Blodgett, Model Zephaire
Gas Full-Size Convection Oven Performance Test

Application of ASTM Standard
Test Method F 1496-99
SCGAT060727A

Energy Resource Center
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Executive Summary

The Blodgett Zephaire gas-fired convection oven (Fig.1) was tested by the Gas Company for inclusion into its cooking energy efficiency program. Gas Comapny engineers tested the gas convection oven according to the specifications of the American Society for Testing and Materials' (ASTM) standard test method F 1496. To be considered energy efficient, a convection oven must achieve at least ***40% efficiency*** for the heavy-load cooking-energy efficiency test. The Blodgett Zephaire oven ***passed*** the standards as set forth. The test results for the Blodgett Zephaire are as follows:

Fig.1

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

Heavy-load cooking-energy Efficiency (%)	**44.7**
Rated Energy Input Rate (Btu/h)	60,000
Measured Energy Input Rate (Btu/h)	61,011
Preheat Time to 340°F (min)	12.08
Preheat Energy to 340°F (Btu)	12,301
Idle Energy Rate @ 350°F (Btu/h)	14,012
Pilot Energy Rate (Btu/h)	N/A
Production Capacity (lb/h)	78.05

The heavy-load cooking-energy efficiency test consists of baking thirty russet potatoes on five full-size sheet pans. 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:

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

Commercial Foodservice Equipment Testing Program

Recent advances in equipment design have produced commercial foodservice equipment that operates more efficiently, quickly, safely and conveniently. Energy efficient commercial equipment reduces energy consumption primarily through advanced technology and design.

The purpose of the The Gas Company's Energy Efficiency Commercial Foodservice Equipment Testing Program is to provide energy efficiency measurement data for cost effectiveness modeling in order to establish energy efficiency standards and ratings for commercial food service equipment. This measurement data is then utilized and integrated with typical equipment usage profiles for California utility customer participants for the Food Service Equipment Rebate program.

Equipment performance is determined by applying the ASTM Standard Test Method for Performance. The ASTM standard test method is considered to be the industry standard for quantifying the efficiency and performance of ovens.

Performance of Convection Ovens
RESULTS REPORTING SHEET
ASTM F 1496-99

Manufacturer	Blodgett
Model	Zephaire
Date	7/27/06-7/28/06
Test Reference Number (Optional)	

1. Test Rack Oven (11.1)

Fuel type:	Natural gas
Half-size or full-size:	Full-size
Rated input:	60,000 Btu/h
Oven cavity volume (in.^{3}):	16,530

Controls (Lists and discusses control settings, including input rate, fan speed, fan mode, and moisture injection options):

The oven's control panel consisted of an analog thermostat control dial with temperature values in increments of 25°F and a maximum setting of 500ºF, a three position blower control switch with "hi," "lo," and "off" options, a cool down control switch with "manual" and "auto" options, a switch for the interior oven lights, an indicator light for oven readiness, and a cook timer with a maximum setting of 60 minutes.

Description of operational characteristics:

The oven's thermostat was calibrated with the dial set at 350ºF.

2. Apparatus (11.2)

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

Deviations:

3. Thermostat Calibration (11.4)

As-Received:

Oven temperature control setting (°F)	350
Oven cavity temperature (°F)	350.53
Oven temperature control setting (°F)	300
Oven cavity temperature (°F)	N/A

As-Adjusted:

