Lang Gas Griddle Performance Test

Application of ASTM Standard
Test Method F 1275-03

FSTC Report 5011.04.06

Food Service Technology Center
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Specific appreciation is extended to Lang, for supplying the Food Service Technology Center with a 3-foot gas griddles for controlled testing in the appliance laboratory.

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Executive Summary

Griddles are widely used throughout the hospitality industry to prepare a variety of menu items, from pancakes to hamburgers. As concern over food safety continues, griddle performance parameters such as temperature uniformity and productivity are becoming more important to the food service operator.

Lang's griddle features stainless steel construction, solid state controls, and a 1 ¼-inch thick-brushed steel cooking surface. Food Service Technology Center (FSTC) engineers tested the 3-foot griddle under the tightly controlled conditions of the American Society for Testing and Materials' (ASTM) Standard Test Method for the Performance of Griddles.[1] Griddle performance is characterized by temperature uniformity, preheat time and energy consumption, idle energy consumption rate, cooking-energy efficiency, and production capacity.

Cooking-energy efficiency and production capacity were determined by cooking frozen hamburgers under two different loading scenarios (heavy—24 hamburgers and light—4 hamburgers). The cook time for the heavy-load cooking scenarios was 7.50 minutes. Production capacity includes the cooking time and the time required for the cooking surface to return to within 25°F of the thermostat set point. Production rate varies with the amount of food being cooked.

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:

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

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[1] American Society for Testing and Materials. 2003. *Standard Test Method for the Performance of Griddles.* ASTM Designation F 1275-03, in *Annual Book of ASTM Standards,* West Conshohocken, PA.

Executive Summary

A summary of the ASTM test results is presented in Table ES-1.

Table ES-1. Summary of Griddle Performance.

Rated Energy Input Rate (Btu/h)	81,000
Measured Energy Input Rate (Btu/h)	81,896
Temperature Uniformity (°F) [a]	± 34.5
Useable cooking surface area (in^2) [b]	611
Preheat Time to 375°F (min)	21.9
Preheat Energy to 375°F (Btu)	27,264
Idle Energy Rate @ 375°F (Btu/h)	21,400
Heavy-Load Cooking-Energy Efficiency (%)	31.7 ± 0.8
Light-Load Cooking-Energy Efficiency (%)	11.8 ± 0.7
Production Capacity (lb/h) [c]	43.2 ± 1.8
Cooking Surface Recovery Time (min) [c]	< 1.00

[a] Temperature uniformity reflects the absolute temperature variance across the cooking surface to within 1 inch from each edge.
[b] Area that is between 360°F and 390°F.
[c] Based on the heavy load cooking test with a minimum 30-second preparation time between loads.

The Lang demonstrated tight temperature control during the cooking tests, maintaining an average temperature of 366°F while cooking frozen hamburger patties. In addition, the griddle's 43 lb/h production capacity matches the reported capacity for other high-output infrared griddles.

During heavy-load testing, the griddle exhibited a 32% cooking-energy efficiency while running at a 75% duty cycle. The extra power reserved during cooking suggests that the griddle has more horsepower than it needs for full-load cooking. Reducing the rated input somewhat could result in an improvement in energy efficiency without sacrificing productivity by eliminating excessive short cycling of the burners.

The cost model estimates showed that the Lang griddle, when used to cook 100 pounds of hamburgers a day, 365 days a year, would consume 137,100 kBtu of energy. Assuming an energy cost of 60 cents per therm, 137,100 kBtu (1,371 therms) translates to an annual operating cost of 823 dollars.

The test results can be used to estimate the annual energy consumption for the griddle in a real-world operation. Using the ASTM test data, a simple cost model was developed to calculate the relationship between the various cost components (e.g., preheat, idle and cooking costs) and the annual operating cost. For the calculations shown in Table ES-2, the griddle was used to cook 100 pounds of hamburger patties over a 12-hour day, with one preheat per day, 365 days per year.

Table ES-2. Estimated Griddle Energy Consumption and Cost.

Preheat Energy (kBtu/day)	27.3
Idle Energy (kBtu/day)	132.0
Cooking Energy (kBtu/day)	216.4
Annual Energy (kBtu/year)[a]	137,100
Annual Cost ($/year)[b]	823

[a] 1kBtu = 1,000 Btu

[b] Griddle energy costs are based on $0.60/therm for gas appliances (1 therm = 100,000 Btu)

1 Introduction

Background

Griddles are used throughout the hospitality industry, from their first order of bacon at breakfast to the last seared steak at dinner. The griddle is a workhorse that usually occupies a central position on the short order line. Its versatility ranges from crisping and browning, for foods like hash brown potatoes, bacon and pancakes, to searing, for foods like hamburgers, chicken, steak and fish, and to warming or toasting, for bread and buns. For a high production restaurant, the temperature uniformity of the griddle surface is important to assure that the food is evenly cooked.

Dedicated to the advancement of the food service industry, the Food Service Technology Center (FSTC) has focused on the development of standard test methods for commercial food service equipment since 1987. The primary component of the FSTC is a 10,000 square-foot appliance laboratory equipped with energy monitoring and data acquisition hardware, 60 linear feet of canopy exhaust hoods integrated with utility distribution systems, appliance setup and storage areas, and a state-of-the-art demonstration and training facility.

The test methods, approved and ratified by the American Society for Testing and Materials (ASTM), allow benchmarking of equipment such that users can make meaningful comparisons among available equipment choices. By collaborating with the Electric Power Research Institute (EPRI) and the Gas Technology Institute (GTI) through matching funding agreements, the test methods have remained unbiased to fuel choice. End-use customers and commercial appliance manufacturers consider the FSTC to be the national leader in commercial food service equipment testing and standards, sparking alliances with several major chain customers to date.

Since the development of the ASTM test method for griddles in 1989, the FSTC has tested a wide range of gas and electric griddles.[2-14]

Introduction

The Lang GG – 3 gas griddle features stainless steel construction, solid state controls, a 1 ¼-inch thick steel griddle-cooking surface, front mounted grease trough, and removable grease pan. The Lang gas griddle was tested according to the ASTM procedure, and this report documents the results.

The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report.

Objectives

The objective of this report is to examine the operation and performance of the Lang, Model GG – 3, gas griddle under the controlled conditions of the ASTM standard test method. The scope of this testing is as follows:

1. Verify that the appliance is operating at the manufacturer's rated energy input.
2. Document the temperature uniformity of the cooking surface and the accuracy of the thermostats.
3. Determine the time and energy required to preheat the cooking surface from room temperature to 375°F.
4. Characterize the idle energy use with the thermostats set at a calibrated 375°F.
5. Document the cooking energy consumption and efficiency under two hamburger loading scenarios: heavy (24 patties), and light (4 patties).
6. Determine the production capacity and cooking surface temperature recovery time during the heavy-load test.
7. Estimate the annual operating cost for the griddle using a standard cost model.

Appliance Description

Lang's gas griddle features 1¼ -inch thick polished steel plate with double walled stainless steel construction on the sides. A single programmable computer controls the griddle temperature through a RTD probe for each 12-inch section. The griddle is powered by three 27,000 Btu/h steel burners housed in an insulated lining and burner box. The griddle features four adjustable legs and a built in grease trough with a large-capacity, removable grease container.

Appliance specifications are listed in Table 1-1, and the manufacturer's literature is in Appendix B.

Table 1-1. Appliance Specifications.

Manufacturer	Lang Manufacturing
Model	GG – 3
Generic Appliance Type	Counter Top Thermostatically Controlled Griddle
Rated Input	81,000 Btu/h
Dimensions	36.1" x 30.4" x 20.4"
Construction	1¼ -inch thick polished steel plate with double walled stainless steel construction on the sides. The griddle features four adjustable legs and a built in grease trough with a large-capacity, removable grease container.
Controls	A single programmable computer controls the griddle temperature through an RTD probe per 12'' sections.

