



**U.S. Range Model RGTA-2436-1 Gas Griddle
Application of ASTM Standard Test Method**

Report 5017.93.1

FSTC Manager: Don Fisher

Final Report, September 1993

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PREFACE

The Food Service Technology Center (FSTC) in San Ramon, California, is dedicated to helping the food service industry conserve energy. FSTC researchers monitor equipment in a production setting at PG&E's Learning Center dining facility. Production data are compared with laboratory performance results obtained at the 6,700-square-foot appliance research laboratory. Researchers then use this information to develop test methods, which they submit to the American Society for Testing and Materials (ASTM) for approval as national standards.

The FSTC accomplishes technology transfer through the *Kitchen Monitor*, a national subscription service published by *Restaurants and Institutions* magazine. *Kitchen Monitor* provides appliance production and performance reports, as well as special reports, every other month. Other technical reports produced by the FSTC are also available through the *Kitchen Monitor*. For more information, write or call Corinne Zollars, *Kitchen Monitor*, 1350 East Touhy Avenue, Des Plaines, IL 60018 (708-390-2806; fax 708-635-6856).

ACKNOWLEDGMENTS

The establishment of a state-of-the-art Food Service Technology Center reflects PG&E's commitment to the hospitality industry. The goal of the research project is to provide PG&E's food service customers with information to help them evaluate technically innovative cooking appliances and make informed equipment purchases regarding advanced technologies and energy sources. The project was the result of many people and departments working together within PG&E and the overwhelming support of the commercial equipment manufacturers who loan the cooking appliances for testing. Specific appreciation is extended to U.S. Range for supplying PG&E with a countertop gas griddle for testing at the Food Service Technology Center.

PG&E's Food Service Technology Center acknowledges the support of the project's National Advisory Group. Participating organizations from the research community include the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), the American Gas Association Laboratories (AGAL), and Underwriters Laboratories (UL). Representing end users are the National Restaurant Association, Restaurants & Institutions, McDonald's Corporation, General Mills Restaurants, and Marriott International. Academia is represented by The Pennsylvania State University.

EXECUTIVE SUMMARY

This study documents the performance of the U.S. Range Regal series countertop gas griddle, model RGTA-2436-1, as determined by applying the American Society for Testing and Materials (ASTM) *Standard Test Methods for the Performance of Griddles* (Designation F 1275-90). Griddle performance is characterized by tests of temperature uniformity, preheat time and energy consumption, idle energy consumption, pilot energy consumption, water-boil and cooking energy efficiencies, and production capacity. A summary of the test results is presented in Table ES-1.

Table ES-1
Summary of Griddle Performance

Rated Energy Input Rate:	72.0 kBtu/h
Measured Energy Input Rate	69.5 kBtu/h
Temperature Uniformity:	± 37.0°F
Preheat Time:	21.8 min
Preheat Energy:	19.2 kBtu
Idle Energy Rate:	17.4 kBtu/h
Pilot Energy Rate:	817.1 Btu/h
Water-Boil Efficiency:	45.1%
Full-Load Cooking Efficiency:	29.3%
Half-load Cooking Efficiency:	21.2%
Light-Load Cooking Efficiency:	20.7%
Production Capacity: ^a	25.2 lb/h

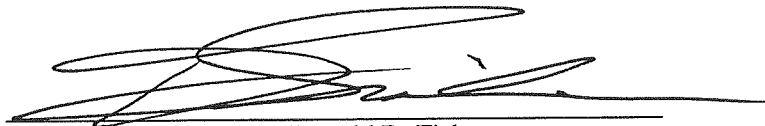
^aBased on the full-load cooking test.

The performance of the U.S. Range griddle was considered favorable for an atmospheric burner griddle, particularly with respect to energy efficiency under light-load conditions. The modulating thermostat control eliminated preheat overshoot and allowed a remarkably steady plate temperature during idle conditions.

The measured hamburger patty production capacity (25.2 pounds per hour) under full-load test conditions was surprisingly low for a griddle with a 72-kBtu/h input. However, this moderate production capacity was attributed to the modulating thermostat and the associated reduction in input energy as the griddle surface temperature approached set point.

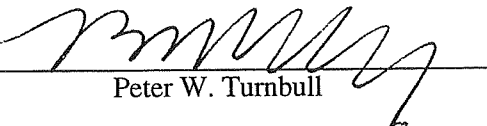
The higher energy efficiency under light-load conditions and the associated stable surface temperatures suggest that this griddle would be ideal for short-order operations. Refining the thermostat response curve could improve the griddle's peak production capacity.

FSTC Manager



Donald R. Fisher

Technical Support Supervisor



Peter W. Turnbull

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Section 1

INTRODUCTION

BACKGROUND

Numerous PG&E reports have documented the development of test procedures for cooking equipment¹ and the results of appliances tested in the Production-Test Kitchen, including the appliances' natural gas and electric energy use under varying conditions. Much of this information was not previously available, or if available, had been determined by a variety of test procedures. PG&E has been developing uniform testing procedures (UTPs) to provide standard methods of testing commercial cooking appliances, and we are submitting these procedures to the American Society for Testing and Materials (ASTM) for approval as national standard test methods.

Since the ASTM *Standard Test Methods for the Performance of Griddles* (Designation F 1275-90) was published,² we have been exploring possible areas for improvement in the test method. Through sensitivity testing and comparison of the results from one test procedure to another, we developed a set of revisions that simplify the griddle performance tests. Those revisions will be incorporated into the next version of the ASTM test method.

