

Blodgett B36N-TTT Gas Griddle Performance Test

Application of ASTM Standard
Test Method F 1275-03

FSTC Report 5011.04.02

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Executive Summary



Figure ES-1.
Blodgett B36N-TTT gas
griddle.

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.

Blodgett's B36N-TTT griddle features stainless steel construction, snap-action thermostats, and a 1-inch thick brushed-steel cooking surface (see Figure ES-1). 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 three different loading scenarios (extra-heavy—30 hamburgers, heavy—24 hamburgers, and light—4 hamburgers). The cook time for the heavy-load cooking scenarios was 7.68 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:

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

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)	96,000
Measured Energy Input Rate (Btu/h)	96,829
Temperature Uniformity (°F) ^a	± 55.1
Useable cooking surface area (in ²) ^b	470
Preheat Time to 375°F (min)	15.7
Preheat Energy to 375°F (Btu)	21,449
Idle Energy Rate @ 375°F (Btu/h)	18,711
Extra-Heavy Load Cooking-Energy Efficiency (%)	40.1 ± 3.2
Heavy-Load Cooking-Energy Efficiency (%)	36.9 ± 1.1
Light-Load Cooking-Energy Efficiency (%)	12.5 ± 0.8
Production Capacity (lb/h) ^c	40.3 ± 1.1
Cooking Surface Recovery Time (min) ^c	1.37

^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 Blodgett B36N-TTT gas griddle incorporates a simple, solid and easy to clean design into a daily workhorse. Food service operators can expect a swift 15.7 minute preheat to 375°F from the Blodgett griddle and a competitive idle rate of 18,711 with a duty cycle of 19.3%. Temperature uniformity across the griddle-cooking surface was fair with a range of 110°F and a useable cooking surface area of 470 in².

The gas griddle demonstrated competitive cooking-energy efficiencies while being tested at the Food Service Technology Center with a heavy-load cooking-energy efficiency of 37% and a production capacity of 40.3 lb/h. An optional extra-heavy load scenario (30 hamburgers) was applied to the griddle, which resulted in improved cooking-energy efficiency (40%) and production capacity (48.6 lb/h). Most food service operations cook under less than full-load scenarios with light-loads being more representative of real world opera-

Executive Summary

tions. The Blodgett posted a respectable light-load cooking-energy efficiency of 13%.

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, using the ASTM test data. 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) ^a	21.0
Idle Energy (kBtu/day) ^a	94.7
Cooking Energy (kBtu/day) ^a	210.0
Annual Energy (kBtu/year) ^a	118,990
Annual Cost (\$/year) ^b	714

^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 work-horse 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.²⁻¹⁵

Introduction

The Blodgett B36N-TTT gas griddle features stainless steel construction, 110V snap-action thermostats, a 1-inch thick steel griddle-cooking surface, front mounted grease trough, and removable grease pan. The Blodgett 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 Blodgett gas griddle, model B36N-TTT, 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

Blodgett's B36N-TTT gas griddle features three U-shaped atmospheric burners – one for every twelve inches of griddle surface. One 110V snap-action thermostat controls each burner with a cooking temperature range between 100°F to 450°F (Figure 1-1). The cooking surface is 1-inch thick steel sur-

Introduction

rounded by stainless steel front sides and landing ledge, as well as 14 gauge side splashguards and back splash. The griddle sits on four adjustable legs.

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



*Figure 1-1.
Blodgett B36N-TTT gas
griddle.*

Table 1-1. Appliance Specifications.

Manufacturer	Blodgett
Model	B36N-TTT
Generic Appliance Type	Counter Top Thermostatically Controlled Griddle
Rated Input	96,000 Btu/h
Dimensions	36" x 35 3/4" x 17 1/4"
Construction	1-inch thick steel plate with stainless steel construction on the sides, landing ledge and front. The griddle features four adjustable legs and a built in grease trough with a large-capacity, removable grease container.
Controls	Individual 110V snap-action thermostats for each 1-foot cooking zone adjustable from 100 to 450°F.

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 (one at the center of each linear foot of griddle plate (Figure 2-2) were used for the remainder of the tests.