2 Methods

Setup and Instrumentation

FSTC researchers installed the griddle on a table over a tiled floor under a 4-foot-deep canopy hood that was installed at a height of 6 feet, 6 inches above the floor. The exhaust rate was set to a nominal rate of 300 cfm per linear foot of hood. The griddle was installed with at least 6 inches of clearance between the vertical plane of the griddle and the edge of the hood. All test apparatus were installed in accordance with Section 9 of the ASTM test method.[1]

Researchers instrumented the griddle with thermocouples to measure cooking surface temperatures. For the temperature uniformity test, 48 thermocouples were welded to the cooking surface in a grid pattern (see Figure 2-1). Three thermocouples, with one at the center of each linear foot of griddle plate (Figure 2-2), were used for the remainder of the tests.

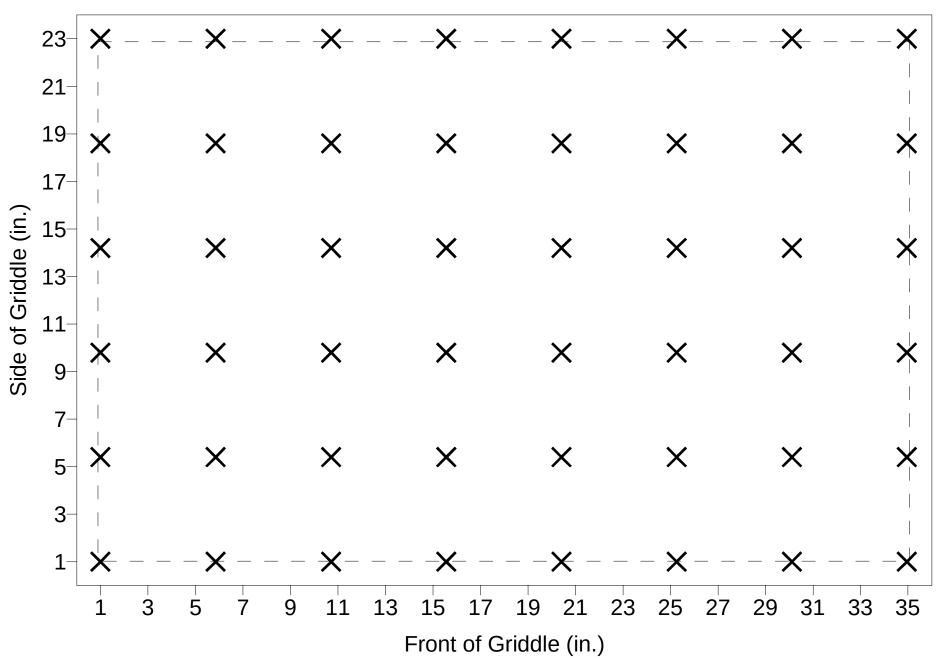


Figure 2-1. Thermocouple grid for temperature uniformity test.

Natural gas consumption was measured using a positive displacement-type gas meter that generated a pulse every 0.1 ft^3. The gas meter and the thermocouples were connected to an automated data acquisition unit that recorded data every 5 seconds. A chemical laboratory used a gas chromatograph to determine the gas heating value on each day of testing. All gas measurements were corrected to standard conditions.

Measured Energy Input Rate

Rated energy input rate is the maximum or peak rate at which the griddle consumes energy—as specified on the griddle's nameplate. Measured energy input rate is the maximum or peak rate of energy consumption, which is recorded during a period when the burners are operating at full input (such as preheat). Researchers compared the measured energy input rate with the nameplate energy input rate to ensure that the griddle was operating properly.

Cooking Tests

Researchers specified frozen, 20% fat, quarter-pound hamburger patties for all cooking tests. Each load of hamburgers was cooked to a 35% weight loss. The cooking tests involved "barreling" six loads of frozen hamburger patties; cooking surface temperature was used as a basis for recovery (see Figure 2-2). Each test was followed by a 1-hour wait period and was then repeated two more times. Researchers tested the griddle using 24 patty (heavy) loads and 4 patty (light) loads.

Due to the logistics involved in removing one load of cooked hamburgers and placing another load onto the griddle, a minimum preparation time of 30 seconds (based on 10 seconds per linear foot) was incorporated into the cooking procedure. This ensures that the cooking tests are uniformly applied from laboratory to laboratory. Griddle recovery was then based on the cooking surface reaching a threshold temperature of 350°F (measured at the center of each linear foot of griddle plate). Reloading within 25°F of the 375°F thermostat set point does not significantly lower the average cooking surface over the cooking cycle, nor does it extend the cook time. The griddle was reloaded

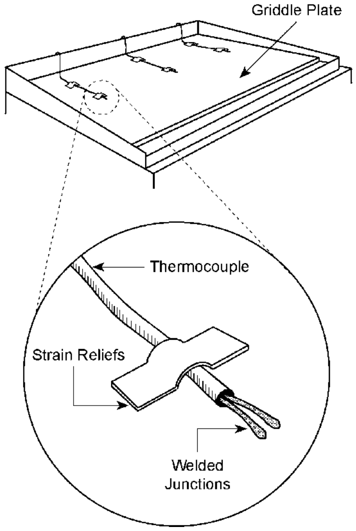


Figure 2-2. Thermocouple placement for testing.

either after all three thermocouples reached the threshold temperature, or 30 seconds after removing the previous load from the griddle, whichever was longer.

Prior to the six-load test, one to two loads of hamburgers were cooked to stabilize the griddle response. Energy consumption, elapsed time, and the average weight loss of the hamburger patties were recorded during the final six loads of the cooking test. After removing the last load and allowing the griddle to recover, researchers terminated the test.

Each cooking test scenario (heavy and light) was repeated a minimum of three times to ensure that the reported cooking-energy efficiency and production capacity results had an uncertainty of less than ±10%. The results from each test run were averaged, and the absolute uncertainty was calculated based on the standard deviation of the results.

The ASTM results reporting sheets appear in Appendix C.

3 Results

Energy Input Rate

Prior to testing, the energy input rate was measured and compared with the manufacturer's nameplate value. This procedure ensured that the griddle was operating within its specified parameters. The measured energy input rate was 81,896 Btu/h (a difference of 1.1% from the nameplate rating).

Temperature Uniformity

Thermocouples were welded to the cooking surface at the center of each linear foot to facilitate temperature calibration. The thermostat control was turned to a ~ 375°F setting. The thermocouples were then monitored after the griddle had stabilized at the set temperature for one hour. Researchers manually adjusted the control to maintain an average of 375 ± 5°F on the cooking surface at the center of each linear foot. To characterize the temperature profile of the cooking surface at 375°F, researchers welded additional thermocouples to the cooking surface in a 48-point grid with approximately 5 inches between adjacent points. Griddle temperatures were monitored for one hour after the cooking surface had stabilized at a calibrated 375°F. Figure 3-1 illustrates the temperatures across the griddle-cooking surface. The temperature uniformity profiles are represented Figure 3-2. The results from these temperature uniformity tests are summarized in Table 3-1.

Results

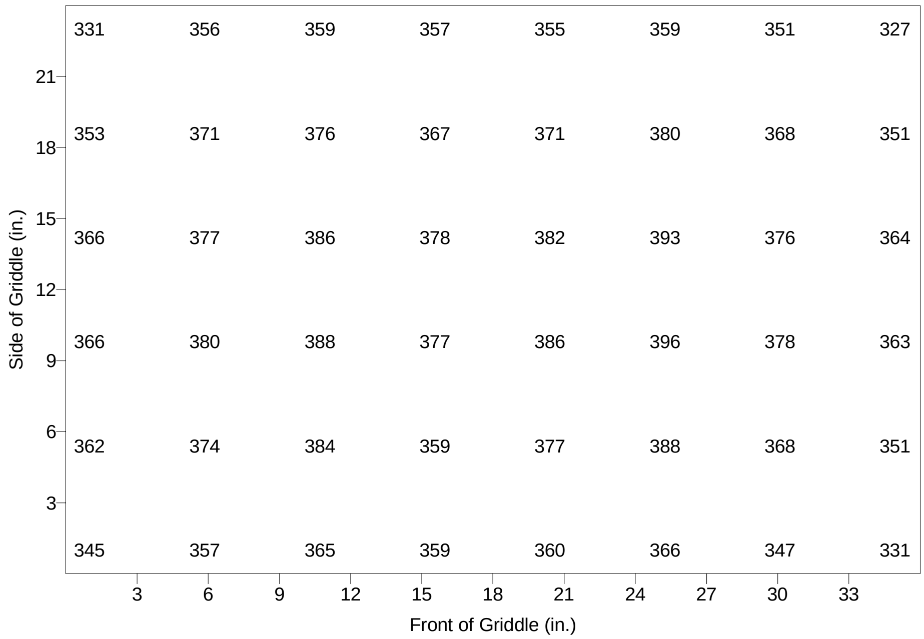


Figure 3-1.
Temperature sensing points on the griddle surface.