PG&E has previously tested four griddles (two gas and two electric) according to the ASTM test method.^{1,2} While applying the test method to the U.S. Range countertop griddle, we had to alter the test method because it was not applicable to griddles with modulating thermostats. This report documents the results of applying the revised test method to the U.S. Range griddle.

OBJECTIVE AND SCOPE

The objective of this report is to examine the operation and performance of the U.S. Range Regal series gas griddle, model RGTA-2436-1, under the controlled conditions of the ASTM test method. The scope of this testing is as follows:

- Document the temperature uniformity of the cooking surface and the accuracy of the thermostats.
- Verify that the appliance operates at the manufacturer's rated energy input.
- Document the pilot energy consumption.
- Characterize the preheat and idle energy consumption under controlled conditions.
- Determine the water-boil efficiency.
- Document the cooking energy consumption and efficiency under three loading scenarios (full, half, and light).
- Determine the production capacity and cooking surface temperature recovery time.

APPLIANCE DESCRIPTION AND OPERATION

This thermostatically controlled griddle is powered by three gas atmospheric burners. The controls use modulating thermostats with a minimum flame. The griddle has two thermostat controls. The left thermostat controls the left burner, and the right thermostat controls the right and center burners. The cooking surface is a 1-inch-thick steel plate. Appliance specifications are listed in Table 1-1 and the manufacturer's literature is in Appendix A.

Table 1-1
Appliance Specifications

Manufacturer:	U.S. Range, Inc.
Model:	RGTA-2436-1
Generic Appliance Type:	Thermostatically controlled counter griddle
Rated Energy Input:	72 kBtu/h
Dimensions:	22" x 36"
Construction:	1"-thick cold rolled steel plate
Controls:	Modulating thermostat with a minimum flame
Accessories:	Metal stand (22" high)

Section 2 METHODS

REVISIONS TO ASTM STANDARD TEST METHOD

Because of limitations in the ASTM test method, we deviated from it in the following areas: energy input rate (section 9.2), preheat energy consumption (section 9.4), cooking time determination (section 9.7), cooking energy efficiency and cooking capacity for a full-load test (section 9.8) and for half- and light-load tests (section 9.9).

Determining the energy input rate and the preheat energy consumption requires observance of burner cycling (either directly or by means of an indicator light). The burners on the U.S. Range griddle do not cycle off, but modulate down to a minimum level. We observed surface temperature by tack-welding thermocouples to the cooking surface on the point directly above each thermostat sensor and measuring the amount of time to preheat the cooking surface from room temperature to 375°F.

To determine the energy input rate, we also had to record the energy consumption over the course of the preheat. Due to the griddle's modulating input, we monitored the energy consumption during the first 10 minutes of preheat.

Rather than conducting the cooking time determination as a separate test with eight hamburger patties, we started each cooking energy efficiency and cooking capacity test with the cooking time determination for that loading scenario, using the number of patties dictated by the loading scenario. After establishing the proper cook time, we began the cooking test with a stabilization load. A six-load run followed, during which time we monitored griddle energy consumption and determined bulk temperature and weight loss for each load.

To improve the accuracy of the bulk temperature measurements during the cooking tests (sections 9.7, 9.8, and 9.9), we added a calorimeter that held eight hamburger patties and had five fixed temperature probes in the lid. We defined bulk temperature of the cooked patties as the average of these five thermocouples after 2 minutes in the calorimeter. Calorimeter patties were chosen at random from the cooking surface. We eliminated the visual inspection of the cooked patties and determined patty doneness based on temperature and weight loss only.

For sections 9.8 and 9.9, we used a threshold temperature of 365°F at the center of each linear foot of cooking surface as a recovery criterion in place of burner cycling. Surface temperature was monitored by tack-welding thermocouples to the cooking surface.

Instead of analyzing the moisture content of the cooking patties in the full-load test only, we revised the procedure to include analysis in *all* loading scenarios to obtain more accurate cooking energy efficiency results (sections 9.8 and 9.9).

TEST SETUP/INSTRUMENTATION

We used a calibrated gas meter with a 0.01-cu ft resolution to measure gas consumption and surface-type thermocouples to measure the temperature of the cooking surface. The gas meter was fitted with a contact-closure generating sensor, which allowed gas usage to be logged on a minute-by-minute basis. The thermocouples were welded to the griddle plate to obtain accurate temperature measurement.

We installed the griddle under a 4-foot-deep canopy hood, 6 feet 6 inches from the floor, as specified in section 8 of the ASTM test method. The hood operated at a nominal exhaust rate of 300 cfm per linear foot.

Section 3
RESULTS

TEMPERATURE UNIFORMITY AND THERMOSTAT ACCURACY

We tack-welded thermocouples to the cooking surface directly above the thermostat temperature sensing probes. After allowing the cooking surface to stabilize at 375°F for 1 hour, we monitored these points for 1 hour, and then manually calibrated the controls so that the temperature on the plate directly above the thermostat sensing probes was within 5°F of the set temperature.

After laying out additional monitoring points in a 35-point grid on the plate, 3 inches from each side, we allowed the cooking surface to stabilize for 1 hour. The plate temperatures were then monitored for 1 hour, and the temperatures at each point were averaged over the monitoring period. Table 3-1 lists the average temperatures above the thermostats and the maximum temperature difference across the cooking surface. The temperature sensing points and the resulting profile are illustrated in Figures 3-1 and 3-2.