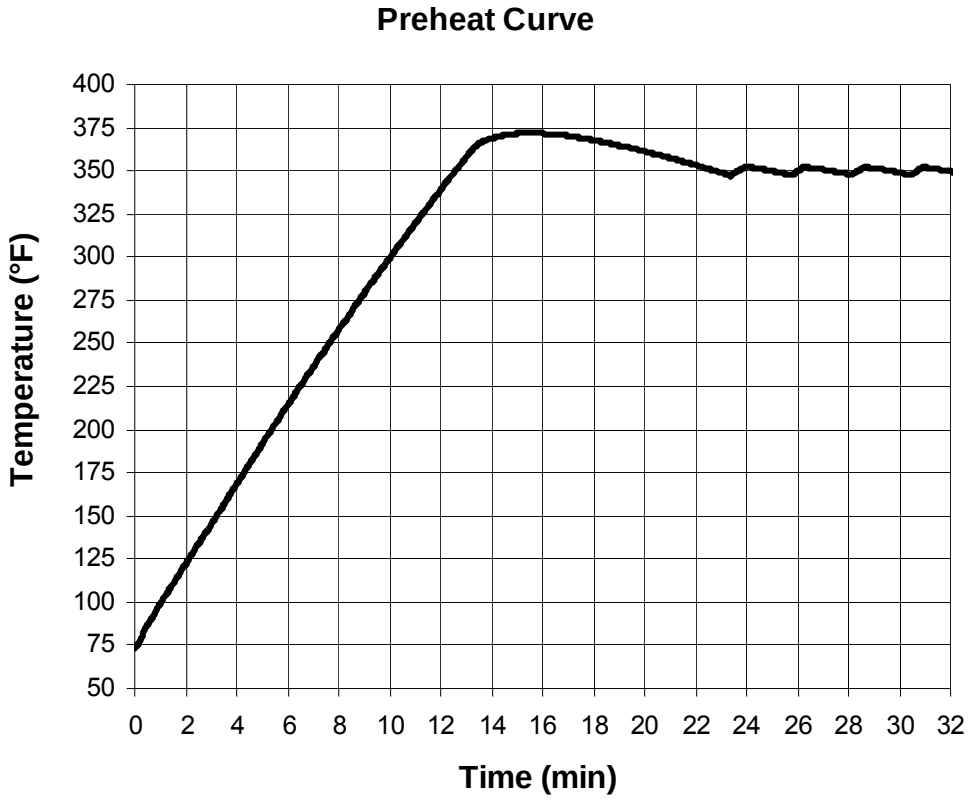
Oven temperature control setting (°F)	350
Oven cavity temperature (°F)	350 ± 5
Oven temperature control setting (°F)	N/A
Oven cavity temperature (°F)	300 ± 5

4. Energy Input Rate (11.5)

Test voltage (V)	113.0
Gas heating value (Btu/ft^3)	1014
Measured (Btu/h)	61,011
Rated (Btu/h)	60,000
Percent difference between measured and rated (%)	1.7
Gas oven-fan and control energy rate (kW)	0.1778

5. Preheat Energy and Time (11.6)

Test Voltage (V)	113.0
Gas heating value (Btu/ft^3)	1014
Starting temperature (°F)	73.48
Energy consumption (Btu)	12,301
Electric energy consumption (kW)	0.1940
Duration (min)	12.08
Preheat rate (°F/min)	17.56



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

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

7. Idle Energy Rate (11.8)

Test Voltage (V)	112.9
Gas heating value (Btu/ft^3)	1014
Idle energy rate at 350°F (Btu/h)	14,012
Electric energy rate at 350°F (kW)	0.1510

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

Heavy-Load:

Test voltage (V)	113.1
Gas heating value (Btu/ft^3)	1015
Cooking time (min)	56.32
Production rate (lb/h)	78.05 ± 3.64
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	46,079
Electric energy rate (kW)	0.1276
Energy per pound of food cooked (Btu/lb)	590
Cooking energy efficiency (%)	44.7 ± 0.6

Medium-Load:

Test voltage (V)	
Gas heating value (Btu/ft^3)	
Cooking time (min)	
Production rate (lb/h)	
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	
Electric energy rate (kW)	
Energy per pound of food cooked (Btu/lb)	
Cooking energy efficiency (%)	

Light-Load:

Test voltage (V)	
Gas heating value (Btu/ft^3)	
Cooking time (min)	
Production rate (lb/h)	
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	
Electric energy rate (kW)	
Energy per pound of food cooked (Btu/lb)	
Cooking energy efficiency (%)	

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

Test voltage (V) _____

Gas heating value (Btu/ft^3) _____

Rack	Average Rack Temperature (°F)
1 (Top)	
2	
3	
4	
5 (Bottom)	

Cooking time (min) _____

Production rate (lb/h) _____

Energy to food (Btu/lb) _____

Cooking energy rate (Btu/h) _____

Electric energy rate (kW) _____

Cooking energy efficiency (%) _____

10. Browning Uniformity (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.

Test voltage (V) _____

Gas heating value (Btu/ft^3) _____

Initial cake temperature (°F) _____

Final cake temperature (°F) _____

Initial cake weight (lb) _____

Final cake weight (lb) _____

Sheet cake cook time (min) _____

Sheet cake cooking energy (Btu) _____

Electric energy (kW) _____

Signatures: The undersigned have performed the above test and have verified that the results recorded were the actual results observed.