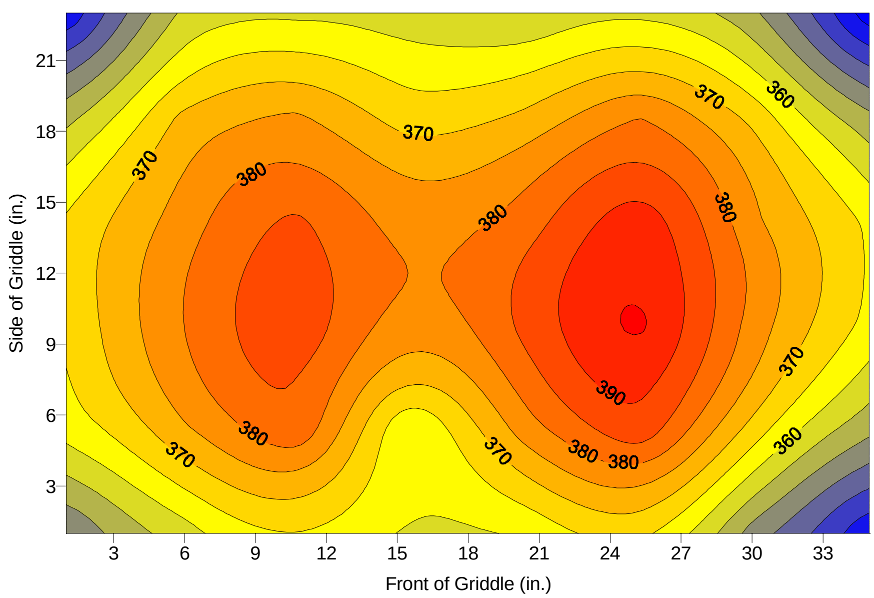


Figure 3-2.
Temperature map of the cooking surface.

Results

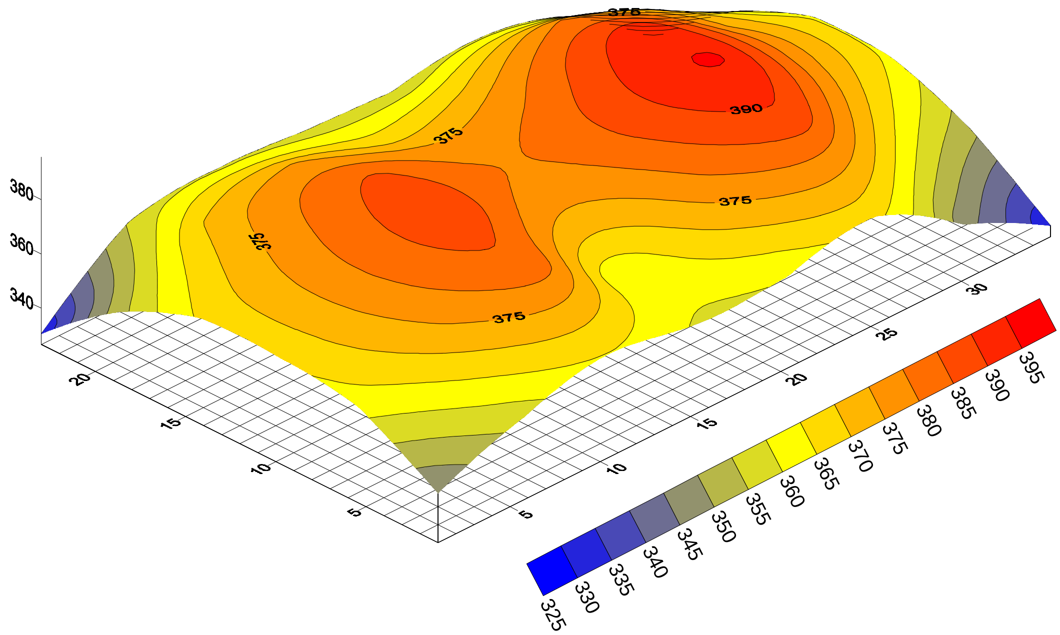


Table 3-1. Temperature Uniformity and Thermostat Accuracy [a]*.*

Thermostat Setting (°F)	375
Average Surface Temperature (°F)	346
Left Thermostat (°F)	379
Center Thermostat (°F)	378
Right Thermostat (°F)	378
Maximum Temperature Difference Across Plate (°F) [b]	69
Useable Cooking Surface (in^2) [c]	611
Standard Deviation of Surface Temperatures (°F)	14.7

[a] Thermostat accuracy is the thermostat setting required to maintain 375 ± 5°F on the cooking surface.

[b] Maximum temperature difference to within 1-inch of the edge of the griddle plate.

[c] Area that is between 360°F and 390°F.

Preheat and Idle Tests

Preheat Energy and Time

Researchers removed the additional thermocouples, leaving only the points at the center of each linear foot. The cooking surface temperature was an average of 73°F at the outset of the preheat test. Researchers measured the energy consumption and time required to preheat the cooking surface to a calibrated 375°F. The time necessary to raise the temperature of the griddle surface to 375°F was 21.9 minutes, during which the griddle consumed 27,264 Btu. Figure 3-3 shows the energy consumption rate in conjunction with the cooking surface temperature during the preheat test.

Idle Energy Rate

The griddle was allowed to stabilize at 375°F for one hour. Researchers then monitored the energy consumption over a 2-hour period. The idle energy rate during this period was 21,400 Btu/h.

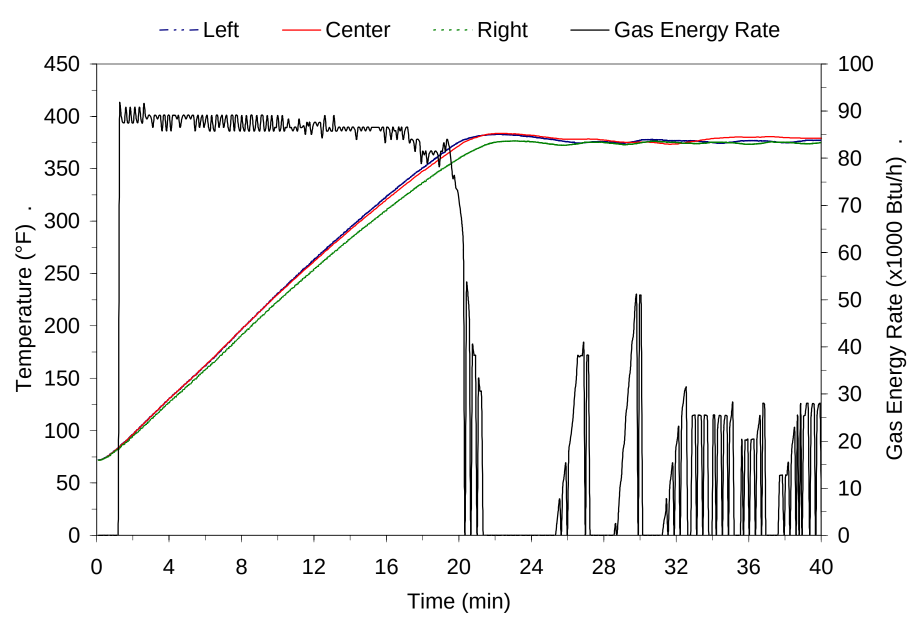


Figure 3-3.
Preheat characteristics.

Results

Test Results

Input, preheat, and idle test results are summarized in Table 3-2.

Table 3-2. Input, Preheat, and Idle Test Results.

