Blodgett, Model DFG-200
Gas Full-Size Convection Oven Performance Test

Application of ASTM Standard
Test Method F 1496-99
SCGAT060228A

Energy Resource Center
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Prepared by:
The Gas Company

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Executive Summary

The Blodgett DFG-200 gas-fired convection oven (Fig.1) was tested by the Gas Company for inclusion into its cooking energy efficiency program. Gas Company 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 DFG-200 oven ***passed*** the standards as set forth. The test results for the Blodgett DFG-200 are as follows:

Fig.1

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

Heavy-load cooking-energy Efficiency (%)	**44**
Rated Energy Input Rate (Btu/h)	60,000
Measured Energy Input Rate (Btu/h)	64,740
Preheat Time to 340°F (min)	10.43
Preheat Energy to 340°F (Btu)	11,200
Idle Energy Rate @ 350°F (Btu/h)	12,280
Pilot Energy Rate (Btu/h)	N/A
Production Capacity (lb/h)	99.10

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	DFG-200
Date	2/28/06-4/27/06
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}):	16,390

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 550ºF, a four position fan control dial with "oven off," "high fan," "low fan," and "cool down" options, a switch for "gas on" or "gas off," a switch for "high rate" or "std rate" gas flow, a button 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)	353.8
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

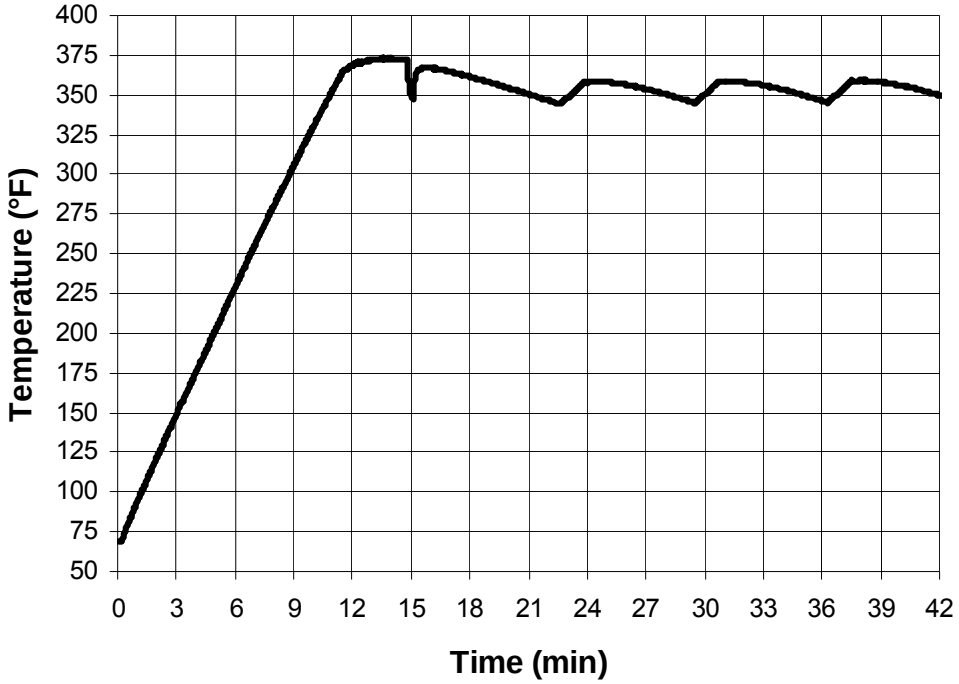
4. Energy Input Rate (11.5)

Test voltage (V)	119.0
Gas heating value (Btu/ft^3)	1024
Measured (Btu/h)	64,740
Rated (Btu/h)	60,000
Percent difference between measured and rated (%)	7.9
Gas oven-fan and control energy rate (kW)	0.0826

5. Preheat Energy and Time (11.6)

Test Voltage (V)	119.0
Gas heating value (Btu/ft^3)	1024
Starting temperature (°F)	68.33
Energy consumption (Btu)	11,200
Electric energy consumption (kW)	0.8986
Duration (min)	10.43
Preheat rate (°F/min)	19.80

Preheat Curve



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)	117.6
Gas heating value (Btu/ft^3)	1017
Idle energy rate at 350°F (Btu/h)	12,280
Electric energy rate at 350°F (kW)	0.0885

