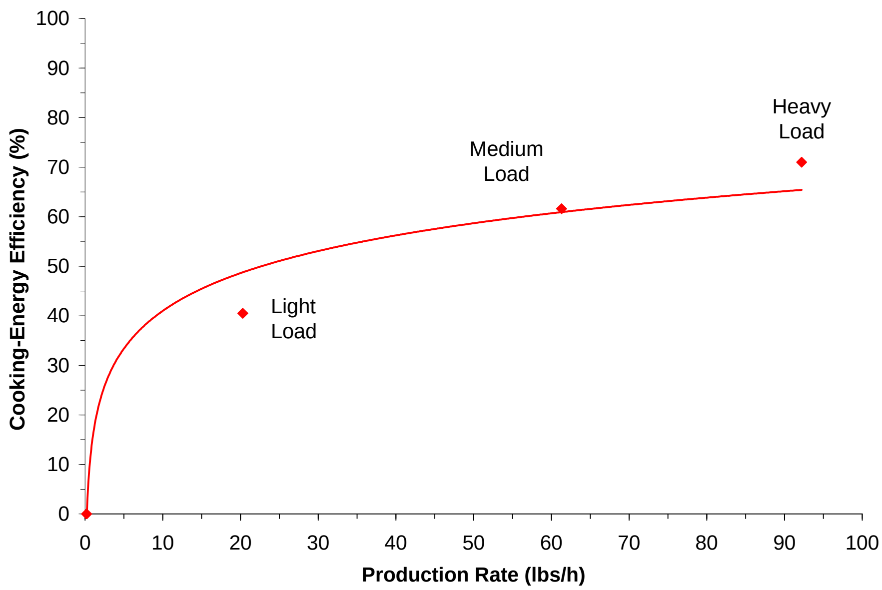


Figure 3-2.

Convection oven part-load cooking-energy efficiency.

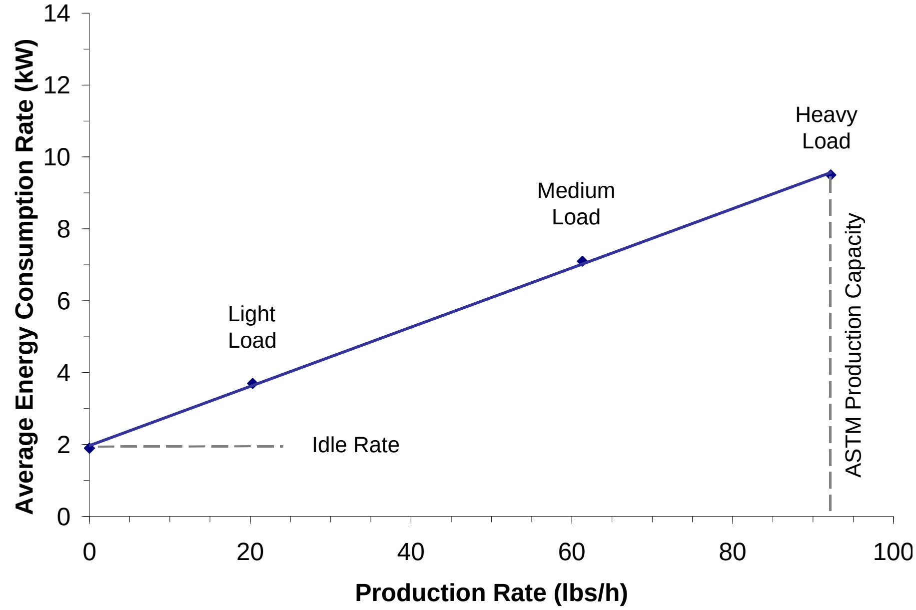


Figure 3-3. Convection oven cooking energy consumption profile.

Note: Light-load = 1 pan/load; medium-load = 3 pans/load; heavy-load = 5 pans/load.

Cooking Uniformity

The HEC504 oven completed the macaroni and cheese cooking uniformity test in 46.1 minutes with a cooking-energy rate of 11.7 kW. The average rack temperatures were calculated by averaging the temperatures of the 4 pans on each rack, just as the average temperature of all 20 pans of macaroni and cheese reached 170°F. The average rack temperature varied from a low of 151.1°F in the rack position second from the top of the oven, to a high of 190.2°F in the third rack position.

Table 3-3 summarizes the results of the cooking uniformity tests.

Table 3-3. Cooking Uniformity Test Results.

Cook Time (min)	46.1
Cooking Energy Rate (kW)	11.7
Average Rack Temperatures (°F):	
Rack #1	163
Rack #2	151
Rack #3	190
Rack #4	167
Rack #5	179

Browning Uniformity

White sheet cakes provide a visual indication of the temperature uniformity of an oven while baking. The cook time was experimentally determined so that the cakes were uniformly cooked while exhibiting the greatest possible differences in color. The results of the test are described below and visual representations of the browning are shown in Figures 3-4 through 3-8.

Figure 3-4. Rack #1 (Top).

Rack #1. The surface of this cake had an even golden brown color that was very uniform across the entire surface.

Figure 3-5.
Rack #2.

Rack #2. This cake was characterized by a light section near the middle of the cake that grew slightly wider towards the front. The edges were also a dark brown color.

