Convection Ovens for Food Service Applications – Blodgett SHO-E

ET09SCE1091 Report

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Disclaimer

ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
Btu	British Thermal Unit
CFM	Cubic Feet Per Minute
CT	Current Transducer
DAS	Data Acquisition System
F	Fahrenheit
ft	Feet
FTC	Foodservice Technology Center
hr.	Hour
in	Inches
kW	Kilowatts
kWh	Kilowatt-hours
lb	Pound
SCE	Southern California Edison
VAR	Volt-Ampere Reactive

FIGURES

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EXECUTIVE SUMMARY

Convection ovens are general-purpose (standard) ovens used to cook food products by forcing hot dry air over the surface of the food product. Convection ovens originated from standard ovens and were developed to increase the amount of food production as well as to solve the problem of uneven heat distribution in the cooking cavity. The fans inside convection ovens ensure that a uniform temperature reaches all parts of the food and transfers heat more evenly and efficiently, allowing food to cook faster and at a lower temperature. Convection ovens are popular in both full- and half-sizes.

This project assesses the energy efficiency level of the Blodgett Model SHO-E electric convection oven and seeks to determine an appliance baseline and a minimum energy efficiency level necessary to qualify for the food service qualifying product list.

During this project the Blodgett Model SHO-E oven, a full-size commercial electric convection oven with a capacity of eleven pans, was examined for various performance metrics. A test procedure was conducted in order to characterize the Blodgett convection oven's energy input rate, preheat energy, idle energy rate, cooking energy efficiency, production capacity, cooking uniformity, and browning uniformity according to the American Society for Testing and Materials F1496-99(2005) Standard Test Method for Performance of Convection Ovens.

Testing was performed at the Southern California Edison Foodservice Technology Center (FTC) in Irwindale, CA. Cook time, oven temperature, oven power input, and the weight and temperature of the test food were carefully measured. The test food used during the procedure was potatoes.

From the extensive measurements collected, oven efficiency and numerous heat rate and uniformity factors were calculated. The test data provides key information to help determine the operational costs and the percentage of total kitchen productivity a single appliance can deliver.

The following parameters of the Blodgett Model SHO-E oven were determined during the testing procedure:

- **Energy Input Rate:** The maximum energy input rate recorded during the test was 10.72 kilowatt (kW).
- **Preheat Energy Rate:** The oven took 8.63 minutes to reach a temperature of 340 degree Fahrenheit (°F), yielding a preheat energy rate of 31.27°F per minute (/min).
- **Idle Energy Rate:** The idle energy rate, the amount of energy to maintain a 350°F setpoint, was recorded as 1.63 kW.
- **Cooking Energy Efficiency:** The average cooking energy efficiency as determined by three heavy-load tests was 73%.
- **Production Capacity:** The average measured production capacity was 90.04 pounds (lbs)/hour (hr.).

INTRODUCTION

Convection ovens are general-purpose (standard) ovens used to cook food products by forcing hot dry air over the surface of the food product. Convection ovens originated from standard ovens and were developed to increase the amount of food production as well as to solve the problem of uneven heat distribution in the cooking cavity. The fans inside the ovens ensure that a uniform temperature reaches all parts of the food and transfers heat more evenly and efficiently allowing it to cook food faster and at a lower temperature. Convection ovens allow four to eight closely spaced racks of food to cook at the same time and are a popular choice in the food service industry. The heat in a convection oven is typically supplied through a heating element shielded from the baking cavity by a steel baffle plate. Fans push air over the heating elements and into the cooking chamber where the food is cooked. Electric convection ovens are typically insulated on all sides and most have stainless steel exterior cladding, with an optional front window. Convection ovens are popular in full- and half-sizes.

The Blodgett Model SHO-E oven, a full-size commercial electric convection oven with a capacity of 11 pans, was examined for various performance metrics. A test procedure was conducted in order to characterize the Blodgett Model SHO-E oven's energy input rate, preheat energy, idle energy rate, cooking energy efficiency, and production capacity, according to the American Society for Testing and Materials (ASTM) F 1496-99(2005) Standard Test Method for Performance of Convection Ovens report[1].