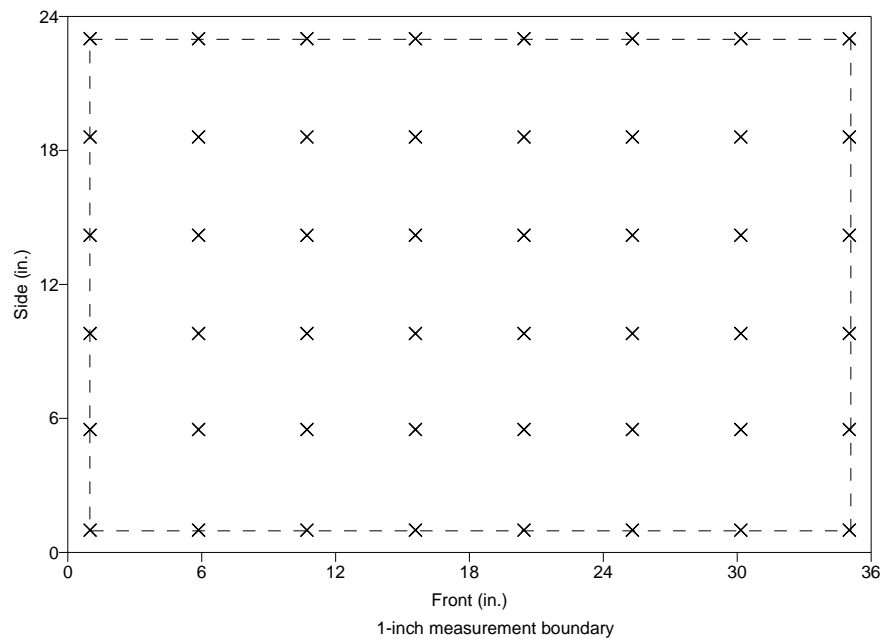


Figure 2-1.
Thermocouple grid for
temperature uniformity
test.

Methods

Natural gas consumption was measured using a positive displacement-type gas meter that generated a pulse every 0.1 ft³. 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 on full (such as pre-heat). 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 30 patty (extra-heavy) loads, 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

Methods

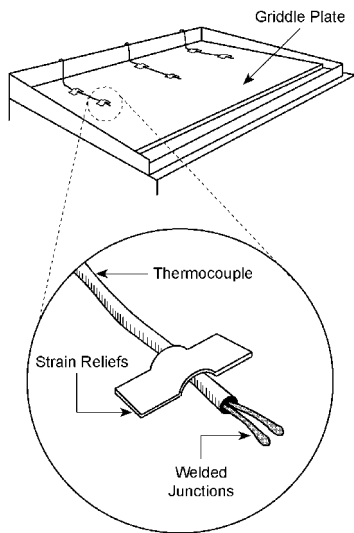


Figure 2-2.
Thermocouple place-
ment for testing.

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 (extra-heavy, 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 $\pm 10\%$. 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

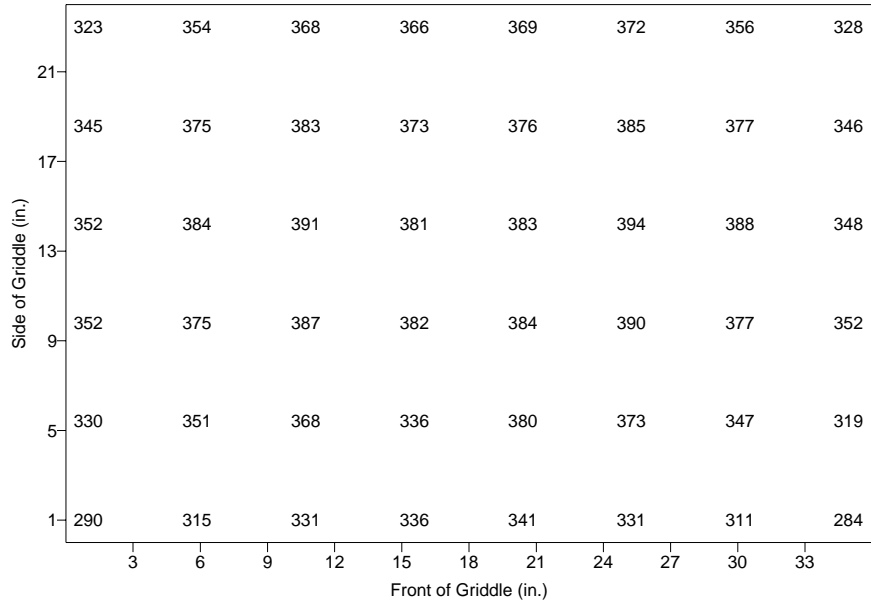
Prior to testing, the energy input rate was measured and compared with the manufacturer's nameplate value. This procedure ensured that the griddle was operating within its specified parameters. The measured energy input rate was 96,829 Btu/h (a difference of 0.86 % from the nameplate rating).