Figure 3-6.
Rack #3 (Middle).

Rack #3. This cake had a small light section near the middle rear of the pan. The light area transitioned to edges on both sides that were dark brown, especially near the front left and right middle.

Figure 3-7.
Rack #4.

Rack #4. This cake showed a light area, generally around the middle of the cake, that also extended to the front middle. The edges were dark brown in certain areas, especially along the left front and right sides.

Figure 3-8.
Rack #5 (Bottom).

Rack #5. This cake exhibited a light area from the left rear to the center front of the cake. The remainder of the cake was a golden brown color.

Energy Cost Model

Based on a 365-day-per-year operation cooking 100 lbs of food per day, the oven would consume approximately 12,300 kWh per year. At an energy cost of $0.10 per kWh, the average annual operating cost is estimated at $1,230. Details of this calculation can be found in Appendix E of this report.

4 Conclusions

The Hobart, model HEC504, full-size electric convection oven produced solid performance numbers under the rigorous conditions of the ASTM test method. The heavy-load cooking-energy efficiency of 71.0% fell midway between previously tested electric convection ovens, while the production capacity of 92.2 lbs/h was among the highest, regardless of fuel type.[3-12]

The idle test showed an energy consumption rate of 1.9 kW, a result that again placed the HEC504 between the two electric ovens previously tested.[3,8]

During the white sheet cake uniformity tests, the cake on the top was nearly perfect in terms of color and evenness, while the cakes lower in the oven had some lighter and darker brown spots of varying degrees, giving the HEC504 oven an acceptable browning uniformity.

The energy cost model applied to the HEC504 electric convection oven assumed 100 lbs of food cooked per day, 365 days per year, at an energy rate of $0.10 per kWh. The model showed an annual energy consumption of 12,300 kWh, equaling an annual estimated energy cost of $1,230.

With fast cook times and solid energy-efficiency numbers, the Hobart HEC504 would be an excellent addition to any kitchen looking for an electric full-size convection oven.

5 References

1. American Society for Testing and Materials, 1999. *Standard Test Method for Performance of Convection Ovens*. ASTM Designation F1496-99. In Annual Book of ASTM Standards, West Conshohocken, PA.

2. Blessent, J., 1994. *Development and Application of a Uniform Testing Procedure for Convection Ovens.* Pacific Gas and Electric Company Department of Research and Development Report 008.1-94-12, October.

3. Blessent, J., 1996. *Montague Model SEK15AH Electric Convection Oven: Application of ASTM Standard Test Method F1496-93*. Food Service Technology Center Report 5011.95.24, April.

4. Blessent, J., 1996. *Montague Model SE70AH Gas Convection Oven: Application of ASTM Standard Test Method F1496-93.* Food Service Technology Center Report 5011.95.25, April.

5. Zabrowski, D., Cadotte, B., Cowen, D., 1999. *Montague, Model Vectaire HX63A Gas Full-Size Convection Oven Performance Test.* Food Service Technology Center Report 5011.99.79, December.

6. Kong, V., 2003. *Vulcan-Hart, Model SG4D Gas Full-Size Convection Oven Performance Test.* Food Service Technology Center Report 5011.03.15, April.

7. Kong, V., 2004. *Vulcan-Hart, Model VC4GD Gas Full-Size Convection Oven Performance Test.* Food Service Technology Center Report 5011.03.08-2nd Edition, May.

8. Wilson, L., 2006 *Lang ChefSeries OCE Convection Oven Performance Test*. Food Service Technology Center Report 5011.06.09, June.

9. Sorensen, G., 2007 *Vulcan-Hart, Model VC4ED Electric Convection Oven Performance Test*. Food Service Technology Center Report 5011.07.09, May.

References

10. Kong, V., 2007 *Blodgett, Model DFG100 Xcel Gas Full Size Convection Oven Performance Test*. Food Service Technology Center Report 5011.07.27, December.
11. Sorensen, G., 2008 *Garland Master Gas Convection Oven with Master 200 Controls*. Food Service Technology Center Report 5011.08.05, March.
12. Sorensen, G., 2008 *Garland Master Gas Convection Oven with Master 450 Controls*. Food Service Technology Center Report 5011.08.06, March.

Appendixes

A Glossary

Cooking-Energy (kWh or kBtu)

The total energy consumed by an appliance as it is used to cook a specified food product.

Cooking-Energy Consumption Rate (kW or kBtu/h)

The average rate of energy consumption during the cooking period.

Cooking-Energy Efficiency (%)

The quantity of energy input to the food products; expressed as a percentage of the quantity of energy input to the appliance during the heavy-, medium-, and light-load tests.

Duty Cycle (%)
Load Factor

The average energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

$$\text{Duty Cycle} = \frac{\text{Average Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Energy Input Rate (kW or kBtu/h)
Energy Consumption Rate
Energy Rate

The peak rate at which an appliance will consume energy, typically reflected during preheat.

Heating Value (Btu/ft^3)
Heating Content

The quantity of heat (energy) generated by the combustion of fuel. For natural gas, this quantity varies depending on the constituents of the gas.