Cook time, oven temperature, oven power input, and the weight and temperature of the test food were carefully measured. The test food used during the procedure was potatoes. Oven efficiency and numerous heat rate and uniformity factors were calculated based on the collected measurements.

BACKGROUND

Southern California Edison (SCE) is committed to the advancement of the food service industry and is part of a statewide team offering a food service qualifying product list that identifies the most efficient commercial kitchen appliances within a specific appliance category. The qualifying appliances are eligible to receive incentives for their use. Currently, convection ovens are listed as one of the appliance categories on the food service qualifying list. Testing is in progress to add different categories and manufacturers to this qualified list.

Commercial electric convection ovens are the most widely used appliances in the food service industry; they are used in 80% of restaurants, 95% of school districts, 75% of supermarkets, and 70% of the hotel and hospitality industry [2]. Because such a large number of convection ovens are used, incentivizing more efficient convection ovens will have a significant energy savings impact.

GOALS OF THE STUDY

This project evaluates the operation and performance of the Blodgett full-size convection oven using ASTM standard test methods. The testing seeks to determine the efficiency level of the appliance. Once a large enough sampling of ovens is tested, an appliance baseline and a minimum efficiency level for inclusion into the food service qualifying product list can be determined. The testing examines the:

- **Energy Input Rate:** The peak rate at which a convection oven consumes energy, in kilowatts (kW).
- **Preheat Energy Rate:** The amount of energy consumed, kilowatt-hours (kWh), by the convection oven while preheating its cavity from the ambient temperature to the specified thermostat setpoint.
- **Idle Energy Rate:** The convection ovens required rate of energy consumption (kW) when empty that is necessary to maintain its cavity temperature at a specified thermostat setpoint.
- **Cooking Energy Efficiency:** The quantity of energy imparted to a specific food product; this is expressed as a percentage of energy consumed by the convection oven during the cooking event.
- **Cooking Energy Rate:** The average rate of energy consumption (kW) during the heavy load-cooking test.
- **Production Capacity:** The rate pounds (lbs)/hour (hr) at which a convection oven brings the specified food product to a specified cooked condition. This does not necessarily refer to the maximum rate, and the production rate varies based on the amount of food cooked.

APPLIANCE EVALUATED

The Blodgett Model SHO-E oven, shown in Figure 1, has a stainless steel outer construction, with dual pane thermal glass window on the left oven door, solid stainless steel on the right oven door and an insulated porcelain steel inner compartment liner. The unit features solid mineral fiber insulation on back, and fiberglass insulation on top, sides, and bottom of cooking compartment. It is equipped with solid-state temperature control accurate to ±4°F, a two-speed fan, 1/3 horsepower blower motor with automatic thermal overload protection and a control area cooling fan. In addition, the oven features an operating range from 200°F to 500°F. Appliance specifications and the manufacturer's literature are included in Appendix A. The biggest market barriers of electric convection ovens are the lack of customer education on efficient ovens and incentives and the low number of efficient full- and half-sized convection ovens listed on the food service qualifying product list.

FIGURE 1. BLODGETT MODEL SHO-E

TEST METHODOLOGY

Laboratory testing of this oven was performed according to the ASTM F 1496-99(2005) test method for convection ovens. Testing methods are outlined for general purpose, full-size, and half-size convection ovens primarily used for baking food products. The testing provides information to determine:

- Energy Input Rate
- Preheat Energy Rate
- Idle Energy Rate
- Cooking Energy Efficiency
- Cooking Energy Rate
- Production Capacity