Table 3-1
Temperature Uniformity and Thermostat Accuracy

Left Thermostat (set @ 375°F):	371°F
Right Thermostat (set @ 375°F):	377°F
Maximum Temperature Difference Across Plate:	73°F

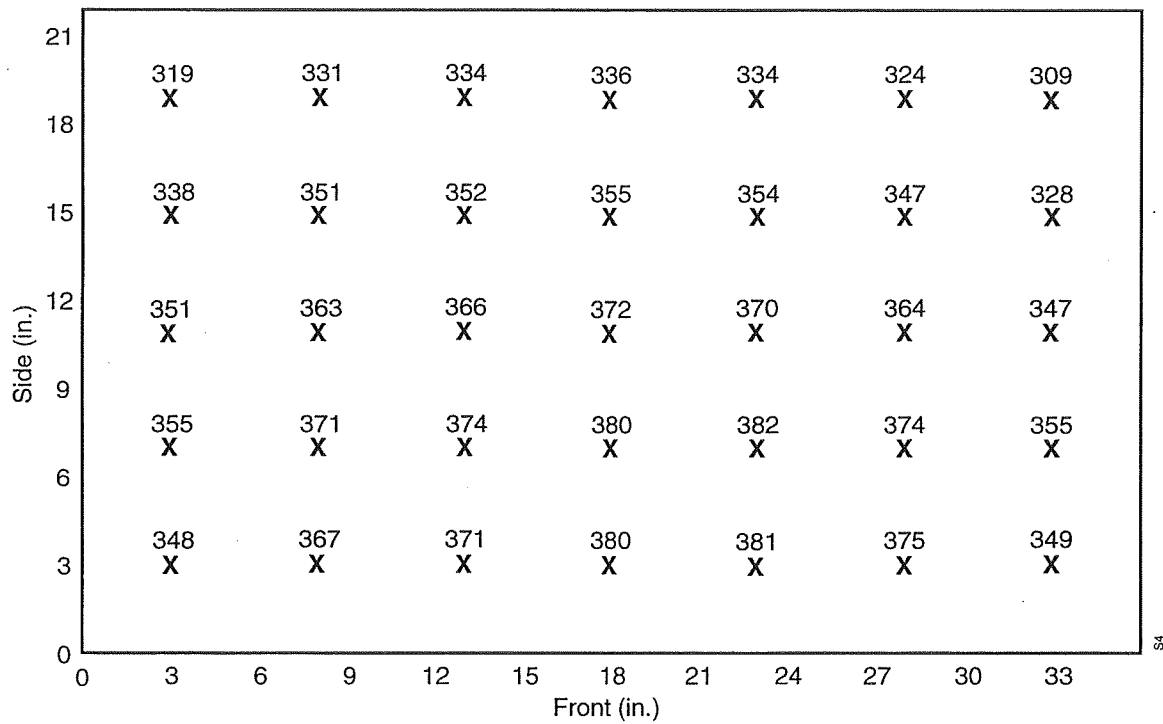


Figure 3-1. Temperature sensing points on the griddle surface.

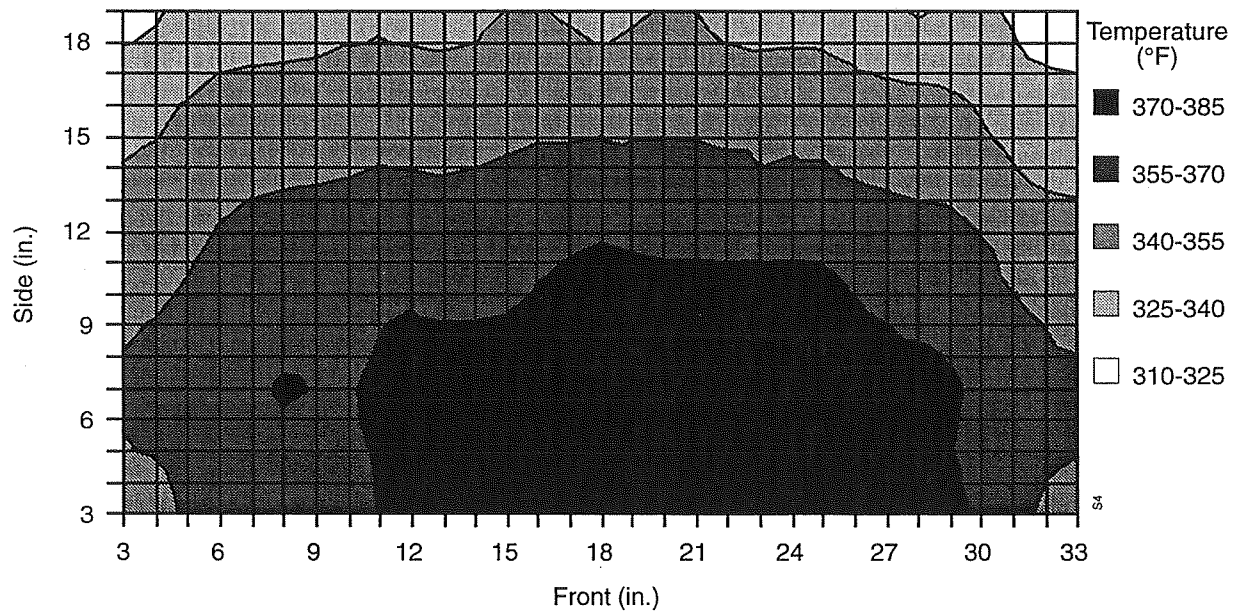


Figure 3-2. Temperature map of the griddle surface.