Idle Energy Rate (kW or Btu/h)
Idle Energy Input Rate
Idle Rate

The rate of appliance energy consumption while it is holding or maintaining a stabilized operating condition or temperature at a specified control setting.

Idle Temperature (°F, Setting)

The temperature of the cooking cavity/surface (selected by the appliance operator or specified for a controlled test) that is maintained by the appliance under an idle condition.

Idle Duty Cycle (%)
Idle Energy Factor

The idle energy consumption rate expressed as a percentage of the measured energy input rate.

$$\text{Idle Duty Cycle} = \frac{\text{Idle Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Measured Input Rate (kW or Btu/h)
Measured Energy Input Rate
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during appliance preheat (i.e., the period of operation when all burners or elements are "on").

Pilot Energy Rate (kBtu/h)
Pilot Energy Consumption Rate

The rate of energy consumption by the standing or constant pilot while the appliance is not being operated (i.e., when the thermostats or control knobs have been turned off by the food service operator).

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

The total amount of energy consumed by an appliance during the preheat period.

Preheat Rate (°F/min)

The rate at which the cook zone heats during a preheat.

Preheat Time (minute)
Preheat Period

The time required for an appliance to "preheat" from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

Production Capacity (lb/h)

The maximum production rate of an appliance while cooking a specified food product in accordance with the heavy-load cooking test.

Production Rate (lb/h)
Productivity

The average rate at which an appliance brings a specified food product to a specified "cooked" condition.

Rated Energy Input Rate
(kW, W or Btu/h, Btu/h)
Input Rating (ANSI definition)
Nameplate Energy Input Rate
Rated Input

The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

Recovery Time (minute, second)

The average time from the removal of the cooked food product from the appliance until the cooking cavity is within 10°F of the thermostat set point and the appliance is ready to be reloaded.

Test Method

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.

B Appliance Specifications

Appendix B includes the product literature for the Hobart HEC504 electric convection oven.

Item # ____________________

Quantity ____________________

C.S.I. Section 11400

HOBART

701 S Ridge Avenue, Troy, OH 45374

1-888-4HOBART • www.hobartcorp.com

HEC5 SERIES ELECTRIC CONVECTION OVENS

STANDARD FEATURES

- Stainless Steel Front, Sides and Top
- Painted Legs
- Stainless Steel Doors with Windows
- 12.5 KW Input
- ½ H.P. Two Speed Oven Blower Motors.
- Solid State Temperature Controls Adjust from 150° to 500°F
- 60 Minute Timer per Section with Audible Alarm
- Oven Cool Switch for Rapid Cool Down
- Porcelain Enamel on Steel Oven Interior
- Five Nickel Plated Oven Racks with Eleven Rack Positions per Section
- 208 or 240 Volt, 60 Hz, 1 or 3 Phase
- Computer Controls with Digital Time & Temperature Readout. Includes Cook & Hold Cycle, Shelf ID, and 24 hr. Timer with Audible Alarm (D Models Only)

OPTIONS

- ❑ Stainless Steel Legs
- ❑ Casters
- ❑ Stainless Steel Back Panel
- ❑ 480 Volt, 60 Hz, 3 Phase

UL® NSF®

MODELS

- ❑ HEC501 – Single Deck Electric Convection Oven
- ❑ HEC501D – Single Deck Computer Control Electric Convection Oven
- ❑ HEC502 – Double Deck Electric Convection Oven
- ❑ HEC502D – Double Deck Computer Control Electric Convection Oven
- ❑ HEC504 – Single Deck Electric Convection Oven with Open Stand
- ❑ HEC504D – Single Deck Computer Control Electric Convection Oven with Open Stand

ACCESSORIES

- ❑ Extra Oven Rack(s)
- ❑ Stainless Steel Drip Pan
- ❑ Down Draft Flue Diverter for Direct Vent Connection
- ❑ Stacking Kit (HEC501 and HEC501D only)

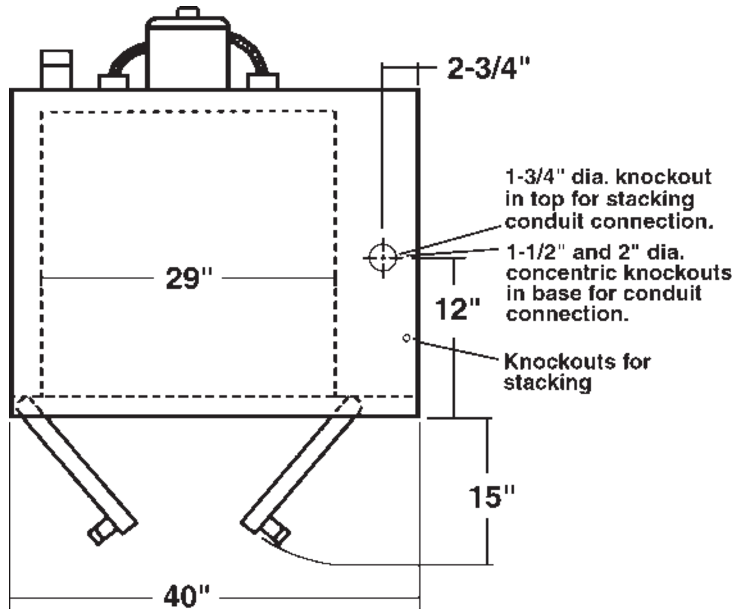
Specifications, Details and Dimensions on Inside and Back.