LABORATORY AND INSTRUMENTATION DESCRIPTION

Testing was performed at the SCE Foodservice Technology Center (FTC), a 2,000 square-foot demonstration, and equipment test center. The center is part of the Energy Education Center, located in Irwindale, CA and is a certified ASTM and ENERGY STAR® testing laboratory. The FTC is capable of maintaining voltage regulation to ± 1 volt (V) on 120 V, 208 V, and 240 V single- and three-phase. Receptacle configurations range from 20 amperes (A)/120 V single-phase to 100 A/208 V/240 V single- and three-phase. The FTC is also equipped with a Data Acquisition System (DAS), a National Instruments LabVIEW-based software, as shown in Figure 2, used to monitor power (kW), amperage, voltage, power factor, frequency, and volt-ampere reactive (VAR) from all receptacles and displays the results in a real-time graph during testing. The electrical consumption of the ovens is logged in intervals of 1 second and the data from up to 36 thermocouples and 8 resistant temperature detection sensors is recorded. The interface also allows the user to configure the monitoring parameters and select specific monitoring hardware.

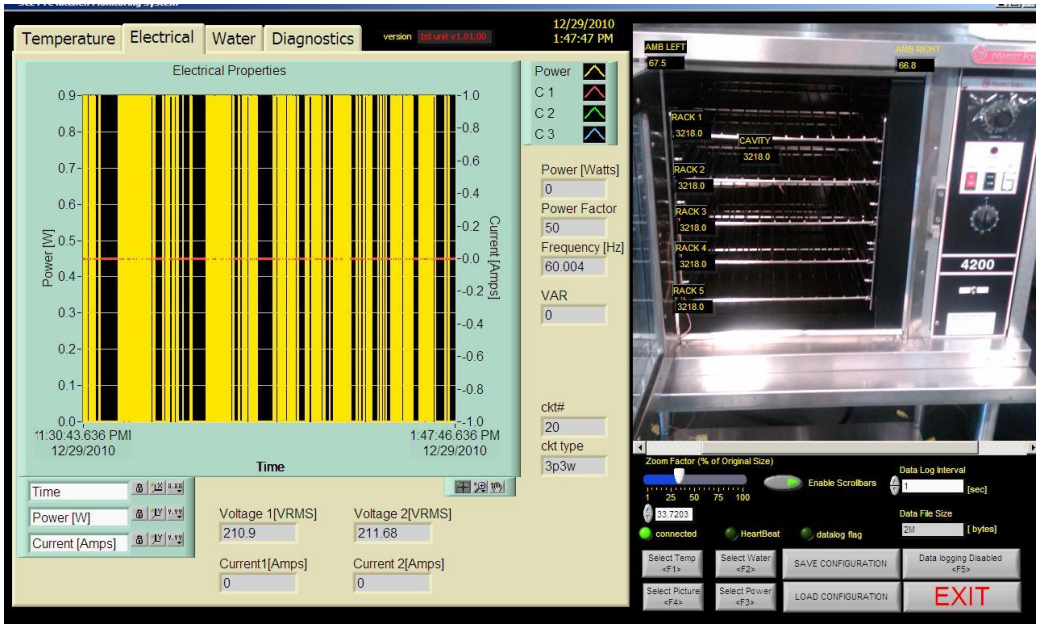

FIGURE 2. DAS INTERFACE WITH NATIONAL INSTRUMENTS LABVIEW

The DAS system is equipped with multi-functional digital transducers, integrated serial current transducers (CTs), and voltage leads. The multi-functional digital transducers create power readings from the CT and voltage inputs and have an accuracy of ± 0.5% over the full-scale readings. The CTs used in this project are accurate to 10% FS, or better, and have a frequency response ranging from 44 Hertz (Hz) to 3,000 kHz. The DAS system was calibrated in November 2009 and uses K type thermocouples and connectors. The K type thermocouples can read a temperature range of -328°F to 2,282°F with accuracy of ± 2.2°F or 0.75% of temperature reading above 32°F and 2% of temperature reading below 32°F[3]. A fiberglass insulated 24-gauge thermocouple was used to determine the cavity temperature as well as the temperature of the potatoes. When determining the weight of the potatoes, a model A&D FG-60KAL digital scale that has a resolution of 0.01 lb. and an uncertainty of 0.01 lb. (Figure 3) was used.

