Appliance Test Report SCGAT172802A

Imperial ICVG-1
Full-Size Gas Convection Oven Performance Test
Revision 4

SoCalGas
A Sempra Energy utility

Southern California Gas Company
Customer Programs Department

Issued Date: May 16, 2017

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Revision History

Revision No.	Date	Description	Author
0	March 31, 2017	Initial Release	Jose Urzua, Ahmed Sallam
1	April 20, 2017	Revised electric energy rate	Jose Urzua Ahmed Sallam
2	April 27, 2017	Revised heavy load values	Jose Urzua Ahmed Sallam
3	April 28, 2017	Revised electric cooking rate	Jose Urzua Ahmed Sallam
4	May 16, 2017	Final Release	Jose Urzua

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Executive Summary

The "Imperial" Model ICVG-1, a full-size gas-fired convection oven (Figure 1), was evaluated for energy performance at the Southern California Gas Company's (SCG) Commercial Food Service Testing Laboratory (FSTL). The oven was tested according to the specifications of The American Society for Testing and Materials' (ASTM) standard test method F 1496-13. To be considered energy efficient, a convection oven must achieve at least ***46% efficiency*** for the heavy-load cooking-energy efficiency test and an idle rate less than **12,000 Btu/h.** The Imperial Model ICVG-1 oven ***passed*** the standards as set forth. The test results for the Imperial ICVG-1 (S/N 2236317) are as follows:

Figure 1
"Imperial"
ICVG-1
Gas convection oven

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

Heavy-load cooking-energy efficiency (%)	52.5
Rated Energy Input Rate (Btu/h)	70,000
Measured Gas Energy Input Rate (Btu/h)	71,902
Preheat Time to 340°F (min)	10.9
Preheat Energy to 340°F (Btu)	13,143
Idle Energy Rate (*natural gas fuel*) at 350°F (Btu/h)	11,435
Idle Energy Rate (*combined gas & electric*) at 350°F (Btu/h)	12,737
Pilot Energy Rate (Btu/h)	N/A
Production Rate (lb/h)	102

The heavy-load cooking-energy efficiency test consisted of baking thirty russet potatoes per full-size sheet pans on six levels. 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:

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

Mission Statement - Commercial Food Service Equipment Testing

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

The purpose of Southern California Gas Company's Energy Efficiency Commercial Food Service Equipment Testing Program is to provide energy efficiency measurement 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 Customers participating in the Food Service Equipment Rebate Program.

The equipment performance is determined by applying the American Society for Testing and Materials (ASTM) standard test method for performance. The ASTM standard test method is considered the industry standard for quantifying the efficiency and performance for cooking equipment.

Scope

The scope of this test is to evaluate the performance of the "Imperial" ICVG-1 gas-fired convection oven, by using ASTM F 1496-13 "*Standard Test Method for Performance of Convection Ovens*" for the test procedure and evaluation criteria.

In order to evaluate the oven's energy consumption and cooking performance, the following were performed:

- Verify energy rating
- Verify thermostat calibration
- Determine energy input rate, preheat energy consumption and time
- Determine pilot energy consumption [1]
- Verify cooking uniformity [1]
- Verify cake browning [1]
- Determine cooking rate uncertainty
- Determine production rate uncertainty
- Report findings

Appliance and test overview

The "Imperial" ICVG-1 is a natural gas-fired, full size oven rated at 70,000 Btu/h. The oven is equipped with two swing-out doors, with a surrounding stainless steel outer case. The electric power requirements for the oven are 120 Volts AC single-phase 9 amps. The inner cavity measured 24.0 inches in height, 29.0 inches in width and 28.5 inches in depth for a total cavity volume of 19,836 cubic inches. The oven's cavity can accommodate up to six (6) steel wired racks spaced evenly. The oven's controls include on/off switches for oven "ON", oven cool down, fan speed and cavity lights. The controls also include two large analog dials, one for cavity temperature and the other for cooking timer. The oven was equipped with a door seal

[1] Was not performed

and flue stack at the rear. Labels and controls are located in a front right panel in order to adjust to a desired setting.