HOBART

HEC5 SERIES ELECTRIC CONVECTION OVENS

IMPORTANT

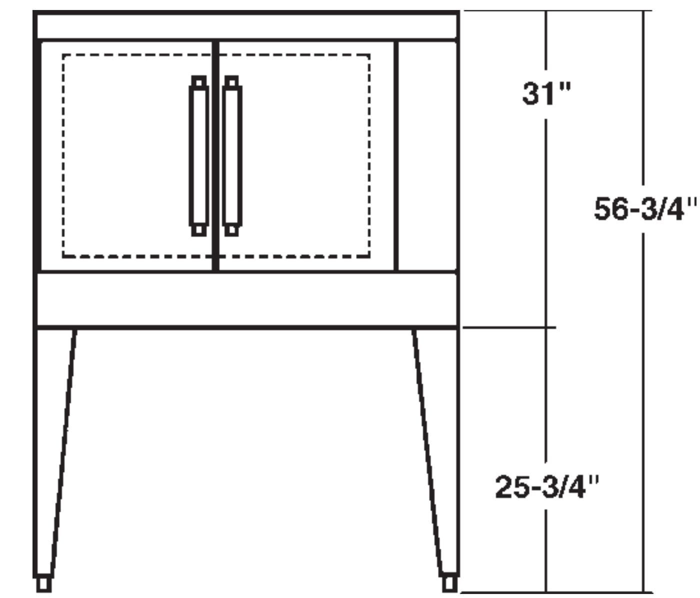
1. An adequate ventilation system is required for commercial cooking equipment. Information may be obtained by writing to the National Fire Protection Association, Batterymarch Park, Quincy, MA 02289. When writing, refer to NFPA No. 96.
2. This appliance is manufactured for commercial installation only and is not intended for home use.

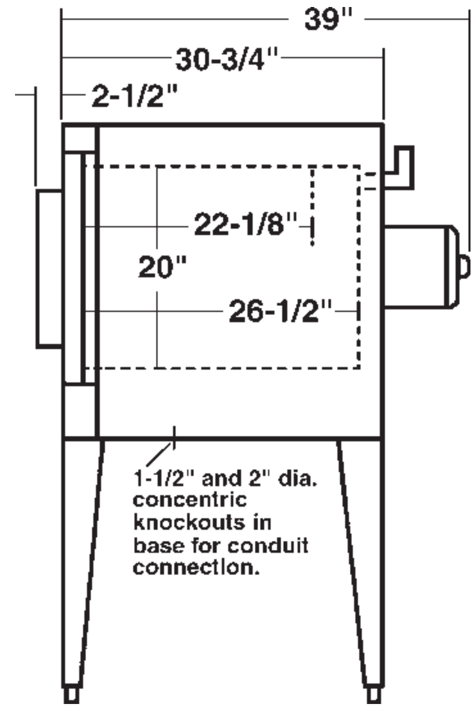


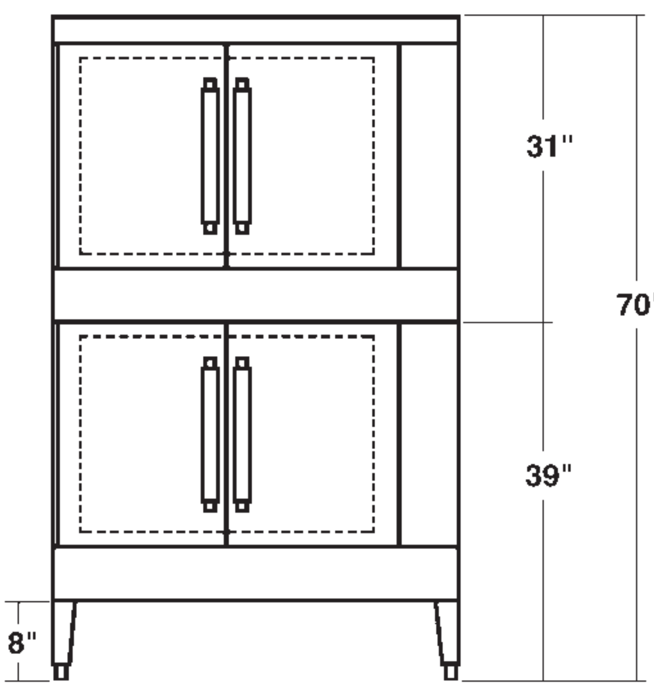
MODEL NO.	WIDTH	DEPTH (INCLUDES HANDLES)	HEIGHT	KW PER OVEN	TOTAL KW	ELECTRICAL	APPROX. SHP. WT. LBS.
HEC501 HEC501D	40"	41½"	56¾"	12.5	12.5	208 or 240/60/1 or 3	590
HEC502 HEC502D	40"	41½"	70"	12.5	25	208 or 240/60/1 or 3	1,180