FIGURE 3. A&D FG-60KAL MODEL DIGITAL SCALE

TEST SITE SETUP

The test site setup refers to the installation of the convection oven, condition of the environment, and the setup of temperature measurements for the potatoes and macaroni and cheese. At the test site, the convection oven was installed according to the manufacturer's instructions and placed under a deep canopy exhaust hood that was mounted against the wall. The lower edge of the hood was positioned 6 feet (ft.), 6 inches (in.) from the floor, with the front edge of the oven door inset 6 in. from the vertical plane of the front edge of the hood. Both sides of the convection oven were 3 feet away from any nearby walls. The exhaust ventilation rate was set to 300 cubic feet per minute (CFM) per linear foot of hood length. The ambient conditions were kept at a temperature of 75 ± 5°F during operation of the exhaust ventilation system. The oven was connected to a calibrated energy test meter, and supply voltage was maintained within 2.5% of the manufacturer's nameplate voltage.

For standard full-size ovens with 9 rack positions, racks are placed at positions 1, 3, 5, 7, and 9. The Blodgett Model SHO-E oven is a full-size oven with 11 rack positions, so five racks were positioned to divide the cavity into approximately equal cooking zones.

The bead of a bare junction thermocouple measured the temperature of the test potatoes both before and after they were cooked, measuring from the center of each monitored test potato. The initial temperatures for the potatoes at the start of each test were 75 ± 5°F.

THERMOSTAT CALIBRATION

Thermostat calibration is verified by installing a thermocouple in the center of the oven cavity; placing a thermocouple in the center of the cavity allows for consistent temperature measurement on all types of convection ovens. Calibration is necessary since the placement of the oven's temperature sensors can differ greatly between varying models and manufacturers. The convection oven display temperature typically differs from the reading taken by the cavity thermocouple. When performing a thermostat calibration, the oven is set to 350°F and allowed to stabilize for 1 hour before readings of the cavity thermocouple are taken. After the 1-hour idle period, oven temperatures are recorded at 30-second intervals for 15 minutes. If the thermocouple reads an average temperature of 350 ± 5°F for a 15-minute period, the oven's thermostat is calibrated.

ENERGY INPUT RATE AND PREHEAT ENERGY CONSUMPTION

Both the energy input and preheat energy rates are used to confirm proper operation of the convection oven. The preheat test records the required amount of time and energy needed to raise the convection oven cavity temperature from an ambient of 75°F to a ready-to-cook-condition. In this test, the oven was considered to be in ready-to-cook-condition when the cavity reached 340°F. Temperature measurements were taken every 5 seconds. Once the oven reached its setpoint of 350°F, it stabilized for 1 hour.

The energy input rate is the peak energy consumption of the oven while preheating the oven from ambient temperature to a setpoint of 350°F. The peak energy consumption, measured by an electrical meter must be operating within 5% of the nameplate energy input rate.

IDLE ENERGY RATE

After stabilization, the idle energy rate was taken by monitoring the consumption of the convection oven for a 3-hour period, with the same setpoint of 350°F. The idle energy rate is the convection oven's required rate of energy consumption (kW) when empty, needed to maintain its cavity temperature at a specified thermostat setpoint.

COOKING ENERGY EFFICIENCY AND PRODUCTION CAPACITY

The cooking energy efficiency is the quantity of energy imparted to the specific food product, and is expressed as a percentage of energy consumed by the oven during the test. For convection ovens, potatoes were used for the cooking efficiency test and the test was run under a heavy-loading scenario. The heavy load testing required five pans of potatoes for a full-sized convection oven. The heavy-load testing was run at least three times.

The potato tests consisted of thirty potatoes in each pan, for a total pan weight of 14.5 ± 0.3 lbs for a full-size oven.

The average potato temperature began at 75 ± 5°F, and the temperature was monitored during cooking until the temperature of the potatoes reached 205°F. Once this temperature was reached, the oven immediately shut off, and the amount of cooking time and energy used was recorded. The weight of the cooked potatoes was measured and compared to the pre-cooked weight. Cooking energy efficiency is a

precise indicator of oven energy performance when cooking a typical food product. Equation 1 calculates the cooking energy efficiency.