PREHEAT AND IDLE ENERGY CONSUMPTION

Energy Input Rate

The ASTM procedure calls for measuring the quantity of gas consumed during preheat and dividing it by the preheat time to obtain an average input rate. This minimizes any effects caused by burner orifice heating. Due to the added effect of the modulating control, the average input rate determined by this procedure was 55.5 kBtu/h (or 23% below the griddle's nameplate value). Since the test purpose is to confirm that the appliance is operating under its rated condition, we measured the quantity of gas consumed during the first 10 minutes of preheat and divided it by the 10-minute interval. The calculated value was 69.5 kBtu/h, using a gas heating value of 1,026.3 Btu/ft³. Table 3-2 shows the reduction in average input rate caused by the griddle's modulating controls for various measuring intervals.

Table 3-2
Modulating Input Rate During Preheat

Interval (min)	Input Rate (kBtu/h)
5	72.4
10	69.3
15	64.2
20	55.5
25	48.6

Pilot Energy Consumption

The pilots were monitored over a 15.4-hour period. The total gas consumed during this time was 12.3 cu ft, resulting in a pilot energy consumption rate of 817 Btu/h. Gas heating value was 1,023.2 Btu/ft³.

Preheat Energy Consumption

Contrary to the ASTM test method (section 9.4), we had to determine preheat completion from the surface temperature above the thermostat sensors. The burners gradually reduced their input rate until they reached a minimum level, but did not cycle off. The griddle plate averaged 68°F at the beginning of the preheat. The griddle preheat required 19.2 kBtu, based on a 1,026.3-Btu/ft³ gas heating value. Figure 3-3 shows the energy consumption rate in conjunction with the plate temperatures above the thermostat sensors during preheat.

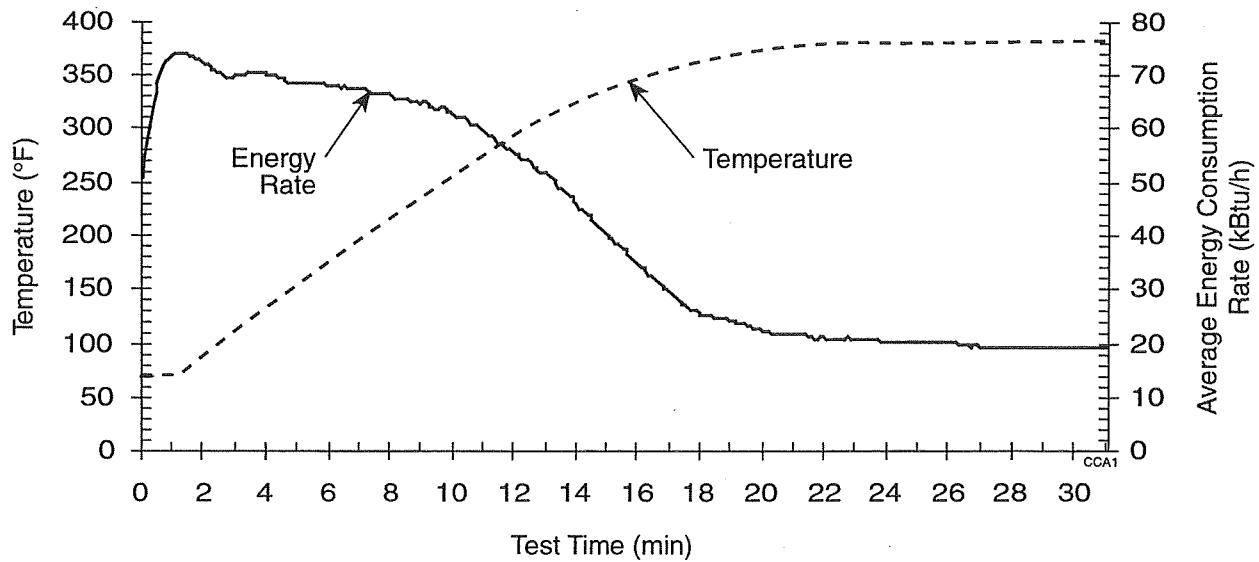


Figure 3-3. Preheat characteristics.

Idle Energy Consumption

The griddle was allowed to stabilize at 375°F for 1 hour. After the plate was stabilized, we monitored the energy over an additional 2-hour idle period. The gas heating value was 1,029.8 Btu/ft³. The idle energy rate was 17.4 kBtu/h.

Test Results

The preheat and idle test results are summarized in Table 3-3.

**Table 3-3
Input, Preheat, and Idle Test Results**

Rated Energy Input Rate:	72 kBtu/h
Measured Energy Input Rate: ^a	69.5 kBtu/h
Pilot Energy Consumption:	817 Btu/h
Preheat:	
Time to 375°F:	21.8 min
Energy:	19.2 kBtu
Rate to 375°F:	14°F/min
Idle Energy Rate @ 375°F:	17.4 kBtu/h

^aMeasured during the first 10 minutes of preheat.

WATER-BOIL AND COOKING PERFORMANCE TESTS

Water-Boil Efficiency

A water-boil test was conducted in accordance with section 9.6 of the ASTM test method. The barometric pressure during the test was 14.426 psia. After the griddle was stabilized by boiling 10 pounds of water, the griddle boiled off water at a rate of 29.3 pounds per hour. The gas heating value was 1,020.9 Btu/ft³. The calculated water-boil efficiency was 45.1%.

Cooking Performance

In the absence of indicator lights to characterize burner operation, as required by the ASTM test method (section 9.8), we modified the existing test method to incorporate the cooking surface temperature measurement into the recovery criterion. To determine plate recovery during the cooking tests, we welded thermocouples to the surface at the center of each linear foot (center points). On the recommendation of the FSTC National Advisory Group, we allowed the griddle plate to recover to within 10 degrees of the set temperature at the center points prior to reloading.