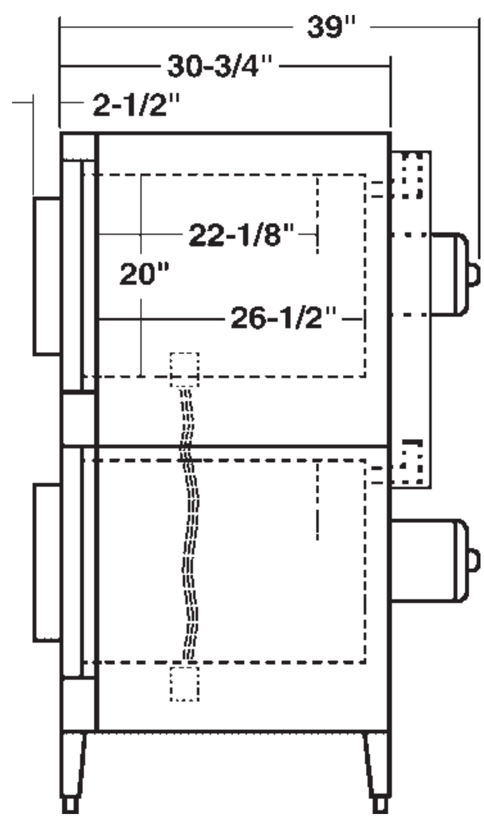
MODEL NO.	TOTAL CONN. KW	3 PHASE LOAD KW PER PHASE			NOMINAL AMPS PER LINE WIRE										
					3 PHASE									1 PHASE	
					208 VOLT			240 VOLT			480 VOLT				
		X-Y	Y-Z	X-Z	X	Y	Z	X	Y	Z	X	Y	Z	208V	240V
HEC501 HEC501D	12.5	4	4	4.5	35	33	35	33	29	33	14	15	15	60	52
HEC502 HEC502D	25	8	8	9	70	66	70	66	58	66	28	30	30	120	104

DETAILS AND DIMENSIONS









HOBART
701 S Ridge Avenue, Troy, OH 45374
1-888-4HOBART • www.hobartcorp.com

SPECIFICATIONS

General: Electric convection oven. Basic section **(HEC5/HEC5D)** is without legs; may be ordered separately for replacement, for stacking 2-high or for mounting on legs. **HEC501/HEC501D** single basic section on 25¾" legs. **HEC502/HEC502D** two basic HEC5/HEC5D sections on 8" legs.

Construction: Stainless steel front, sides and top, painted legs. Porcelain enamel on steel oven interior. Simultaneously operated stainless steel doors with windows. Two interior oven lights per section. Non-sag insulation applied to the top, rear, sides, bottom and doors.

Oven interior measures 29"w x 22⅛"d x 20"h. Five nickel plated oven racks per section measure 28¼" x 20½". Eleven position nickel plated rack guides with positive rack stops per section.

Controls: Side mounted, solid-state temperature controls adjust from 150° to 500°F. 60-minute timer with audible alarm. Oven cool switch for rapid cool down.

“D” models feature side-mounted computer controls adjustable from 150° to 500°F, 24-hour timer with audible alarm, six programmable preset buttons, Cook & Hold and Shelf ID.

Electrical: One ½ H.P. two-speed oven blower-motor per section. Rated power input is 12.5 KW per section. 208 or 240 volts, 60 Hz, 1 or 3 phase.

IMPORTANT

WHEN ORDERING: The following must be specified:

1) Required voltage

C Results Reporting Sheets

Test Oven Description

Manufacturer:	Hobart
Model Number:	HEC504
Date:	May 2007

1. Test Convection Oven (11.1)

Fuel Type:	Electricity
Half-size or full-size:	Full-size
Rated Input:	12.5 kW
Oven cavity volume (in^3):	12,833
Controls:	Single thermostat adjustable from 150 to 500°F, 0 to 60 minute cook timer, two-speed fan switch, cool switch, and moisture vent damper.

Description of operational characteristics:

The Hobart HEC504 is an electric, full size convection oven with a rated energy input of 12.5kW. A two-speed fan, located in the rear of the oven, is used to circulate hot air throughout the cavity. A switch changes the fan between low and high speeds. The fan is typically operated in high speed, but may be set to low speed when cooking delicate food products. A solid-state control main tains oven temperature by means of a dial control. There is a cool down mode that runs the fan while the oven doors are open to speed up the cooling off period.

2. Apparatus (11.2)

_√_ Check if testing apparatus conformed to specifications in Section 6.

Deviations: None

3. Thermostat Calibration (11.4)

As-Received:

Oven temperature control setting (°F)	350
Oven cavity temperature (°F)	364.1
Oven temperature control setting (°F)	300
Oven cavity temperature (°F)	315.4

As-Adjusted Condition:

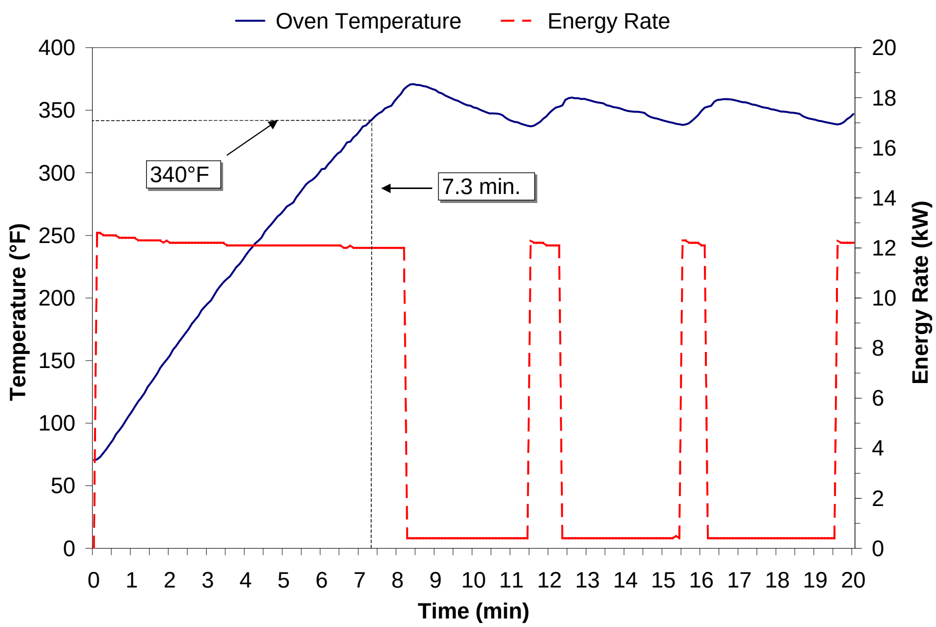
Oven temperature control setting (°F)	335
Oven cavity temperature (°F)	350 ± 5
Oven temperature control setting (°F)	285
Oven cavity temperature (°F)	300 ± 5

4. Energy Input Rate (11.5)

Test voltage (V)	208
Gas heating value (Btu/ft^3)	N/A
Measured (Btu/h or kW)	12.2
Rated (Btu/h or kW)	12.5
Percent difference between measured and rated (%)	2.7
Gas oven-fan and control energy rate (kW)	N/A

5. Preheat Energy and Time (11.6)

Test voltage (V)	208
Gas heating value (Btu/ft^3)	N/A
Starting temperature (°F)	70.6
Energy consumption (Btu or kWh)	1.48
Electric energy consumption (kW, gas ovens only)	N/A
Duration (min)	7.3
Preheat rate (°F/min)	37



Preheat Curve

6. Pilot Energy Rate (if applicable) (11.7)

Gas heating value (Btu/ft^3)	N/A
Pilot energy rate (Btu/h or kW)	N/A

7. Idle Energy Rate (11.8)

Test voltage (V)	208
Gas heating value (Btu/ft^3)	N/A
Idle energy rate at 350°F (Btu/h or kW)	1.9
Electric energy rate at 350°F (kW, gas ovens only)	N/A

8. Cooking-Energy Efficiency, Cooking Energy Rate, and Production Capacity (11.9)

Heavy-Load:

Test voltage (V)	208
Gas heating value (Btu/ft^3)	N/A
Cooking time (min)	47.9
Production rate (lb/h)	92.2 ± 3.4
Energy to food (Btu/lb)	250
Cooking energy rate (Btu/h or kW)	9.5

Electric energy rate (kW, gas ovens only)	N/A
Energy per pound of food cooked (Btu/lb or kWh/lb)	351
Cooking-energy efficiency	71.0 ± 1.3

Medium-Load:

Test voltage (V)	208
Gas heating value (Btu/ft^3)	N/A
Cooking time (min)	43.3
Production rate (lb/h)	61.3 ± 1.7
Energy to food (Btu/lb)	244
Cooking energy rate (Btu/h or kW)	7.1
Electric energy rate (kW, gas ovens only)	N/A
Energy per pound of food cooked (Btu/lb or kWh/lb)	396
Cooking-energy efficiency	61.6 ± 1.6

Light-Load:

Test voltage (V)	208
Gas heating value (Btu/ft^3)	N/A
Cooking time (min)	43.7
Production rate (lb/h)	20.3 ± 0.4
Energy to food (Btu/lb)	252
Cooking energy rate (Btu/h or kW)	3.7
Electric energy rate (kW, gas ovens only)	N/A
Energy per pound of food cooked (Btu/lb or kWh/lb)	622
Cooking-energy efficiency	40.5 ± 1.2

9. Cooking Uniformity (Frozen Macaroni and Cheese) (11.10)

Test Voltage (V)	208
Gas heating value (Gas heating value (Btu/ft^3)	N/A

Rack	Average Rack Temperature (°F)
1 (Top)	163
2	151
3	190
4	167
5 (Bottom)	179

10. Browning Uniformity Test (White Sheet Cakes) (11.11)

Description of sheet cake browning and surface irregularities. Includes a sketch or photograph of the browning pattern and a discussion of the differences of the results from cake to cake.

Cake #1 (Top). The surface of this cake had an even golden brown color that was very uniform across the entire surface.

Cake #2. This cake was characterized by a light section near the middle of the cake that grew slightly wider towards the front. The edges were also a dark brown color.

Cake #3 (Middle). This cake had a small light section near the middle rear of the pan. The light area transitioned to edges on both sides that were dark brown, especially near the front left and right middle.