EQUATION 1. COOKING ENERGY EFFICIENCY

$$\eta_{cook} = \frac{E_{food}}{E_{appliance}} \times 100 = \frac{[W_{uncooked} \times C_p(F) \times (T_2 - T_1)] + [(W_{uncooked} - W_{cooked}) \times H_{fgt2}]}{E_{appliance}} \times 100$$

Where:

η_{cook}	=	Cooking energy efficiency (%)
E_{food}	=	Amount of energy into the food (British thermal unit (Btu))
$W_{uncooked}$	=	Total weight of test food before cooking (lbs)
W_{cooked}	=	Total weight of cooked test food (lbs)
$C_p(F)$	=	The specific heat of the food based on the specified food (0.84 Btu/lb°F)
H_{fgt2}	=	Heat of vaporization of water as found from a table of thermodynamic properties of water at saturation (982 Btu/lb)
T_2	=	Average final temperature of the food (°F)
T_1	=	Average initial temperature of the food (°F)
$E_{appliance}$	=	Amount of energy into the appliance (Btu)

The cooking energy rate is the average rate of energy consumption (kW) during the heavy load test. The cook energy rate is calculated using Equation 2.

EQUATION 2. COOKING ENERGY RATE

$$E_{cookrate} = \frac{E_{oven} \times 60}{t}$$

Where:

$E_{cookrate}$	=	Cooking energy rate (kW)
E_{oven}	=	Amount of energy consumed by an appliance during cook testing (kWh)
t	=	Cook test period (min.)

Production capacity information is the production capability of a convection oven as it is used to cook a typical food product. This information can be used to determine the proper size and the quantity needed to fit any user's needs. Equation 3 is used to calculate the production capacity.

EQUATION 3. PRODUCTION CAPACITY

$$PC = \frac{W_{food} \times 60}{t}$$

Where:

PC	=	Production capacity of the convection oven (lb/hr)
Wf_{ood}	=	Weight of food required for a heavy load
t	=	Cook test period (min.)

For cooking energy efficiency and production capacity results, the percentage of uncertainty in each result is specified to be no greater than ±10% based on at least three test runs.

RESULTS AND DATA ANALYSIS

THERMOSTAT CALIBRATION

The oven's thermostat was calibrated by setting the oven temperature to 360°F and allowing the oven temperature to stabilize. After a 1-hour stabilization period, the thermocouple temperature readings were taken inside the oven chamber. Fifteen minutes of data, sampled every 30 seconds, was collected, and the resultant average temperature reading was 349°F. Because this result is within 5°F of 350°F, the oven's thermostat was deemed properly calibrated.

ENERGY INPUT RATE AND PREHEAT ENERGY CONSUMPTION

The energy input rate and preheat energy rate are used to confirm proper operation of the convection oven.

During the test, the Blodgett Model SHO-E oven took 8.3 minutes to reach a temperature of 340°F, yielding a preheat rate of 24°F /min. Figure 4 shows a graph of the oven chamber temperature versus time.