Rated Energy Input Rate (Btu/h)	81,000
Measured Energy Input Rate (Btu/h)	81,896
Percentage Difference (%)	1.1
Preheat	
Time to 375°F (min)	21.9
Energy (Btu)	27,264
Rate to 375°F (°F/min)	13.9
Idle Energy Rate @ 375°F (Btu/h)	21,400

Cooking Tests

The griddle was tested under two loading scenarios: heavy (24 hamburger patties) and light (4 hamburger patties). The hamburgers used for the cooking tests consisted of 20% fat and approximately 60% moisture, as specified by the ASTM procedure. Researchers monitored hamburger patty cook time and weight loss, cooking surface recovery time, and griddle energy consumption during these tests.

Heavy-Load Tests

The heavy-load cooking tests were designed to reflect a griddle's maximum performance. The griddle is used to cook six loads of 24 frozen hamburger patties—one load after the other, similar to a batch-cooking procedure. Figure 3-4 shows the average cooking surface temperature during a heavy-load test. One load was used to stabilize the griddle, and six loads were used to calculate cooking-energy efficiency and production capacity.

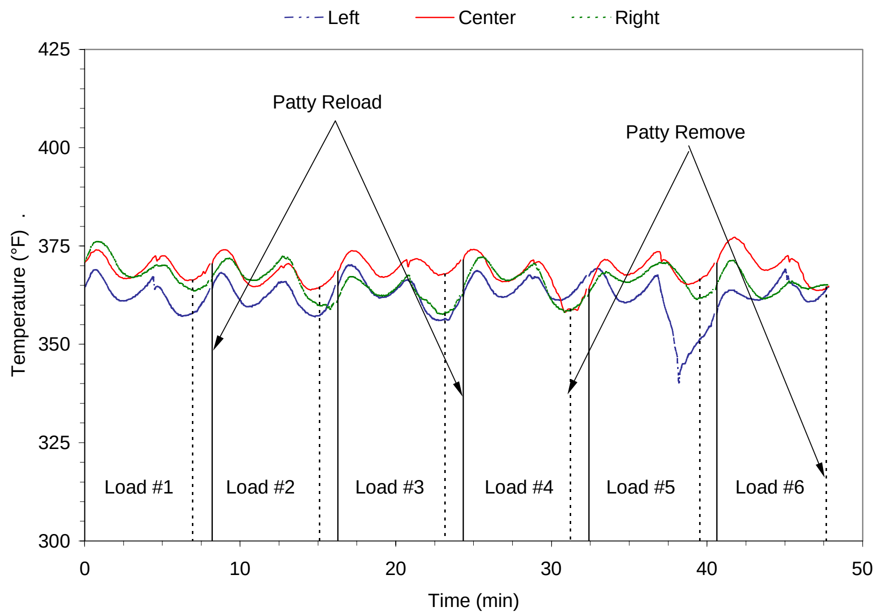


Figure 3-4.
Average heavy-load cooking surface temperatures.

Figure 3-5 illustrates the griddle's temperature response while a heavy load of frozen hamburger patties was cooked. Since the griddle plate never fell below the 350°F threshold temperature specified by the test method, the griddle is considered to be fully-recovered by the end of the cooking cycle. Production capacity includes the time required to scrape and reload the cooking surface (recovery time).

Light-Load Tests

Light-load tests represent a more typical usage pattern for a griddle in cook-to-order applications. Since a griddle is seldom fully loaded in many food service establishments, these light-load efficiencies can be used to estimate griddle performance in an actual operation. Since the entire griddle was heated to 375°F, the energy consumed during these light-load tests includes radiant heat losses from the unused portions of the griddle.

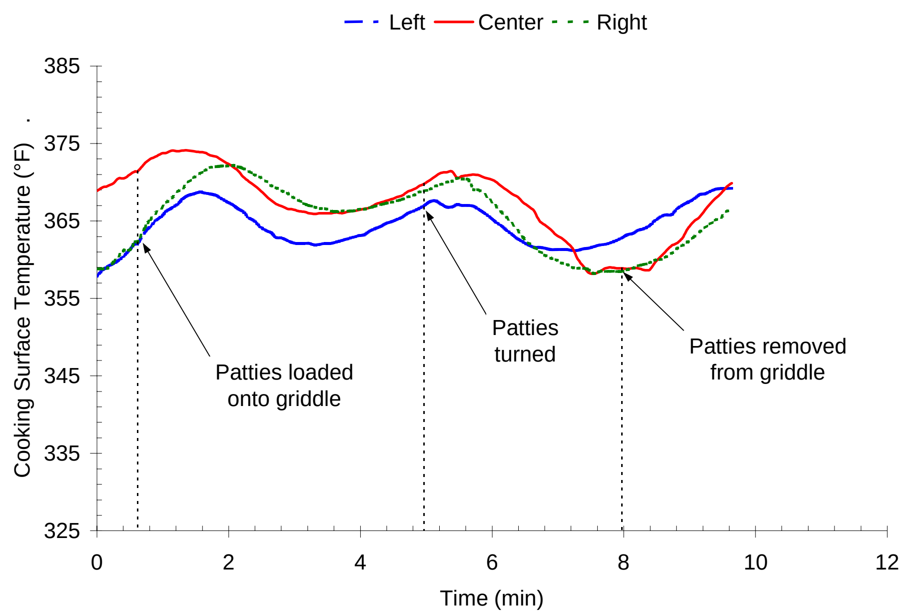


Figure 3-5.
Griddle temperature signature while cooking a heavy-load of hamburgers.

Test Results

Energy imparted to the hamburger patties was calculated by separating the various components of the patties (water, fat, and solids) and determining the amount of heat gained by each component (Appendix D). The griddle's cooking-energy efficiency for a given loading scenario is the amount of energy imparted to the hamburger patties, expressed as a percentage of the amount of energy consumed by the griddle during the cooking process.

Cooking-energy efficiency results for the heavy-load tests were 31.8%, 32.0%, and 31.4% yielding a maximum uncertainty of 2.6% in the test results. Table 3-3 summarizes the results of the ASTM cooking-energy efficiency and production capacity tests.

Table 3-3. Cooking-Energy Efficiency and Production Capacity Test Results.

	Heavy-Load	Light-Load
Hamburger Cook Time (min)	7.50	7.35
Average Recovery Time (min)	< 1.0	< 1.0
Production Rate (lb/h)	43.2 ± 1.8	7.8 ± 0.7
Energy per Pound of Food Cooked (Btu/lb)	1,409	3,914
Cooking Energy Rate (Btu/h)	60,780	30,650
Cooking-Energy Efficiency (%)	31.7 ± 0.8	11.8 ± 0.7

Figure 3-6 illustrates the relationship between cooking-energy efficiency and production rate for this griddle. Griddle production rate is a function of both the hamburger patty cook time and the recovery time. Appendix D contains a synopsis of test data for each replicate of the cooking tests.

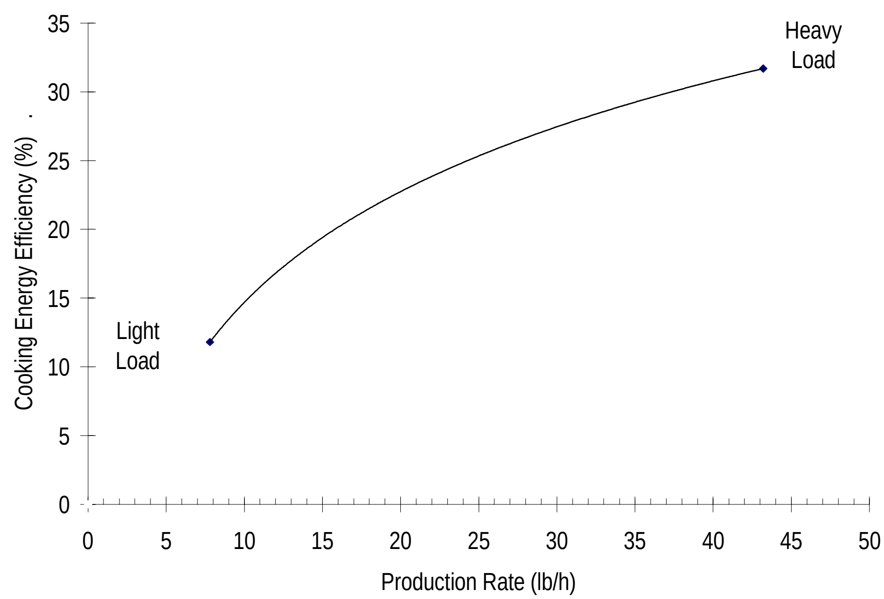


Figure 3-6.
Griddle part-load cooking-energy efficiency.