The right thermostat had to be turned up an additional 15 degrees from the set point to maintain 375°F at the center points. The full-load cooking test, consisting of six loads, was completed in 84 minutes. The hamburger patties used in the full-load test contained 60% moisture and 20% fat. Gas heating value on the day of the full-load test was 1,028.7 Btu/ft³.

The hamburger patties used in the half- and light-load tests contained 58% moisture and 22% fat. The half load was cooked on the right half of the cooking surface, with only the right thermostat turned on (this was the minimum area of cooking surface necessary to conduct the test). The left thermostat was turned down 35 degrees from the 375°F set point for the light-load test. Gas heating value was 1,020.8 Btu/ft³ on the day of the half-load testing and 1,024.4 Btu/ft³ on the day of the light-load testing.

Test Results

Table 3-4 presents the results of the water-boil efficiency test and the cooking energy and production capacity tests. Figure 3-4 illustrates the cooking and water-boil efficiencies. Appendix B contains a summary of the application under full-, half-, and light-load scenarios.

Table 3-4
Water-Boil, Cooking Energy Efficiency, and Production Capacity Test Results

Test Condition	Water Boil	Full Load	Half Load	Light Load
Patty Cook Time (min)	NA	7.0	6.5	6.0
Average Recovery Time (min)	NA	7.0	7.7	1.3
Production Rate (lb/h)	29.3 ^a	25.2	12.6	8.1
Energy Consumption (Btu/lb)	2,152 ^a	1,589	2,217	2,156
Average Input Rate (kBtu/h)	63.0	40.1	27.9	17.5
Efficiency (%)	45.1	29.3	21.2	20.7

NA = Not applicable

^aThese quantities are based on pounds of water boiled off during the water-boil test.

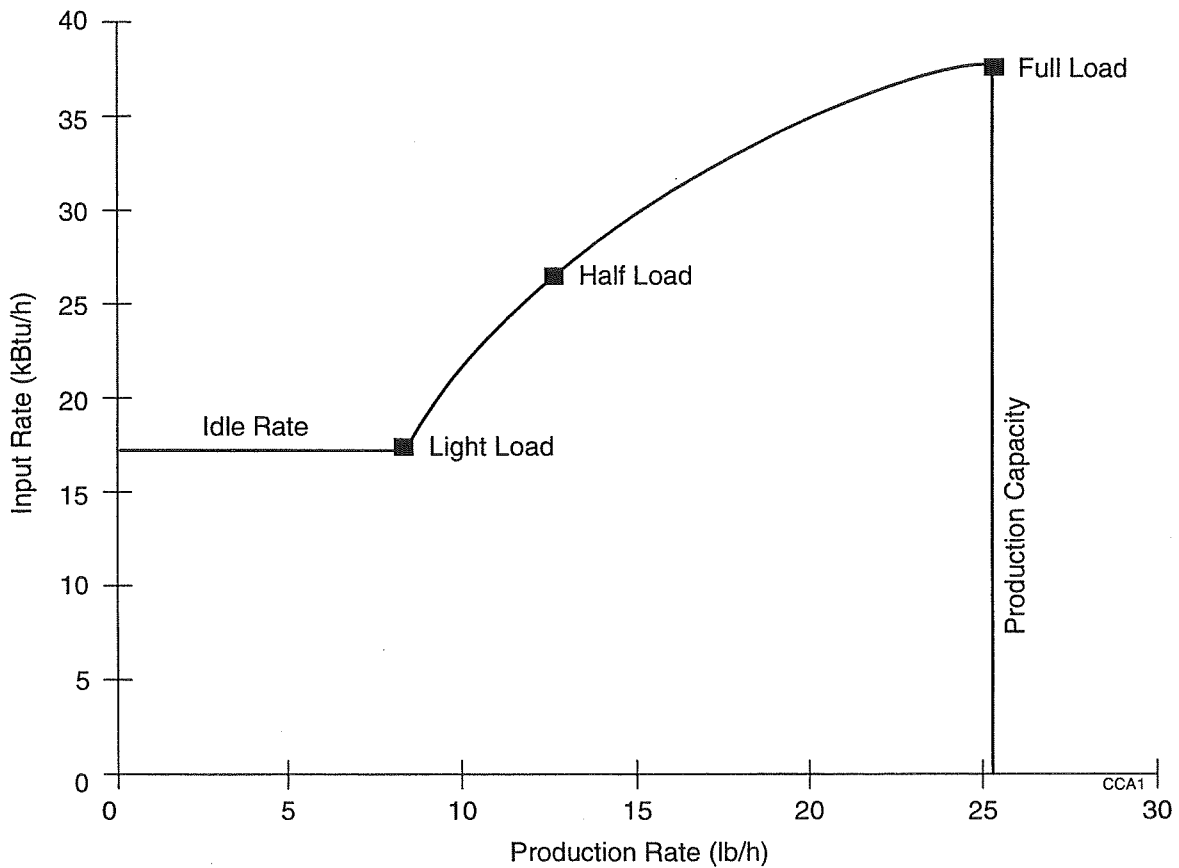


Figure 3-4. Energy input rate vs. production rate.

CONCLUSIONS AND RECOMMENDATIONS

GRIDDLE PERFORMANCE

The performance of the U.S. Range griddle was considered favorable for an atmospheric burner griddle, particularly with respect to energy efficiency under light-load conditions. For example, its cooking energy efficiency under the light-load hamburger patty test was significantly higher than the previously reported efficiency for an atmospheric burner griddle with conventional thermostat control (21% vs. 13%).¹ In fact, its light-load efficiency exceeded that measured for a comparably sized infrared burner griddle (18%).¹ The idle energy consumption rate of 17.4 kBtu/h also reflected improved light-load performance because the burners operated at a minimum flame setting as opposed to a typical on-off burner control. The rate of energy consumption during the light-load hamburger test was the same as the idle energy consumption rate.