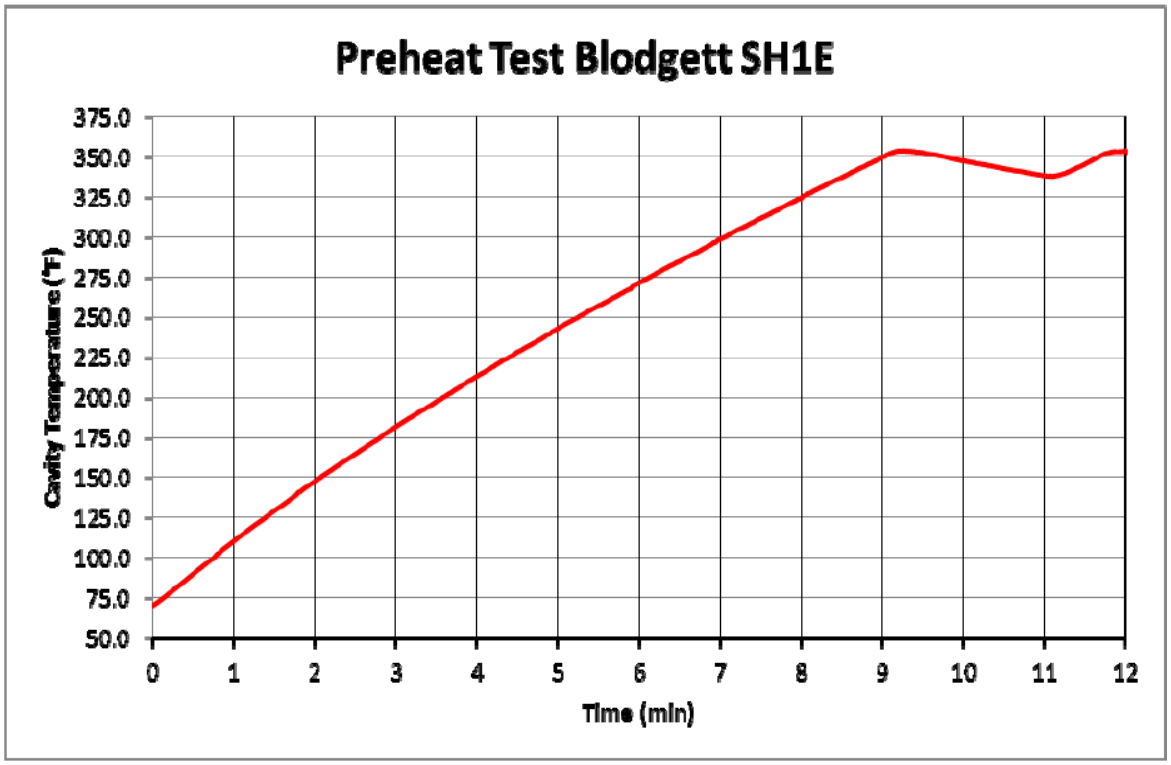

FIGURE 4. OVEN PREHEAT CURVE

The energy input rate is the peak energy consumption of the oven while preheating the oven from ambient temperature to a setpoint of 350°F. The maximum energy input rate recorded during the test was 10.72 kW.

IDLE ENERGY RATE

The idle energy rate is the convection oven's required rate of energy consumption (kW), when empty, needed to maintain its cavity temperature at a specified thermostat setpoint. In this test, the idle energy rate was taken after stabilization by monitoring the consumption of the convection oven for a 3-hour period, with the same setpoint of 350°F. The idle energy rate was calculated to be 1.63 kW or 5,563 BTU/hr.

COOKING ENERGY EFFICIENCY, ENERGY RATE AND PRODUCTION CAPACITY

The cooking energy efficiency is the quantity of energy imparted to the specific food product, and is expressed as a percentage of energy consumed by the oven during the test. Cooking energy efficiency is a precise indicator of oven energy performance when cooking a typical food product. Results of three heavy load cooking energy efficiency tests are shown in Table 1.

TABLE 1. COOKING ENERGY EFFICIENCY RESULTS

TEST RUN	W UNCOOKED [LBS]	CP [BTU/LB-°F]	T1 [°F]	T2 [°F]	E FOOD [BTU]	W COOKED [LBS]	Δ WEIGHT [LBS]	HFGT2 [BTU/LB]	E OVEN [BTU]	N COOK EFFICIENCY [%]
Heavy load 1	71.70	0.84	75.36	205.98	18,314	60.93	10.77	970	24,212	75.64%
Heavy load 2	71.52	0.84	73.68	205.99	17,852	61.31	10.21	970	24,803	71.98%
Heavy load 3	71.61	0.84	72.69	206.00	17,601	61.67	9.94	970	24,768	71.06%

The average efficiency and uncertainty results are shown in Table 2.