Note: Light-load = 4 hamburgers/load; heavy-load = 24 hamburgers/load

Figure 3-7 illustrates the relationship between the griddle's average energy consumption rate and the production rate. This graph can be used as a tool to estimate the average energy rate for different types of operations. Average energy consumption rates at 10, 20, and 30 pounds per hour are 32,500 Btu/h, 41,000 Btu/h, and 49,550 Btu/h, respectively.

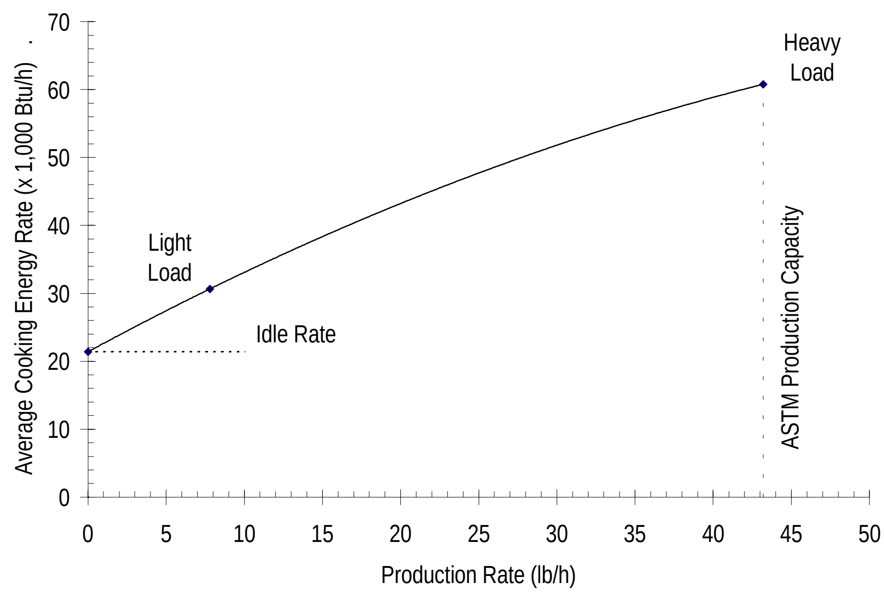


Figure 3-7.
Griddle cooking energy consumption profile.

Note: Light-load = 4 hamburgers/load; heavy-load = 24 hamburgers/load

Energy Cost Model

The test results can be used to estimate the annual energy consumption for the griddle in a real-world operation. A simple cost model was developed to calculate the relationship between the various cost components (e.g., preheat, idle and cooking costs) and the annual operating cost (Appendix E), using the ASTM test data. For this model, the griddle was used to cook 100 pounds of hamburger patties over a 12-hour day, with one preheat per day, 365 days per year. The idle (standby) time for the griddle was determined by taking the difference between the total daily on time (12 hours) and the time spent cooking and preheating. This approach produces a more accurate estimate of the operating costs for the griddle. Table 3-4 summarizes the annual energy consumption and associated energy cost for the griddle under this scenario.

Table 3-4. Estimated Griddle Energy Consumption and Cost.

Preheat Energy (kBtu/day)	27.3
Idle Energy (kBtu/day)	132.0
Cooking Energy (kBtu/day)	216.4
Annual Energy (kBtu/year)[a]	137,100
Annual Cost ($/year)[b]	823

[a] 1kBtu = 1,000 Btu

[b] Griddle energy costs are based on $0.60/therm for gas appliances (1 therm = 100,000 Btu)

4 Conclusions

The Lang gas griddle was successfully tested in accordance with the ASTM standard test method, exhibiting performance that compares favorably with other griddles in its class. The griddle demonstrated tight temperature control during the cooking tests, maintaining an average temperature of 366°F while cooking frozen hamburger patties. In addition, the griddle's 43 lb/h production capacity matches the reported capacity for other high-output infrared griddles.[2-14]

During heavy-load testing, the griddle exhibited a 32% cooking-energy efficiency while running at a 75% duty cycle. The extra power reserved during cooking suggests that the griddle has more horsepower than it needs for full-load cooking. Reducing the rated input somewhat could result in an improvement in energy efficiency without sacrificing productivity by eliminating excessive short cycling of the burners.

The cost model estimates showed that the Lang griddle, when used to cook 100 pounds of hamburgers a day, 365 days a year, would consume 137,100 kBtu of energy. Assuming an energy cost of 60 cents per therm, 137,100 kBtu (1,371 therms) translates to an annual operating cost of 823 dollars.

Lang's GG – 3 griddle demonstrated good uniformity with 611 in^2 of usable cooking surface (that is, the area between 360°F and 390°F). The uniform temperature of the cooking surface, coupled with the griddle's tight temperature control and high productivity make this it a good fit for high-volume applications.

5 References

1. American Society for Testing and Materials, 2003. *Standard Test Method for the Performance of Griddles*. ASTM Designation F 1275-03. In Annual Book of ASTM Standards, West Conshohocken, PA.

2. Pacific Gas and Electric Company. 1989*. Development and Application of a Uniform Testing Procedure for Griddles.* Report 008.1-89.2 prepared for Research and Development. San Ramon, California: Pacific Gas and Electric Company.

3. Zabrowski, D., Nickel, J., 1993. *U.S. Range Model RGTA-2436-1 Gas Griddle Application of ASTM Standard Test Method.* Food Service Technology Center Report 5017.93.1, September.

4. Zabrowski D., Nickel, J., 1993. *Keating MIRACLEAN Model 36 x 30 IBLD Gas Griddle: Application of ASTM Standard Test Method F 1275-90.* Food Service Technology Center Report 5017.93.3, September.

5. Zabrowski, D., Mogel, K., Weller, T., 1996. *Toastmaster® Accu-Miser™, Model AM36SS Electric Griddle Performance Test.* Food Service Technology Center Report 5011.96.34, January.

6. Zabrowski, D., Cadotte, R., Sorensen, G., 1998. *AccuTemp, Model 2-3-14-208 Electric Griddle Performance Test.* Food Service Technology Center Report 5011.98.55, February.

7. Zabrowski, D., Schmitz, M., Sorensen, G., 1999. *Taylor, Model QS24-23 Electric Double-Sided Griddle Performance Test.* Food Service Technology Center Report 5011.99.69, January.

8. Cowen, D., Zabrowski, D., Miner, S., 2001. *Anets GoldenGRILL™ Gas Griddle Performance Test.* Food Service Technology Center Report 5011.01.04, December.

9. Cowen, D., Zabrowski, D., Miner, S., 2002. *AccuTemp Gas Griddle Performance Test: Application of ASTM Standard Test Method F1275-99.* Food Service Technology Center Report 5011.02.04, January.

10. Cowen, D., Zabrowski, D., 2002. *Garland Gas Griddle Performance Test: Application of ASTM Standard Test Method F1275-99.* Food Service Technology Center Report 5011.02.05, December.

11. Cowen, D., Zabrowski, D., 2003. *Wells Gas Griddle Performance Tests: Application of ASTM Standard Test Method F1275-99.* Food Service Technology Center Report 5011.03.05, January.

12. Cowen, D., Zabrowski, D., 2003. *Imperial Gas Griddle Performance Tests: Application of ASTM Standard Test Method F1275-99.* Food Service Technology Center Report 5011.03.06, January.

13. Cowen, D., Zabrowski, D., 2003. *Jade JGTSD Gas Griddle Performance Tests: Application of ASTM Standard Test Method F1275-99.* Food Service Technology Center Report 5011.03.18, May.

14. Cowen, D., Zabrowski, D., 2003. *US Range RGTSA Gas Griddle Performance Tests: Application of ASTM Standard Test Method F1275-99.* Food Service Technology Center Report 5011.03.27, September.

A Glossary

Cooking Energy (kWh or kBtu)

The total energy consumed by an appliance as it is used to cook a specified food product.

Cooking Energy Consumption Rate (kW or kBtu/h)

The average rate of energy consumption during the cooking period.

Cooking-Energy Efficiency (%)

The quantity of energy input to the food products; expressed as a percentage of the quantity of energy input to the appliance during the heavy-, medium-, and light-load tests.