The effect of the modulating thermostat control was also demonstrated by the “soft landing” during griddle preheat. Although a slightly extended preheat time was required to attain the 375°F set-point temperature, the time-temperature plot for the preheat test illustrates the absence of temperature overshoot that is typical of a conventional thermostat control. Under idle conditions, the plate retained a remarkably steady temperature—the maximum swing at any point on the cooking surface was less than 5°F.

Over the course of testing, we found that the griddle plate temperature was not always consistent with the thermostat setting, and recalibration was often required. Incorporating a more precise temperature control should eliminate this inconsistency.

The measured hamburger patty production capacity (25.2 pounds per hour) under full-load test conditions was surprisingly low for a griddle with a 72-kBtu/h input. However, this moderate production capacity was attributed to the modulating thermostat and the associated reduction in input energy as the griddle surface temperature approached set point. For example, if the surface temperature dropped to 300°F due to the hamburger load, the input rate of the griddle was only 55 kBtu/h. Furthermore, as the griddle plate temperature recovered to set point, the input rate rapidly dropped towards its minimum input (Figure 3-3).

The higher energy efficiency under light-load conditions and the associated stable surface temperatures suggest that this griddle would be ideal for short-order operations. Refining the thermostat response curve could improve the griddle’s peak production capacity. Alternatively, the controls could provide an override for the modulating input when peak production capacity of the griddle is required.

TEST METHOD REVISIONS

As documented in this report, direct application of the ASTM test method was difficult due to the modulating characteristics of the thermostat. Thus, the experience of the FSTC research team in applying the test method to the U.S. Range griddle leads us to recommend several changes:

1. Incorporate surface temperature measurement within the preheat and cooking tests.
2. Reload when the griddle surface temperature has recovered to 365°F.
3. Determine the input rate during the first 10 minutes of preheat.

Section 5

REFERENCES

1. Pacific Gas and Electric Company. 1989. *Development and Application of a Uniform Testing Procedure for Griddles*. Report 008.1-89.2 prepared for the Department of Research and Development. San Ramon, California: Pacific Gas and Electric Company.
2. American Society for Testing and Materials. ASTM F 1275-90. *Standard Test Methods for the Performance of Griddles*. In *Annual Book of ASTM Standards*. Philadelphia: American Society for Testing and Materials. This test method can be purchased from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

Appendix A
MANUFACTURER'S PRODUCT SPECIFICATIONS

GRIDDLES

THERMOSTATICALLY CONTROLLED GRIDDLES - 1" THICK PLATES

ITEM NUMBER _____

JOB NAME/NUMBER _____

Standard Features

- Available in widths ranging from 24" through 72"
- Welded frame construction
- 3/4" gas pressure regulator
- 1" thick, cold rolled steel plate
- 14 gauge splash guard
- Finish - Stainless Steel front, balance Silverco enamel
- Burners - One aluminized burner every 12", rated 24,000 BTU/HR
- Thermostat control with temperature range of 150°F through 400°F
- Large capacity, removable grease pan
- 2" wide, front grease trough
- Stainless Steel landing ledge
- 4" level adjustable legs

Optional Features

- Painted equipment stand
- Stainless Steel equipment stand
- Casters for stand
- Type of gas
 - Natural
 - Propane
 - Other

SERIES:

- RGTA-2424-1
- RGTA-2436-1
- RGTA-2448-1
- RGTA-2460-1
- RGTA-2472-1



MODEL RGTA-2436-1

MODELS AVAILABLE	
Model No.	Descriptions:
RGTA-2424-1	Thermostatically controlled griddle - plate size 22"D x 24"W
RGTA-2436-1	Thermostatically controlled griddle - plate size 22"D x 36"W
RGTA-2448-1	Thermostatically controlled griddle - plate size 22"D x 48"W
RGTA-2460-1	Thermostatically controlled griddle - plate size 22"D x 60"W
RGTA-2472-1	Thermostatically controlled griddle - plate size 22"D x 72"W

229213

U.S. Range

Post Office Box 47060, 14501 So. Broadway, Gardena, CA 90248
 Phone (213) 770-8800 Fax (213) 324-2697



NOTE:

- When placing order, specify type of gas.
- Specify elevation, if above 2,000 feet.
- Many local codes exist, and it is the responsibility of the *Owner and the Installer* to comply with those codes.
- U.S. Range reserves the right to change or improve our specifications without notification.
- These appliances are intended for commercial use by professionally trained personnel.