TABLE 2. COOKING EFFICIENCY AND UNCERTAINTY RESULTS

N, EFFICIENCY AVERAGE	STANDARD DEVIATION	ABSOLUTE UNCERTAINTY	UNCERTAINTY PERCENT
72.89%	0.02	0.06	8.24%

The cooking energy rate is the average rate of energy consumption (kW) during the heavy load test. The results of the Cooking Energy Rate test are shown in Table 3.

TABLE 3. COOKING ENERGY RATE RESULTS

TEST RUN	E APPLIANCE [KWH]	T [MINUTES]	E COOKRATE [KW]

Test Run	E appliance [kWh]	τ [minutes]	E cookrate [kW]
Heavy load 1	7.09	47.08	9.04
Heavy load 2	7.27	48.55	8.98
Heavy load 3	7.26	47.55	9.16

Production capacity information is the production capability of a convection oven as it is used to cook a typical food product. This information can be used to determine the proper size and the quantity needed to fit any user's needs. The results of the Production Capacity Test are shown in Table 4.

Table 4. Production Capacity Test Results

Test Run	W food, initial [lbs]	τ [min]	PC [lb/hr]	PC, avg Prod. Capacity	Standard Deviation	Absolute Uncertainty	Uncertainty Percent
Heavy load 1	71.70	47.08	91.37	90.04	1.52	3.76	4.18%
Heavy load 2	71.52	48.55	88.39				
Heavy load 3	71.61	47.55	90.36				

Conclusion

The following parameters of the Blodgett Model SHO-E oven were determined during the testing procedure:

- **Energy Input Rate:** The maximum energy input rate recorded during the test was 10.72 kW.
- **Preheat Energy Rate:** The oven took 8.63 minutes to reach a temperature of 340°F, yielding a preheat energy rate of 31.27°F/min.
- **Idle Energy Rate:** The idle energy rate, the amount of energy to maintain a 350°F setpoint, was recorded as 1.63 kW.
- **Cooking Energy Efficiency:** The average cooking energy efficiency as determined by three heavy-load tests was 73%.
- **Production Capacity:** The average measured production capacity was 90.04 lbs/hr.

APPENDIX A

BLODGETT®

MODEL SHO-E
Full-Size Electric Convection Oven

Shown with optional casters

OPTIONS AND ACCESSORIES
(AT ADDITIONAL CHARGE)

- **Legs/casters/stands:**
  - ❑ 6" (152mm) seismic legs
  - ❑ 6" (152mm) casters
  - ❑ 4" (107mm) low profile casters
  - ❑ 25" (635mm)stainless steel open stand with rack guide, stainless steel
- ❑ Extra oven racks
- ❑ Flue connector

Project _____

Item No. _____

Quantity _____

SHO-E

Baking compartment - accepts five 18" x 26" standard full-size baking pans in left-to-right position.
All data is shown per oven section, unless otherwise indicated.
Refer to operator manual specification chart for listed model name.

EXTERIOR CONSTRUCTION

- Full angle iron frame
- Stainless steel front, top, sides and legs
- 25" (635mm) stainless steel legs for single ovens
- 6" (152mm) stainless steel legs for double stacked ovens
- Dependent stainless steel doors, dual pane thermal glass window on left hand door, solid right hand door
- Chrome-plated door handle
- Triple-mounted door hinge pins
- Removable front control panel
- Solid mineral fiber insulation on back, fiberglass insulation on top, sides and bottom

INTERIOR CONSTRUCTION

- Double-sided porcelainized baking compartment liner (14 gauge)
- Aluminized blower wheel
- Five chrome-plated racks, eleven rack positions with a minimum of 1-5/8" (41mm) spacing

OPERATION

- Three tubular heaters
- Thermostat with temperature control range of 200°F (93°C) to 500°F (260°C)
- Two speed fan
- 1/3 horsepower blower motor with automatic thermal overload protection
- Control area cooling fan