Duty Cycle (%)
Load Factor

The average energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

$$\text{Duty Cycle} = \frac{\text{Average Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Energy Input Rate (kW or kBtu/h)
Energy Consumption Rate
Energy Rate

The peak rate at which an appliance will consume energy, typically reflected during preheat.

Heating Value (Btu/ft^3)
Heating Content

The quantity of heat (energy) generated by the combustion of fuel. For natural gas, this quantity varies depending on the constituents of the gas.

Idle Energy Rate (kW or Btu/h)
Idle Energy Input Rate
Idle Rate

The rate of appliance energy consumption while it is “holding” or maintaining a stabilized operating condition or temperature.

Idle Temperature (°F, Setting)

The temperature of the cooking cavity/surface (selected by the appliance operator or specified for a controlled test) that is maintained by the appliance under an idle condition.

Idle Duty Cycle (%)
Idle Energy Factor

The idle energy consumption rate expressed as a percentage of the measured energy input rate.

$$\text{Idle Duty Cycle} = \frac{\text{Idle Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Glossary

Measured Input Rate (kW or Btu/h)
Measured Energy Input Rate
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during appliance preheat (i.e., the period of operation when all burners or elements are "on").

Pilot Energy Rate (kBtu/h)
Pilot Energy Consumption Rate

The rate of energy consumption by the standing or constant pilot while the appliance is not being operated (i.e., when the thermostats or control knobs have been turned off by the food service operator).

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

The total amount of energy consumed by an appliance during the preheat period.

Preheat Rate (°F/min)

The rate at which the cook zone heats during a preheat.

Preheat Time (minute)
Preheat Period

The time required for an appliance to "heat up" from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

Production Capacity (lb/h)

The maximum production rate of an appliance while cooking a specified food product in accordance with the heavy-load cooking test.

Production Rate (lb/h)
Productivity

The average rate at which an appliance brings a specified food product to a specified "cooked" condition.

Rated Energy Input Rate
(kW, W or Btu/h, Btu/h)
Input Rating (ANSI definition)
Nameplate Energy Input Rate
Rated Input

The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

Recovery Time (minute, second)

The average time from the removal of the cooked hamburger patties from the griddle cooking surface until the cooking surface is within 25°F of the thermostat set point and then griddle is ready to be reloaded.

Test Method

A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

Typical Day

A sampled day of average appliance usage based on observations and/or operator interviews, used to develop an energy cost model for the appliance.

B Appliance Specifications

Appendix B includes the product literature for the Lang griddle.

Appliance Specifications

Manufacturer	Lang Manufacturing
Model	GG – 3
Generic Appliance Type	Counter Top Thermostatically Controlled Griddle
Rated Input	81,000 Btu/h
Dimensions	36.1" x 30.4" x 20.4"
Construction	1¼ -inch thick polished steel plate with double walled stainless steel construction on the sides. The griddle features four adjustable legs and a built in grease trough with a large-capacity, removable grease container.
Controls	A single programmable computer controls the griddle temperature through an RTD probe per 12'' sections.

Item No. ____________

Project ____________

Quantity ____________

ChefSeries™ Gas, Computerized Counter Model Griddles

Model: GG[2,3,4,5,6]

Model GG3 shown, with optional grooved plate section

SIZING AND PERFORMANCE GUIDE

Model	Unit Width	Surface Area	Burners	BTU Input*
❏ GG2	24”	552 sq. in.	2	54,000
❏ GG3	36”	828 sq. in.	3	81,000
❏ GG4	48”	1104 sq. in.	4	108,000
❏ GG5	60”	1380 sq. in.	5	135,000
❏ GG6	72”	1656 sq. in.	6	162,000

** For both natural and propane gas*

SHORT/BID SPECIFICATION

Griddle shall be a **LANG Manufacturing Model GG__ [specify width: 2=24”, 3=36”, 4=48”, 5=60” or 6=72”]** with Platinum microprocessor based controls; gas heated aluminized burner system, with bottom baffles and direct spark electronic ignition; 1-1/4” thick polished cooking surface; 5-1/2” high side and back splash and full front 1” deep x 3-1/2” wide grease trough; double wall base construction; and all the features listed and the options/ accessories checked:

STANDARD PRODUCT WARRANTY

One year, parts & labor

CONSTRUCTION FEATURES

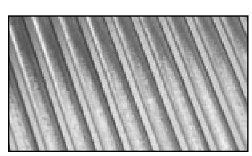
- 1-1/4” thick precision machined, polished steel cooking surface
- Continuously bottom welded 5-1/2” high rear & side splash shields
- Full front 3-1/2” wide x 1” deep stainless steel grease trough with…
- One or two [60” & 72” models] drops provided to one or two grease drawers
- Double wall base construction
- Aluminized burner system spaced every 12”
- Heat shield provided below burners
- 4” adjustable legs provided [Stand option available]

PERFORMANCE FEATURES

- Precise microprocessor based controls ensure accurate and consistent cook temps.
- Extra thick griddle plate minimizes surface temperature variations and retains heat
- Highly polished surface and continuously welded splash and grease trough speed cleanup
- Electronic direct spark ignition, double wall construction and heat shields increase operating efficiency
- Extremely accurate temperature control between 175˚ and 550˚F
- No protruding thermostat knobs to brake or clean around
- No thermostats to recalibrate

PLATINUM CONTROL PACKAGE

- Attractive, recessed control module
- Touch pad setting of cook temperature in 5˚F increments
- Set [zone] cooking temp for each 12” of cook surface
- Automatically changes temperature for different day-parts
- Continuous actual griddle temperature readout
- Choice of degrees C or F readout
- Controls cook surface temperature to ± 1˚F
- Built-in self-diagnostic system



FOCUS OPTION

Custom Grooving [Specified in 12” increments, from left to right.]

Sheet No. LSP-GD5 (rev. 3/04)

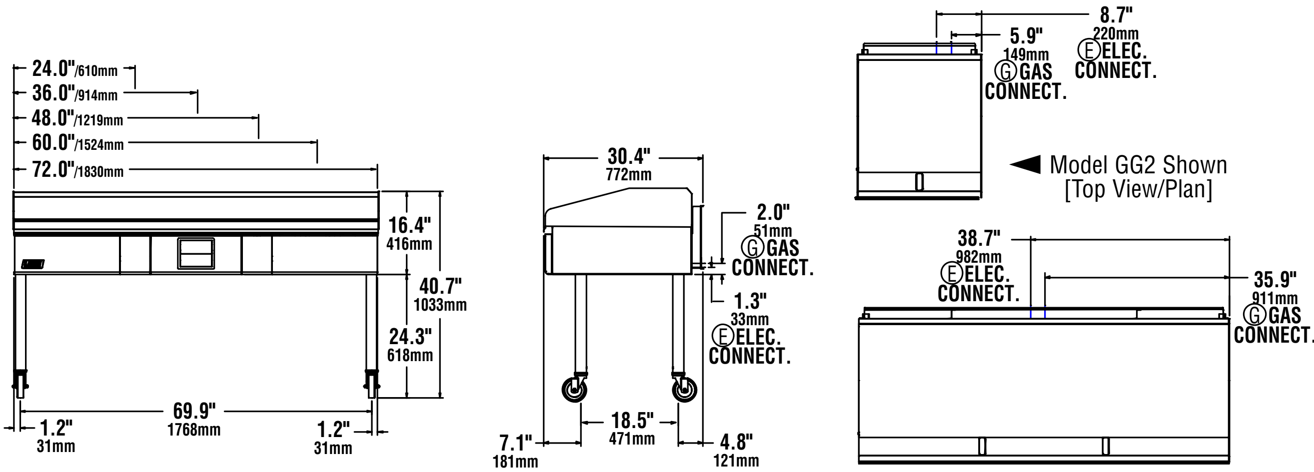
INSTALLATION REQUIREMENTS

- Ⓖ Specify: ❏ natural gas or ❏ propane gas: via 3/4” NPT connection
- Gas pressure regulator provided
- Specify elevation if project is over 2000 feet.
- Ⓔ 115V, 1-Phase, 50/60 Hz, 2-AMP electrical connection
- Cord & plug is provided
- Installation under approved vent hood required.