Cake #4. This cake showed a large light area, generally around the middle of the cake, and extending towards the front left corner. The edges were very dark in certain areas, especially along the left front and right sides.

Cake #5 (Bottom). This cake exhibited a light area from the left rear to the center front of the cake. The remainder of the cake was a golden brown color.

D Cooking-Energy Efficiency Data

Table D-1. Specific Heat and Latent Heat.

Specific Heat (Btu/lb, °F)	
Potatoes	0.84
Macaroni & Cheese	0.695
Latent Heat (Btu/lb)	
Fusion, Water	144
Vaporization, Water	970

Cooking-Energy Efficiency Data

Table D-2. Heavy-Load Potato Test Data.

	Test #1	Test #2	Test #3
Measured Values			
Energy to Oven (kWh)	7.62	7.44	7.66
Cook Time (min)	48.2	47.1	48.3
Initial Weight of Potatoes (lb)	73.48	73.63	73.59
Final Weight of Potatoes (lb)	62.83	63.52	63.03
Initial Temperature of Potatoes (°F)	70.7	72.4	72.0
Final Temperature of Potatoes (°F)	205.0	205.0	205.0
Calculated Values			
Sensible (Btu)	8,290	8,201	8,221
Latent - Water Vaporization (Btu)	10,332	9,800	10,244
Total Energy to Food (Btu)	18,622	18,001	18,466
Energy to Food (Btu/lb)	253	244	251
Total Energy to Oven (Btu)	26,007	25,393	26,144
Energy per Pound of Food Cooked (Btu/lb)	354	345	355
Cooking-Energy Efficiency (%)	71.6	70.9	70.6
Cooking Energy Rate (kW)	9.5	9.5	9.5
Production Rate (lb/h)	91.5	93.8	91.4

Table D-3. Medium-Load Potato Test Data.

	Test #1	Test #2	Test #3
Measured Values			
Energy to Oven (kWh)	5.18	5.16	5.06
Cook Time (min)	43.4	43.7	42.8
Initial Weight of Potatoes (lb)	44.16	44.21	44.24
Final Weight of Potatoes (lb)	38.20	38.02	38.16
Initial Temperature of Potatoes (°F)	70.5	74.4	74.6
Final Temperature of Potatoes (°F)	205.0	205.0	205.0
Calculated Values			
Sensible (Btu)	4,989	4,850	4,846
Latent - Water Vaporization (Btu)	5,786	6,002	5,899
Total Energy to Food (Btu)	10,775	10,852	10,745
Energy to Food (Btu/lb)	244	245	243
Total Energy to Oven (Btu)	17,679	17,611	17,270
Energy per Pound of Food Cooked (Btu/lb)	400	398	390
Cooking-Energy Efficiency (%)	60.9	61.6	62.2
Cooking Energy Rate (kW)	7.2	7.1	7.1
Production Rate (lb/h)	61.1	60.7	62.0

Table D-4. Light-Load Potato Test Data.

	Test #1	Test #2	Test #3
Measured Values			
Energy to Oven (kWh)	2.68	2.70	2.70
Cook Time (min)	43.4	43.8	44.0
Initial Weight of Potatoes (lb)	14.77	14.76	14.78
Final Weight of Potatoes (lb)	12.60	12.50	12.62
Initial Temperature of Potatoes (°F)	78.3	77.4	75.2
Final Temperature of Potatoes (°F)	205.0	205.0	205.0
Calculated Values			
Sensible (Btu)	1,572	1,582	1,611
Latent - Water Vaporization (Btu)	2,107	2,198	2,094
Total Energy to Food (Btu)	3,679	3,780	3,706
Energy to Food (Btu/lb)	249	256	251
Total Energy to Oven (Btu)	9,147	9,215	9,215
Energy per Pound of Food Cooked (Btu/lb)	619	624	624
Cooking-Energy Efficiency (%)	40.2	41.0	40.2
Cooking Energy Rate (kW)	3.7	3.7	3.7
Production Rate (lb/h)	20.4	20.2	20.2

Cooking-Energy Efficiency Data

Table D-5. Cooking-Energy Efficiency and Production Capacity Statistics.

	Cooking-Energy Efficiency			
	Heavy Load	Medium Load	Light Load	Production Capacity
Replicate #1	71.6	60.9	40.2	91.5
Replicate #2	70.9	61.6	41.0	93.8
Replicate #3	70.6	62.2	40.2	91.4
Average	71.0	61.6	40.5	92.2
Standard Deviation	0.50	0.63	0.46	1.35
Absolute Uncertainty	1.25	1.57	1.15	3.36
Percent Uncertainty	1.80	2.60	2.80	3.64

E Energy Cost Model

Procedure for Calculating the Energy Consumption of a Convection Oven Based on Reported Test Results.

Appliance test results are useful not only for benchmarking appliance performance, but also for estimating appliance energy consumption. The following procedure is a guideline for estimating convection oven energy consumption based on data obtained from applying the appropriate test method.

The intent of this Appendix is to present a standard method for estimating oven energy consumption based on ASTM performance test results. The examples contained herein are for informational purposes only, and should not be considered an absolute. To obtain an accurate estimate of energy consumption for a particular operation, parameters specific to that operation should be used (for example, operating time and amount of food cooked under heavy, medium, and light loads).