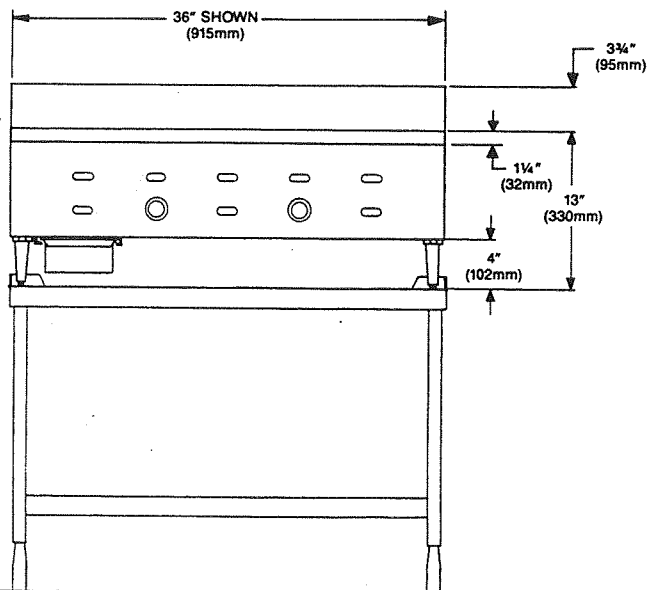
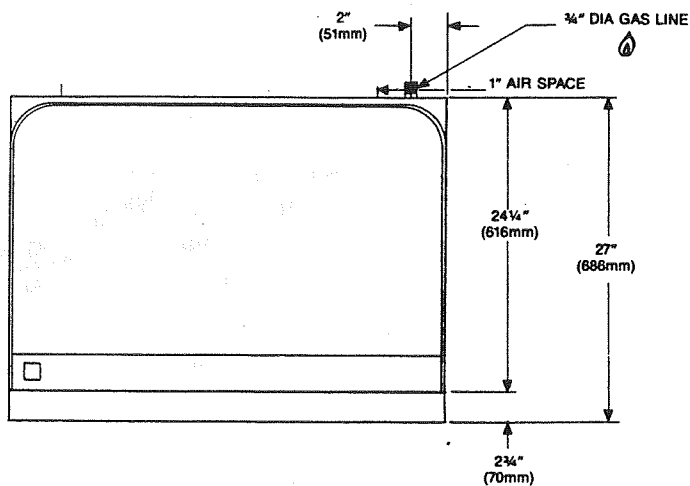
SHORT FORM SPECIFICATION

Shall be U.S. Range, counter type thermostatically controlled griddle. Model—RGTA-_____-1. Total BTU/HR rating of _____ using natural gas.

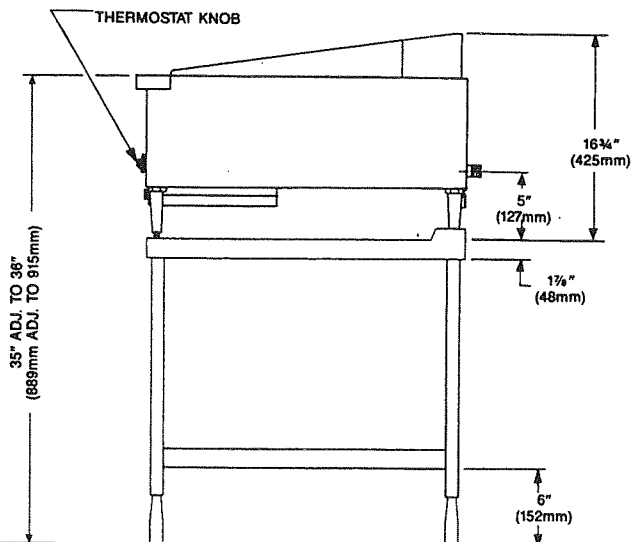
Griddle to have 1" thick steel plate, splash guard, front grease trough and removable grease pan.

Silverco enamel finish on sides and front. Stainless steel front landing ledge, valve cover and 4", level adjustable legs.

GAS ⚡	CLEARANCE
MANIFOLD PRESSURE 5.0" W.C.—NAT. GAS 10.0" W.C.—PROPANE GAS	FOR USE IN NON-COMBUSTIBLE LOCATIONS WITH 4" LEGS (MIN.)
MANIFOLD SIZE — ¾" O.D.	



(SHOWN WITH OPTIONAL STAND)



Scale: 3/4" = 1'

MODEL NO.	(A) WIDTH	NO. OF BURNERS	TOTAL BTU/HR (NATURAL)	GRIDDLE PLATE SIZE	
				WIDTH	DEPTH
RGTA-2424-1	24"	2	48,000	24"	22"
RGTA-2436-1	36"	3	72,000	36"	22"
RGTA-2448-1	48"	4	96,000	48"	22"
RGTA-2460-1	60"	5	120,000	60"	22"
RGTA-2472-1	72"	6	144,000	72"	22"



Appendix B

COOKING ENERGY EFFICIENCY AND PRODUCTION CAPACITY VARIABLES

FULL-LOAD SCENARIO¹

January 21, 1993

Cooking Energy Efficiency	29.3%
Production Rate	25.2 lb/h
Average Recovery Time	7.0 min

Measured Values	
Gas	
Total Gas Volume (ft ³)	55.54
Gas Pressure (in. H ₂ O)	8.4
Gas Temperature (°F)	74
Heating Value (Btu/ft ³)	1,028.7
Barometer (psi)	14.554
Hamburger	
Cook Time (min)	7.0
Total Test Time (min)	84.0
Weight Loss (%)	34.2
Total Burger Weight (lb)	35.3
Initial Fat (%)	20.0
Initial Moisture (%)	60.0
Final Moisture (%)	50.4
Initial Burger Temperature (°F)	0
Final Burger Temperature (°F)	166.0

Assumed Values	
Gas	
Standard Temperature (°R)	519.67
Standard Pressure (psia)	14.73
Hamburger	
Specific Heat of Ice (Btu/lb, °F)	0.50
Specific Heat of Fat (Btu/lb, °F)	0.40
Specific Heat of Solids (Btu/lb, °F)	0.20
Latent Heat of Fusion, Water (Btu/lb)	144
Latent Heat of Fusion, Fat (Btu/lb)	44
Latent Heat of Vaporization, Water (Btu/lb)	970