STANDARD FEATURES

- Solid state manual control with separate dials to control thermostat and timer
- 25" (635mm) adjustable stainless steel legs (for single units)
- 6" (152mm) adjustable stainless steel legs (for double sections)
- One year oven parts and labor warranty*

* *For all international markets, contact your local distributor.*

ENERGY STAR

BLODGETT OVEN COMPANY
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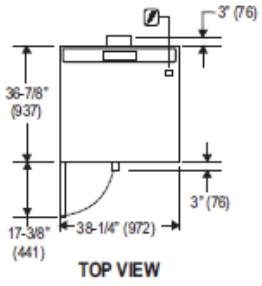
44 Lakeside Avenue, Burlington, VT 05401
Toll Free: (800) 331-5842 • Phone: (802) 860-3700 • Fax: (802) 864-0183

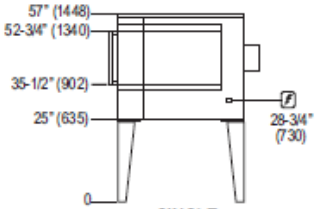
BLODGETT®

MODEL SHO-E

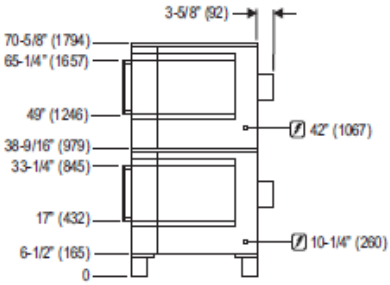
APPROVAL/STAMP



TOP VIEW



SINGLE



DOUBLE

SHORT FORM SPECIFICATIONS

Provide Blodgett full-size convection oven model SHO-E, (single/double) compartment. Each compartment shall have a fully welded angle iron frame. Interior shall have fully coved porcelainized steel liner and shall accept five 18" x 26" standard full-size bake pans in left-to-right position. Right door shall be stainless steel. Left door shall be stainless steel with dual pane thermal glass. Left door shall have chrome plated handle and dependent operation. Unit shall be electrically heated with three tubular heaters. Air in baking chamber distributed by dual inlet blower wheel powered by a two-speed, 1/3 HP motor with thermal overload protection. Each chamber shall be fitted with five chrome-plated removable racks. Control panel shall be recessed with Cook/Cool Down mode selector switch, electromechanical thermostat, 200 - 500 °F (93-260°C), and 60-minute timer. Provide options and accessories as indicated.

DIMENSIONS:

Floor space	38-1/4" (972mm) W x 36-7/8" (936mm) L
Product clearance	1/2" from combustible and non-combustible construction.
Interior	29" (737mm) W x 20" (508mm) H x 24-1/4" (616mm) D
If oven is on casters add to all height dimensions:	
Single	4-1/2" (114mm)
Double	2-1/4" (57mm)

POWER SUPPLY:

208 VAC	60 Hz.	1 phase	11kW	51/0/51 Amperes
208 VAC	60 Hz.	3 phase	11kW	31/29/29 Amperes
220/240 VAC	60 Hz.	1 phase	11kW	44/0/44 Amperes
220/240 VAC	60 Hz.	3 phase	11kW	26/24/24 Amperes
480VAC	60 Hz	3 phase	11kW	14/13/13 Amperes

**At an additional charge*

MAXIMUM INPUT:

Single	11kW
Double	22kw (11kW each section)

MINIMUM ENTRY CLEARANCE:

Uncrated	32-1/4" (819mm)
Crated	37-3/4" (959mm)

SHIPPING INFORMATION:

Approx. Weight:	**Crated**
Single:	480 lbs. (218 kg)
Double:	960 lbs. (435 kg)

Crate sizes:

37-1/2" (952mm) x 43-1/2" (1105mm) x 51-3/4" (1315mm)

REFERENCES

[1] American Society for Testing and Materials, 2005. Standard Test Method for Performance of Convection Ovens. ASTM Designation F1496-99. In Annual Book of ASTM Standards, West Conshohocken, PA

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