The calculation will proceed as follows: First, determine the appliance operating time and total number of preheats. Then estimate the quantity of food cooked and establish the breakdown among heavy (fully loaded oven), and light (single-pan) loads. For example, an oven operating for 12 h a day with two preheats cooked 100 lb of food: 50% of the food was cooked under heavy-load conditions, 40% was cooked under medium-load conditions, and 10% was cooked under light-load conditions. Calculate the energy due to cooking heavy-, medium-, and light-load cooking rates, and then calculate the idle energy consumption. The total daily energy is the sum of the components plus the preheat energy. For simplicity, assume that subsequent preheats require the same time and energy as the first preheat of the day.

The application of the test method to the HEC504 electric convection oven yielded the following results:

Energy Cost Model

Table E-1: Electric Oven Test Results.

Test	Result
Preheat Time	7.3 min
Preheat Energy	1.48 kWh
Idle Energy Rate	1.90 kW
Heavy-load cooking energy rate	9.5 kW
Medium-load cooking energy rate	7.1 kW
Light-load cooking energy rate	3.7 kW
Production Capacity	92.2 lb/h
Medium-load production rate	61.3 lb/h
Light-load production rate	20.3 lb/h

***Step 1*—The operation being modeled has the following parameters**

Table E-2: Oven Operation Assumptions.

Operating Time per Day	12 h
Operating Days per Year	365 d
Number of Preheats per Day	2
Total Amount of Food Cooked per Day	100 lb
Percentage of Food Cooked Under Heavy-load Conditions	50 %
Percentage of Food Cooked Under Medium-load Conditions	40 %
Percentage of Food Cooked Under Light-load Conditions	10 %

***Step 2*—Calculate the time and energy involved in cooking heavy (full) loads.**

The total time cooking heavy loads is as follows:

$$t_h = \frac{\%h \times W}{PC},$$

$$t_h = \frac{50\% \times 100\,lb}{92.2\ lb/h},$$

$$t_h = 0.54\,h$$

The total heavy-load energy consumption is then calculated as follows:

$$E_{elec,h} = q_{elec,h} \times t_h,$$

$$E_{elec,h} = 9.5\ kW \times 0.54\ h,$$

$$E_{elec,h} = 5.13\ kWh$$

***Step 3*—Calculate the time and energy involved in cooking medium (half) loads.**

The total time cooking medium loads is as follows:

$$t_m = \frac{\%m \times W}{PR_m},$$

$$t_m = \frac{40\% \times 100\,lb}{61.3\,lb/h},$$

$$t_m = 0.65\,h$$

The total medium-load energy consumption is then calculated as follows:

$$E_{elec,m} = q_{elec,m} \times t_m,$$

$$E_{elec,m} = 7.1\ kW \times 0.65\ h,$$

$$E_{elec,m} = 4.62\ kWh$$

***Step 4*—Calculate the time and energy involved in cooking light (single-pan) loads.**

The total time cooking light loads is as follows:

$$t_l = \frac{\%l \times W}{PR_l},$$

$$t_l = \frac{10\% \times 100\ lb}{20.3\ lb/h},$$

$$t_l = 0.49\ h$$

The total light-load energy consumption is then calculated as follows:

$$E_{elec,l} = q_{elec,l} \times t_l,$$

$$E_{elec,l} = 3.7\ kW \times 0.49\ h,$$

$$E_{elec,l} = 1.81\ kWh$$

***Step 5*—Calculate the total idle time and energy consumption.**

The total idle time is as follows:

$$t_i = t_{on} - t_h - t_m - t_l - \frac{n_p \times t_p}{60},$$

The total light-load energy consumption is then calculated as follows:

$$t_i = 12\ h - 0.54\ h - 0.65\ h - 0.49\ h - \frac{2\ preheats \times 7.3\min}{60},$$

$$t_i = 10.1\ h$$

The idle energy consumption is then calculated as follows:

$$E_{elec,i} = q_{elec,i} \times t_i,$$

$$E_{elec,i} = 1.9\ kW \times 10.1\ h,$$

$$E_{elec,i} = 19.2\ kWh$$

Step 6—**Calculate the total daily energy consumption as follows:**

$$E_{elec,daily} = E_{elec,h} + E_{elec,m} + E_{elec,l} + E_{elec,i} + (n_p \times E_{elec,p})$$

$$E_{elec,daily} = 5.13\ kWh + 4.62\ kWh + 1.81\ kWh + 19.2\ kWh + (2\ preheats \times 1.48\ kWh)$$

$$E_{elec,daily} = 33.7\ kWh/day$$

Step 7—**Calculate the average demand as follows:**

$$q_{avg} = \frac{E_{elec,daily}}{t_{on}}$$

$$q_{avg} = \frac{33.7\ kWh/day}{12\ h/day}$$

$$q_{avg} = 2.8\ kW$$

***Step 8*—Determine the estimated annual appliance energy cost as follows:**

$$C_{elec,annual} = r_{elec} \times E_{elec,daily} \times d_{op}$$

$$C_{elec,annual} = \$0.10/kWh \times 33.7\ kWh/day \times 365\ days$$

$$C_{elec,annual} = \$1{,}230/year$$