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

Heavy-Load:

Test voltage (V)	117.8
Gas heating value (Btu/ft^3)	1020
Cooking time (min)	44.10
Production rate (lb/h)	99.10 ± 2.2
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	45,970
Electric energy rate (kW)	0.08777
Energy per pound of food cooked (Btu/lb)	464
Cooking energy efficiency (%)	44 ± 2.9

Medium-Load:

Test voltage (V)	118.1
Gas heating value (Btu/ft^3)	1018
Cooking time (min)	44.76
Production rate (lb/h)	57.73 ± 4.6
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	31,980
Electric energy rate (kW)	0.08698
Energy per pound of food cooked (Btu/lb)	555
Cooking energy efficiency (%)	39 ± 0.69

Light-Load:

Test voltage (V)	118.7
Gas heating value (Btu/ft^3)	1024
Cooking time (min)	46.65
Production rate (lb/h)	18.40 ± 1.8
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	18,570
Electric energy rate (kW)	0.09408
Energy per pound of food cooked (Btu/lb)	1,015
Cooking energy efficiency (%)	22 ± 0.63

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

Test voltage (V)	118.1
Gas heating value (Btu/ft^3)	1022

Rack	Average Rack Temperature (°F)
1 (Top)	174.5
2	140.8
3	124.3
4	175.4
5 (Bottom)	188.8

Cooking time (min)	48.3
Production rate (lb/h)	116.8
Energy to food (Btu/lb)	474.6
Cooking energy rate (Btu/h)	54,920
Electric energy rate (kW)	0.0909
Cooking energy efficiency (%)	57

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)	118.0
Gas heating value (Btu/ft^3)	1028
Initial cake temperature (°F)	N/A
Final cake temperature (°F)	N/A
Initial cake weight (lb)	N/A
Final cake weight (lb)	N/A
Sheet cake cook time (min)	30
Sheet cake cooking energy (Btu)	14,999
Electric energy (kW)	0.07812

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

SCG's Tester: _____ 07/17/06
(signature) (date)

ANDRE SALDIVAR
(print name)

Foodservice Testing
UNCERTAINTY CALCULATION PROCEDURE
Annex

Make:	Blodgett
Model:	DFG-200
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 =	46.60%
2.	Iteration 2	X_2 =	46.58%
3.	Iteration 3	X_3 =	42.27%
4.	Iteration 4	X_4 =	41.02%
5.	Iteration 5	X_5 =	
6.	Number of test results being evaluated:	n =	4

B. Calculations

1. $Xa_n = (1/n) * (X_1 + X_2 + \ldots + X_n)$ — **Xa_n =** 0.4412

2. $S_n = \sqrt{\frac{A_n - B_n}{2}}$ — **S_n =** 0.03551

   a. $A_n = (X_1)^2 + (X_2)^2 + \ldots + (X_n)^2$ — A_n = 0.7811

   b. $B_n = (1/n) * (X_1 + X_2 + \ldots + X_n)^2$ — B_n = 0.7786

3. $U_n = C_n * S_n$ — **U_n =** 0.04610

   a. C_n is found in the following table: — C_n = 1.59

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

$\%U_n =$	10.5%

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:	DFG-200
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 =	102.1 lb/h
2.	Iteration 2	X_2 =	97.10 lb/h
3.	Iteration 3	X_3 =	97.89 lb/h
4.	Iteration 4	X_4 =	99.29 lb/h
5.	Iteration 5	X_5 =	
6.	Number of test results being evaluated:	n =	4

B. Calculations

1. $Xa_n = (1/n) * (X_1 + X_2 + \ldots + X_n)$ — **Xa_n =** 99.10

2. $S_n = \sqrt{\frac{A_n - B_n}{2}}$ — **S_n =** 2.695

   a. $A_n = (X_1)^2 + (X_2)^2 + \ldots + (X_n)^2$ — A_n = 39290

   b. $B_n = (1/n) * (X_1 + X_2 + \ldots + X_n)^2$ — B_n = 39280

3. $U_n = C_n * S_n$ — **U_n =** 4.285

   a. C_n is found in the following table: — C_n = 1.59

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

$\%U_n =$	4.3

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)