The test consisted of taking fresh whole U.S. Number 1 Russet potatoes with an initial temperature of 75 ± 5°F and cooking them until their internal temperature reached 205°F. During cooking, the internal temperature of randomly selected potatoes was monitored using thermocouples that were inserted into their core until the temperature averaged 205°F on all the instrumented potatoes. Weight measurements were taken before and after cooking to determine cooking energy efficiency and production rate.

The gas volume, pressure and temperature were monitored and recorded as well as the ambient air temperature and pressure. Type K thermocouples were used to monitor the ambient, oven cavity and inner potato temperature. Electrical power measurements were also monitored and recorded. A National Instruments acquisition system was used to monitor and record all data. See section "Testing Equipment Inventory" for more detail regarding the testing equipment.

Comments, Deviations and Exceptions

Comments:

The heating values for each test were obtained from the SCG's MCS Gas Analysis daily reports.

Pilot energy consumption was not measured since the oven is equipped with an electronic pilot-less ignition system.

Cooking efficiency calculations were revised to follow the updated ASTM F1496 – 13

Deviations:

Testing procedures and results are limited to the heavy-load cooking scenario.

Tests for cooking uniformity and browning uniformity were not performed.

Exceptions:
None

Testing equipment inventory

Energy efficiency testing is conducted at SCG's Commercial Food Service Testing Laboratory located at the Energy Resource Center (ERC) in Downey California. The laboratory can provide utility services such as natural gas, water, electricity, sewer and fume exhaust for a variety of tests.

The testing equipment is mounted onto a mobile test bench providing the flexibility of movement within the test lab or for in the field use. The mobile test bench holds a data acquisition system, transducers, and various meters that allow to capture and record data. The cDAQ acquisition system delivers the capability to run seven hardware-timed channels simultaneously, provide four built in 32-bit counters/timers, and continually stream waveform measurements. The bench mounted pressure transducers monitor barometric ambient pressure and natural gas pressure before and after the gas meter. The electrical transducers are capable of measuring kW consumption. A flowmeter allows measurement of water flow. An analog gas meter is fitted with an electronic counter is used to measure gas consumption. See Tables TEI 1-1 for inventory and specifications on testing equipment.

Table TEI 1-1. Testing Equipment Inventory

ECN	Description	Manufacturer	Model	Date Calibrated	Calibration due date
100	Data Acquisition	National Instruments	cDAQ-9178	3/2/2017	3/2/2018
101a	Gas Meter	Elster	DTM 200A	9/27/2016	9/27/2017
102d	Barometric Pressure Transducer	Omega	EWS-BP-A	9/27/2016	9/27/2017
103b	Differential Pressure Transmitter	Dwyer	607-9	9/27/2016	9/27/2017
108	Bench scale	A&D	FG-60KAL	6/22/2016	6/22/2017
120	Thermocouples	Omega	Type-K	12/16/2016	12/16/2017
125b	Gas Pressure Regulator	Maxitrol	RV48L	9/27/2016	9/27/2017

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Performance of Convection Ovens
RESULTS SUMMARY
ASTM F 1496-13 (10)

Manufacturer	Imperial
Model	ICVG-1
Date	3/31/17
Oven serial number	2236317

1. Appliance Type – Full-Size Convection Oven (10.1)

Fuel type:	Natural gas
Oven rating:	70,000 Btu/h
Physical dimensions	
Size of oven:	34.00 H x 38.00 W x 41 D in.
Size of oven cavity:	24.00 H x 29.00 W x 28.5 D in.
Oven cavity volume:	19,836 $in.^3$

Controls:

All the oven's controls lie on a panel just right of the double swing-out doors. At the top of the panel reside two switches for "Cook and Cool" and oven "On and Off". Below, a "Heat On" indicator light and an oven temperature and timer dial. At the bottom of the panel, a fan speed switch labeled "On and Off" and a light switch.