Calculated Values	
Gas	
Gas Pressure (psia)	0.30
Gas Temperature (°R)	533.97
Pressure Correction Factor	1.009
Temperature Correction Factor	0.973
Total Energy to Griddle (Btu)	56,085
Energy to Griddle (Btu/lb)	1,589
Hamburger	
Final Weight of Water (lb)	11.7
Weight of Water Vaporized (lb)	9.5
Weight of Fat (lb)	7.1
Weight of Solids (lb)	7.1
Final Burger Weight (lb)	23.2
Initial Weight of Water (lb)	21.2
Sensible to Ice (Btu)	339
Sensible to Water (Btu)	2,847
Sensible to Fat (Btu)	470
Sensible to Solids (Btu)	235
Latent - Water Fusion (Btu)	3,050
Latent - Fat Fusion (Btu)	311
Latent - Water Vaporization (Btu)	9,200
Total Energy to Food (Btu)	16,451
Energy to Food (Btu/lb)	466

¹ Right thermostat was turned up from 375°F to 390°F.

HALF-LOAD SCENARIO

January 27, 1993

Cooking Energy Efficiency	21.2%
Production Rate	12.6 lb/h
Average Recovery Time	7.7 min

Measured Values	Calculated Values
Gas	
Total Gas Volume (ft ³)	38.78
Gas Pressure (in. H ₂ O)	8.3
Gas Temperature (°F)	72
Heating Value (Btu/ft ³)	1,020.8
Barometer (psi)	14.491
Hamburger	
Cook Time (min)	6.5
Total Test Time (min)	85.0
Weight Loss (%)	37.1
Total Burger Weight (lb)	17.9
Initial Fat (%)	22.3
Initial Moisture (%)	58.3
Final Moisture (%)	49.7
Initial Burger Temperature (°F)	0
Final Burger Temperature (°F)	162
Assumed Values	
Gas	
Standard Temperature (°R)	519.67
Standard Pressure (psia)	14.73
Hamburger	
Specific Heat of Ice (Btu/lb,°F)	0.50
Specific Heat of Fat (Btu/lb,°F)	0.40
Specific Heat of Solids (Btu/lb,°F)	0.20
Latent Heat of Fusion, Water (Btu/lb)	144
Latent Heat of Fusion, Fat (Btu/lb)	44
Latent Heat of Vaporization, Water (Btu/lb)	970
Gas	
Gas Pressure (psia)	0.30
Gas Temperature (°R)	531.57
Pressure Correction Factor	1.004
Temperature Correction Factor	0.978
Total Energy to Griddle (Btu)	38,880
Energy to Griddle (Btu/lb)	2,176
Hamburger	
Final Weight of Water (lb)	5.6
Weight of Water Vaporized (lb)	4.8
Weight of Fat (lb)	4.0
Weight of Solids (lb)	3.5
Final Burger Weight (lb)	11.2
Initial Weight of Water (lb)	10.4
Sensible to Ice (Btu)	167
Sensible to Water (Btu)	1,356
Sensible to Fat (Btu)	258
Sensible to Solids (Btu)	113
Latent - Water Fusion (Btu)	1,499
Latent - Fat Fusion (Btu)	175
Latent - Water Vaporization (Btu)	4,679
Total Energy to Food (Btu)	8,247
Energy to Food (Btu/lb)	462

LIGHT-LOAD SCENARIO¹

January 28, 1993

Cooking Energy Efficiency	20.7%
Production Rate	8.1 lb/h
Average Recovery Time	1.3 min

Measured Values	Calculated Values
Gas	
Total Gas Volume (ft ³)	12.52
Gas Pressure (in. H ₂ O)	8.4
Gas Temperature (°F)	68
Heating Value (Btu/ft ³)	1,024.4
Barometer (psi)	14.539
Hamburger	
Cook Time (min)	6.0
Total Test Time (min)	44.0
Weight Loss (%)	36.7
Total Burger Weight (lb)	6.0
Initial Fat (%)	22.3
Initial Moisture (%)	58.3
Final Moisture (%)	51.4
Initial Burger Temperature (°F)	0
Final Burger Temperature (°F)	153
Gas	
Gas Pressure (psia)	0.30
Gas Temperature (°R)	527.77
Pressure Correction Factor	1.008
Temperature Correction Factor	0.985
Total Energy to Griddle (Btu)	12,725
Energy to Griddle (Btu/lb)	2,139
Hamburger	
Final Weight of Water (lb)	1.9
Weight of Water Vaporized (lb)	1.5
Weight of Fat (lb)	1.3
Weight of Solids (lb)	1.2
Final Burger Weight (lb)	3.8
Initial Weight of Water (lb)	3.5
Sensible to Ice (Btu)	56
Sensible to Water (Btu)	421
Sensible to Fat (Btu)	81
Sensible to Solids (Btu)	35
Latent - Water Fusion (Btu)	500
Latent - Fat Fusion (Btu)	58
Latent - Water Vaporization (Btu)	1,485
Total Energy to Food (Btu)	2,637
Energy to Food (Btu/lb)	443
Assumed Values	
Gas	
Standard Temperature (°R)	519.67
Standard Pressure (psia)	14.73
Hamburger	
Specific Heat of Ice (Btu/lb,°F)	0.50
Specific Heat of Fat (Btu/lb,°F)	0.40
Specific Heat of Solids (Btu/lb,°F)	0.20
Latent Heat of Fusion, Water (Btu/lb)	144
Latent Heat of Fusion, Fat (Btu/lb)	44
Latent Heat of Vaporization, Water (Btu/lb)	970

¹Left thermostat was turned down from 375°F to 340°F.