[All connections from rear. See below for location and delivery requirements]

OPTIONS & ACCESSORIES

- ❏ Custom Grooving [Specified in 12” increments, from left to right. 24” maximum, from either side.]
- ❏ Stainless steel tubular-leg stand with adjustable feet
- ❏ Stainless steel tubular-leg stand with casters
- ❏ Clamshell“ Two Sided Cooking [See LSP-CS1/CS2/CS3]



All models (Width varies with model) [Front View/Elevation]

All Models [Right Side View]

▲ Model GG5 shown (Connections vary by model. Generally centered at rear.) [Top View/Plan]

Model	Height x Width x Depth (Not including legs)	Clearance from combustible surface	Weight		Freight Class
			Actual	Shipping	
GG2	16.4” x 24.0” x 30.4” 416mm x 610mm x 772mm	Sides: 4” Back: 4” Bottom: 4”	333 lbs. 151 kg	370 lbs. 168 kg	65
GG3	16.4” x 36.0” x 30.4” 381mm x 914mm x 717mm		448 lbs. 204 kg	500 lbs. 227 kg	65
GG4	16.4” x 48.0” x 30.4” 381mm x 1219mm x 717mm		578 lbs. 263 kg	650 lbs. 295 kg	65
GG5	16.4” x 60” x 30.4” 381mm x 1524mm x 717mm		701 lbs. 319 kg	780 lbs. 355 kg	65
GG6	16.4” x 72.0” x 30.4” 381mm x 1830mm x 717mm		809 lbs. 368 kg	920 lbs. 418 kg	65

Model	Ⓔ Electrical Requirements				Ⓖ Gas Requirements (3/4” NPT)
	Voltage	Total kW	Phase	Amps/Line	
GG2	115V/60Hz	0.5	1	2.0	54,000 BTU/hr
GG3					81,000 BTU/hr
GG4					108,000 BTU/hr
GG5					135,000 BTU/hr
GG6					162,000 BTU/hr

CAD SYMBOLS & PRICING

The KCL CADalog

AutoQuotes

Due to continuous improvements, specifications subject to change without notice.

Sheet No. LSP-GD5 (rev. 3/04)

Lang

World Class Cooking Solutions

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C Results Reporting Sheets

Manufacturer:	Lang
Model:	GG - 3
Serial Number:	03110002
Date:	January 2004

Test Griddle.

Description of operational characteristics: 1¼ -inch thick polished steel plate with double walled stainless steel construction on the sides. A single programmable computer controls the griddle temperature through an RTD probe per 12″ sections. Three 27,000 Btu/h steel burners housed in an insulated lining and burner box. The griddle features four adjustable legs and a built in grease trough with a large-capacity, removable grease container.

Apparatus.

____√____ Check if testing apparatus conformed to specifications in section 6.

Deviations: The griddle temperature uniformity plot was increased in size to characterize temperatures to within 1-inch of the outside edge of the griddle plate. Also, surface temperature recovery during the cooking tests was lowered from 365°F to 350°F per an upcoming revision of the ASTM griddle test method.

Energy Input Rate.

Heating Value (Btu/scf)	1026
Rated (Btu/h)	81,000
Measured (Btu/h)	81,896
Percent Difference between Measured and Rated (%)	1.10

Temperature Uniformity and Thermostat Accuracy [a]

Left Thermostat (°F)	379
Center Thermostat (°F)	378
Right Thermostat (°F)	378
Maximum Temperature Difference Across Plate (°F) [b]	69
Useable Cooking Surface (in^2) [c]	611

[a] Thermostat settings required to maintain 375°F cooking surface temperature

[b] Maximum temperature difference to within 1-inch of the edge of the griddle plate.

[c] Area that is between 360°F and 390 °F.

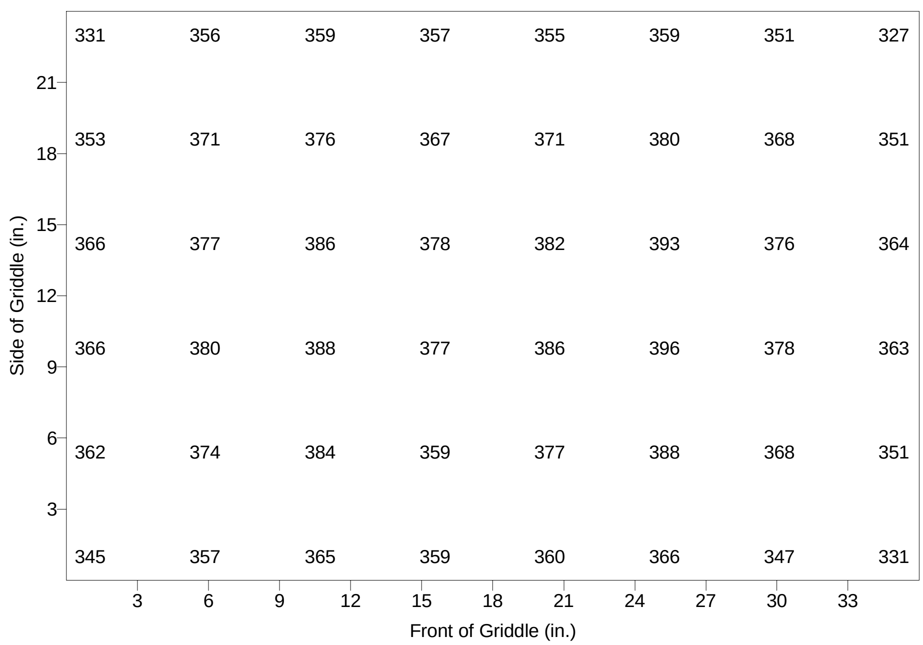

Figure C-1. Average cooking surface temperatures.

Preheat Energy and Time.

Heating Value (Btu/scf)	1017
Starting Temperature (°F)	71.9
Energy Consumption (Btu)	27,264
Duration (min)	21.9
Preheat Rate (°F/min)	13.9

Results Reporting Sheets

Idle Energy Rate.

Heating Value (Btu/scf)	1026
Idle Energy Rate @ 375°F (Btu/h)	21,403

Heavy-Load Cooking-Energy Efficiency Test Results.

Heating Value (Btu/scf)	1018
Cooking Time (min)	7.50
Average Cooking Surface Recovery Time (min)	< 1.0
Production Capacity (lb/h)	43.2 ± 1.8
Energy to Food (Btu/lb)	447
Cooking Energy Rate (Btu/h)	60,782
Energy per Pound of Food Cooked (Btu/lb)	1,409
Cooking-Energy Efficiency (%)	31.7 ± 0.8

Light-Load Cooking-Energy Efficiency Test Results.

Heating Value (Btu/scf)	1016
Cooking Time (min)	7.35
Average Cooking Surface Recovery Time (min)	< 1.0
Production Capacity (lb/h)	7.8 ± 0.7
Energy to Food (Btu/lb)	460
Cooking Energy Rate (Btu/h)	30,645
Energy per Pound of Food Cooked (Btu/lb)	3,914
Cooking-Energy Efficiency (%)	11.8 ± 0.7

D Cooking-Energy Efficiency Data

Table D-1. Specific Heat and Latent Heat

Specific Heat (Btu/lb, °F)	
Ice	0.50
Fat	0.40
Solids	0.20
Latent Heat (Btu/lb)	
Fusion, Water	144
Fusion, Fat	44
Vaporization, Water	970