Description of operational characteristics:

With the thermostat control dial set at approximately 350°F, the average temperature at the center of the oven was not in range. The thermostat was readjusted to approximately 390°F, which yielded a cavity temperature of 351.5°F within the limit of ± 5°F set forth in the ASTM F 1496-13 test method section 11.2.

2. Apparatus (11.2)

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

3. Thermostat Calibration (10.2)

As-Received:

Oven temperature control setting (°F)	390
Oven cavity temperature (°F)	351.5

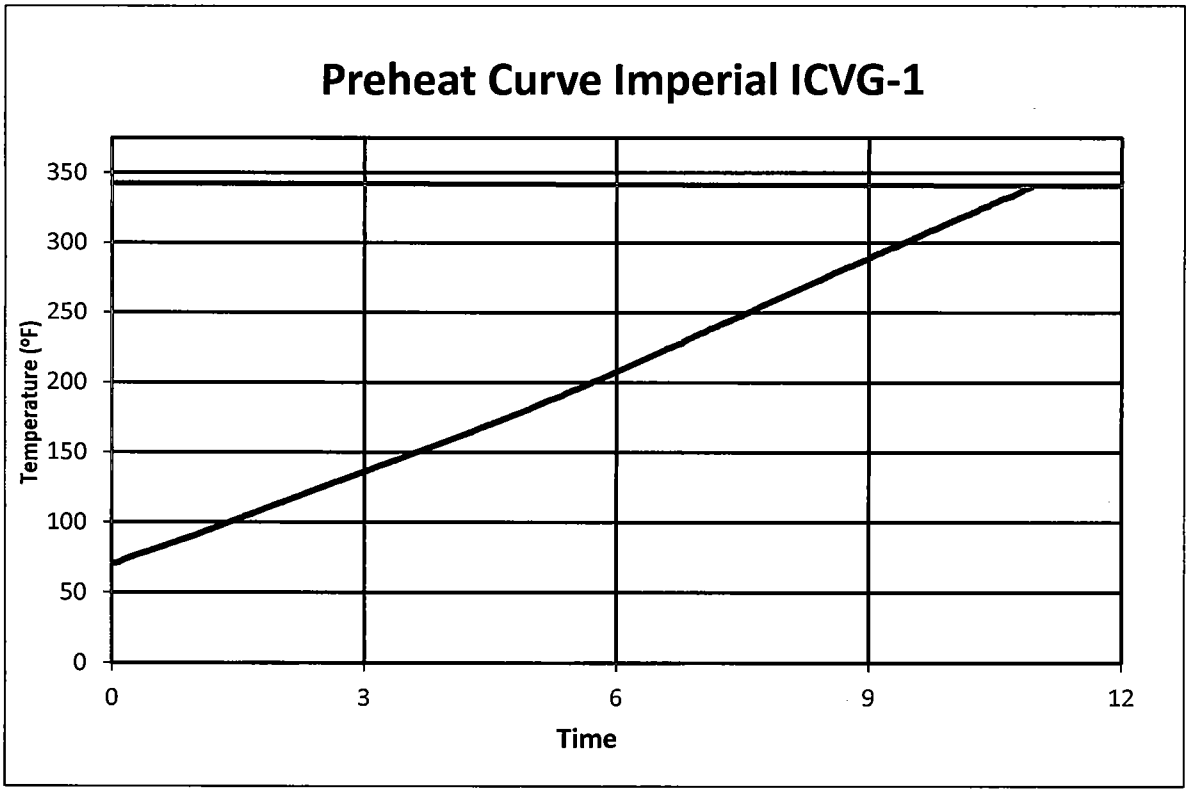
4. Energy Input Rate (10.2)

Test voltage (V)	120
Higher heating value of natural gas (Btu/ft^3)	1027
Measured gas input rate (Btu/h)	71,902
Rated (Btu/h)	70,000
Percent difference between measured and rated (%)	2.7

5a. Preheat Energy and Time (10.3)