SCG's Tester: _____ _____

(signature) (date)

ANDRE SALDIVAR

(print name)

Foodservice Testing
UNCERTAINTY CALCULATION PROCEDURE
Annex

Make:	Blodgett
Model:	Zephaire
Equipment Type:	Convection Oven
Test Results from Form:	ASTM F 1496-99 (10.6)S
Results Evaluated:	Cooking Energy Efficiency

A. Test results

1.	Iteration 1	X_1 =	44.77
2.	Iteration 2	X_2 =	44.10
3.	Iteration 3	X_3 =	45.19
4.	Iteration 4	X_4 =	
5.	Iteration 5	X_5 =	
6.	Number of test results being evaluated:	n =	3

B. Calculations

1. $Xa_n = (1/n) * (X_1 + X_2 + \ldots + X_n)$ — **Xa_n =** 44.69

2. $S_n = \sqrt{\frac{A_n - B_n}{2}}$ — **S_n =** 0.0055

   a. $A_n = (X_1)^2 + (X_2)^2 + \ldots + (X_n)^2$ — A_n = 0.59913

   b. $B_n = (1/n) * (X_1 + X_2 + \ldots + X_n)^2$ — B_n = 0.59907

3. $U_n = C_n * S_n$ — **U_n =** 0.0137

   a. C_n is found in the following table: — C_n = 2.48

Uncertainty Factors

Test Results, *n*	Uncertainty Factors, C_n
3	2.48
4	1.59
5	1.24
6	1.05
7	0.92
8	0.84
9	0.77
10	0.72

4. $\%U_n = (U_n / Xa_n) * 100\%$

$\%U_n =$	3.1

C. Evaluation

	YES	NO	N/A
1. Is $\%U_n \leq \pm 10\%$ [yes]	☑	☐	☐

a. If $\%U_n \geq \pm 10\%$ then repeat the test.

Notes:

1. Expected results are shown between brackets.

Comments:

Signatures: The undersigned have performed the above test and have verified that the results recorded were the actual results observed.

SCG's Tester: _____ (signature) _____ (date)

_____ (print name)

Foodservice Testing
UNCERTAINTY CALCULATION PROCEDURE
Annex

Make:	Blodgett
Model:	Zephaire
Equipment Type:	Convection Oven
Test Results from Form:	ASTM F 1496-99 (10.6)S
Results Evaluated:	Production Rate

A. Test results

1.	Iteration 1	X_1 =	77.46
2.	Iteration 2	X_2 =	79.72
3.	Iteration 3	X_3 =	76.96
4.	Iteration 4	X_4 =	
5.	Iteration 5	X_5 =	
6.	Number of test results being evaluated:	n =	3

B. Calculations

1. $Xa_n = (1/n) * (X_1 + X_2 + \ldots + X_n)$ — **Xa_n =** 78.05

2. $S_n = \sqrt{\frac{A_n - B_n}{2}}$ — **S_n =** 1.470

   a. $A_n = (X_1)^2 + (X_2)^2 + \ldots + (X_n)^2$ — A_n = 18278.16

   b. $B_n = (1/n) * (X_1 + X_2 + \ldots + X_n)^2$ — B_n = 18273.85

3. $U_n = C_n * S_n$ — **U_n =** 3.644

   a. C_n is found in the following table: — C_n = 2.48

Uncertainty Factors

Test Results, *n*	Uncertainty Factors, C_n
3	2.48
4	1.59
5	1.24
6	1.05
7	0.92
8	0.84
9	0.77
10	0.72

4. $\%U_n = (U_n / Xa_n) * 100\%$

$\%U_n =$	4.7

C. Evaluation

	YES	NO	N/A
1. Is $\%U_n \leq \pm 10\%$ [yes]	☑	☐	☐
a. If $\%U_n \geq \pm 10\%$ then repeat the test.			

Notes:

1. Expected results are shown between brackets.

Comments:

Signatures: The undersigned have performed the above test and have verified that the results recorded were the actual results observed.

SCG's Tester: _____ (signature) _____ (date)

_____ (print name)