Cooking-Energy Efficiency Data

Table D-2. Heavy Load Test Data

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (Btu)	49,191	51,117	52,801
Cook Time (min)	7.32	7.50	7.67
Total Test Time (min)	49.66	50.46	50.99
Weight Loss (%)	32.5%	34.4%	34.3%
Initial Weight (lb)	36.321	36.271	36.077
Final Weight (lb)	24.527	23.809	23.711
Initial Fat Content (%)	19.8%	19.8%	19.8%
Initial Moisture Content (%)	60.2%	60.2%	60.2%
Final Moisture Content (%)	53.9%	52.7%	51.4%
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	156	161	161
Calculated Values			
Initial Weight of Water (lb)	21.879	21.849	21.732
Final Weight of Water (lb)	13.215	12.550	12.184
Weight of Fat (lb)	7.177	7.168	7.129
Weight of Solids (lb)	7.264	7.254	7.215
Sensible to Ice (Btu)	350	350	348
Sensible to Water (Btu)	2,718	2,822	2,802
Sensible to Fat (Btu)	449	462	459
Sensible to Solids (Btu)	227	234	232
Latent - Water Fusion (Btu)	3,151	3,146	3,129
Latent - Fat Fusion (Btu)	342	341	339
Latent - Water Vaporization (Btu)	8,404	9,021	9,261
Total Energy to Food (Btu)	15,640	16,375	16,571
Energy to Food (Btu/lb)	431	451	459
Total Energy to Griddle (Btu)	49,191	51,117	52,801
Energy Per Pound of Food Cooked (Btu/lb)	1,354	1,409	1,464
Cooking-Energy Efficiency (%)	31.8	32.0	31.4
Cooking Energy Rate (Btu/h)	59,433	60,781	62,131
Production Rate (lb/h)	43.9	43.1	42.5
Average Recovery Time (min)	< 1.00	< 1.00	< 1.00

Cooking-Energy Efficiency Data

Table D-3. Light-Load Test Data

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (Btu)	24,136	22,720	23,912
Cook Time (min)	7.33	7.13	7.59
Total Test Time (min)	45.65	45.36	47.57
Weight Loss (%)	36.1%	34.5%	34.2%
Initial Weight (lb)	6.067	6.052	5.964
Final Weight (lb)	3.875	3.963	3.925
Initial Fat Content (%)	19.8%	19.8%	19.8%
Initial Moisture Content (%)	60.2%	60.2%	60.2%
Final Moisture Content (%)	53.9%	52.7%	49.3%
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	166	162	161
Calculated Values			
Initial Weight of Water (lb)	3.655	3.645	3.593
Final Weight of Water (lb)	2.088	2.089	1.935
Weight of Fat (lb)	1.199	1.196	1.179
Weight of Solids (lb)	1.213	1.210	1.193
Sensible to Ice (Btu)	58	58	57
Sensible to Water (Btu)	489	472	462
Sensible to Fat (Btu)	79	77	76
Sensible to Solids (Btu)	40	39	38
Latent - Water Fusion (Btu)	526	525	517
Latent - Fat Fusion (Btu)	57	57	56
Latent - Water Vaporization (Btu)	1,520	1,510	1,608
Total Energy to Food (Btu)	2,770	2,739	2,816
Energy to Food (Btu/lb)	457	453	472
Total Energy to Griddle (Btu)	24,136	22,720	23,912
Energy Per Pound of Food Cooked (Btu/lb)	3,978	3,754	4,009
Cooking-Energy Efficiency (%)	11.5	12.1	11.8
Cooking Energy Rate (Btu/h)	31,723	30,053	30,160
Production Rate (lb/h)	8.0	8.0	7.5
Average Recovery Time (min)	< 0.5	< 0.5	< 0.5

Cooking-Energy Efficiency Data

Table D-4. Cooking-Energy Efficiency and Production Capacity Statistics

	Cooking-Energy Efficiency		Production Capacity
	Heavy-Load	Light-Load	
Replicate #1	31.8	11.5	43.9
Replicate #2	32.0	12.1	43.1
Replicate #3	31.4	11.8	42.5
Average	31.7	11.8	43.2
Standard Deviation	0.33	0.29	0.72
Absolute Uncertainty	0.8	0.7	1.8
Percent Uncertainty	2.6	6.1	4.1

E Energy Cost Model

Procedure for Calculating the Energy Consumption of a Griddle Based on Reported Test Results

Appliance test results are useful not only for benchmarking appliance performance, but also for estimating appliance energy consumption. The following procedure is a guideline for estimating griddle energy consumption based on data obtained from applying the appropriate test method.

The intent of this Appendix is to present a standard method for estimating griddle energy consumption based on ASTM performance test results. The examples contained herein are for information only and should not be considered an absolute. To obtain an accurate estimate of energy consumption for a particular operation, parameters specific to that operation should be used (e.g., operating time, and amount of food cooked under heavy- and light-loads).

The calculation will proceed as follows: First, determine the appliance operating time and total number of preheats. Then estimate the quantity of food cooked and establish the breakdown among heavy- (whole cooking surface loaded with product), medium- (half the cooking surface loaded with product), and light- (single-serving) loads. For example, a griddle operating for 12 hours a day with one preheat cooked 100 pounds of food: 70% of the food was cooked under heavy-load conditions and 30% was cooked under light-load conditions. Calculate the energy due to cooking at heavy- and light-load cooking rates, and then calculate the idle energy consumption. The total daily energy is the sum of these components plus the preheat energy. For simplicity, it is assumed that subsequent preheats require the same time and energy as the first preheat of the day.

The application of the test method to the Lang gas griddle yielded the following results:

Energy Cost Model

Table E-1: Gas Griddle Test Results.

Test	Result
Preheat Time	21.9 min
Preheat Energy	27,264 Btu
Idle Energy Rate	21,400 Btu/h
Heavy-Load Cooking Energy Rate	60,780 Btu/h
Light-Load Cooking Energy Rate	30,650 Btu/h
Production Capacity	43.2 lb/h
Light-Load Production Rate	7.8 lb/h

***Step 1*—The following appliance operation is assumed:**

Table E-2: Griddle Operation Assumptions.

Operating Time	12 h
Number of Preheats	1 preheat
Total Amount of Food Cooked	100 lb
Percentage of Food Cooked Under Heavy-Load Conditions	70% (× 100 lb = 70 lb)
Percentage of Food Cooked Under Light-Load Conditions	30% (× 100 lb = 30 lb)

***Step 2*—Calculate the total heavy-load energy.**

The total time cooking heavy-loads is as follows:

$$t_h = \frac{\%_h \times W}{PC},$$

$$t_h = \frac{70\% \times 100\ lb}{43.2\ lb/h},$$

$$t_h = 1.62\ h$$

The total heavy-load energy consumption is then calculated as follows:

$$E_{gas,h} = q_{gas,h} \times t_h$$

$$E_{gas,h} = 60{,}780\ Btu/h \times 1.62\ h$$

$$E_{gas,h} = 98{,}464\ Btu$$

***Step 3*—Calculate the total light-load energy.**

The total time cooking light-loads is as follows:

$$t_l = \frac{\%_l \times W}{PR_l},$$

$$t_l = \frac{30\% \times 100\ lb}{7.8\ lb/h},$$

$$t_l = 3.85\ h$$

The total light-load energy consumption is then calculated as follows:

$$E_{gas,l} = q_{gas,l} \times t_l$$

$$E_{gas,l} = 30{,}650\ Btu/h \times 3.85\ h$$

$$E_{gas,l} = 118{,}002\ Btu$$

***Step 4*—Calculate the total idle time and energy consumption.**

The total idle time is determined as follows:

$$t_i = t_{on} - t_h - t_m - t_l - \frac{n_p \times t_p}{60},$$

$$t_i = 12.0\ h - 1.62\ h - 3.85\ h - \frac{1\ preheat \times 21.9\ min}{60\ min/h}$$

$$t_i = 6.17\ h$$

The idle energy consumption is then calculated as follows:

$$E_{gas,i} = q_{gas,i} \times t_i$$

$$E_{gas,i} = 21{,}400\ Btu/h \times 6.17\ h$$

$$E_{gas,i} = 132{,}038\ Btu$$

***Step 5*—The total daily energy consumption is calculated as follows:**

$$E_{gas,daily} = E_{gas,h} + E_{gas,l} + E_{gas,i} + (n_p \times E_{gas,p},)$$

$$E_{gas,daily} = 98,464 \text{ Btu} + 118,002 \text{ Btu} + 132,038 \text{ Btu} + (1 \times 27,264 \text{ Btu})$$

$$E_{gas,daily} = 375,768 \text{ Btu/day} = 3.76 \text{ therms/day}$$

***Step 6*—The annual energy cost is calculated as follows:**

$$Cost_{annual} = E_{gas,daily} \times R_{gas} \times Days$$

$$Cost_{snnual} = 3.76 \text{ therms/day} \times 0.60 \text{ dollars/therm} \times 365 \text{ days/year}$$

$$Cost_{annual} = 823 \text{ dollars/year}$$