Test Voltage (V)	120
Higher heating value of natural gas (Btu/ft^3)	1027
Starting temperature of oven cavity (°F)	70.7
Energy consumption of natural gas (Btu)	13,143
Duration (min)	10.9
Preheat rate (°F/min)	24.6

5b. Preheat Curve (10.3 - Continued)



6. Pilot Energy Rate (if applicable) (10.4)

	See Comments, Deviations and Exceptions
Gas heating value (Btu/ft³)	N/A
Pilot energy rate (Btu/h)	N/A (Electronic Spark Ignition)

7. Idle Energy Rate (10.5)

Test Voltage (V)	120
Higher heating value of natural gas (Btu/ft³)	1024
Idle energy rate at 350°F – *natural gas only* (Btu/h)	11,435
Idle energy rate at 350°F – *gas & electric* (Btu/h)	12,737
Electric energy rate at 350°F (kW)	0.38

8. Cooking Energy Efficiency, Cooking Energy Rate, and Production Rate (10.6) [2]

Heavy-Load:

Test voltage (V)	120
Higher heating value of natural gas (Btu/ft^3)	1024
Cooking time (min)	51.3
Production rate (lb/h)	102
Energy to food (Btu)	25,597
Total cooking energy consumption (Btu)	48,179
Electric cooking energy rate (kW)	0.33
Energy per pound of food cooked (Btu/lb)	551
Cooking energy efficiency (%)	52.5

Medium-Load: *See Comments, Deviations and Exceptions*

Test voltage (V)	
Higher heating value of natural gas (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: *See Comments, Deviations and Exceptions*

Test voltage (V)	
Higher heating value of natural gas (Btu/ft^3)	
Cooking time (min)	
Production rate (lb/h)	
Energy to food (Btu/lb)	
Cooking energy rate (Btu/h)	
Electric energy rate (kW)	

[2] Test results based on the average of three (3) iterations

Energy per pound of food cooked (Btu/lb)	
Cooking energy efficiency (%)	

9. Cooking Uniformity (Frozen Macaroni & Cheese) (10.7)

See Comments Deviations and Exceptions

Test voltage (V)	
Higher heating value of natural gas (Btu/ft^3)	

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

Cooking time (min)	
Production capacity (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)

See Comments Deviations and Exceptions

Test voltage (V)	
Higher heating value of natural gas (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 (kWh)	

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Performance of Convection Gas Ovens
UNCERTAINTY RESULTS FOR COOKING ENERGY EFFICIENCY
Annex A1.

Make:	Imperial
Model:	ICVG-1
Equipment Type:	Full-size convection oven
Calculations from:	ASTM F 1496-13
Results Evaluated:	Cooking Energy Efficiency (%)

A. Iteration results

1. Iteration 1	X_1 =	51.6
2. Iteration 2	X_2 =	52.8
3. Iteration 3	X_3 =	53.2
4. Iteration 4	X_4 =	
5. Iteration 5	X_5 =	

B. Uncertainty results

Average **Xa_n =**	52.5
Standard deviation **S_n =**	0.87
Absolute Uncertainty **U_n =**	2.16
Uncertainty Percent **$\%U_n$ =**	4.10

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Performance of Convection Gas Ovens
UNCERTAINTY RESULTS FOR PRODUCTION RATE
Annex A1.

Make:	Imperial
Model:	ICVG-1
Equipment Type:	Full-size convection oven
Calculations from:	ASTM F 1496-13
Results Evaluated:	Production Rate (lb/h)

C. Iteration results

1.	Iteration 1	X_1 = 101.0
2.	Iteration 2	X_2 = 102.8
3.	Iteration 3	X_3 = 103.0
4.	Iteration 4	X_4 =
5.	Iteration 5	X_5 =

D. Uncertainty results

Average	Xa_n = 102.3
Standard deviation	S_n = 1.08
Absolute Uncertainty	U_n = 2.67
% Uncertainty	$\%U_n$ = 2.61

Signatures: The undersigned has performed stated tests and has verified that the results recorded were the actual results observed.

SCG's Tester: _____ (signature) 5/16/2017 (date)

Jose Urzua
(print name)