Temperature Uniformity

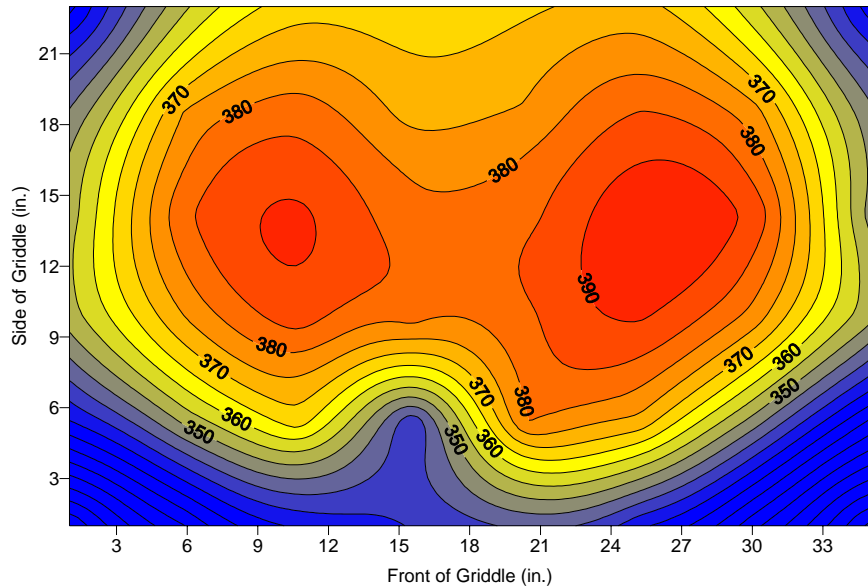
Thermocouples were welded to the cooking surface at the center of each linear foot to facilitate temperature calibration. The thermostat control was turned to a ~ 375°F setting. The thermocouples were then monitored after the griddle had stabilized at the set temperature for one hour. Researchers manually adjusted the control to maintain an average of $375 \pm 5^\circ\text{F}$ 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

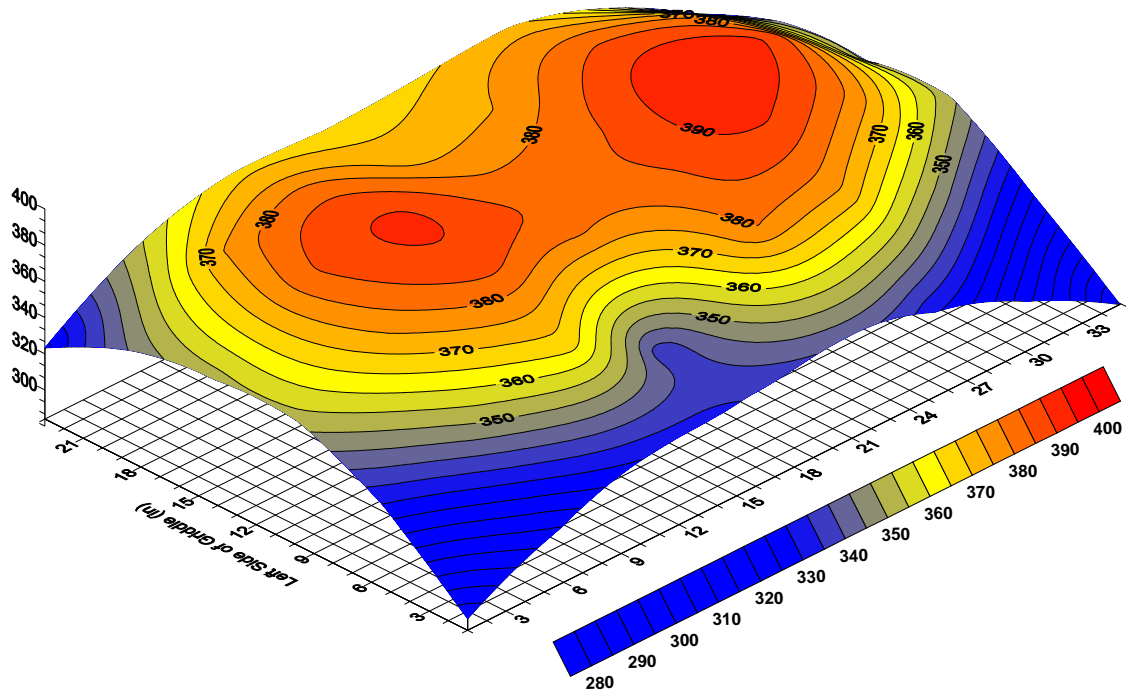


Table 3-1. Temperature Uniformity and Thermostat Accuracy ^a.

Thermostat Setting (°F)	375
Average Surface Temperature (°F)	358
Left Thermostat (°F)	377
Center Thermostat (°F)	375
Right Thermostat (°F)	380
Maximum Temperature Difference Across Plate (°F) ^b	110.3
Useable Cooking Surface (in ²) ^c	470
Standard Deviation of Surface Temperatures (°F)	14.1

^a Thermostat accuracy is the thermostat setting required to maintain $375 \pm 5^\circ\text{F}$ 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 .

Results

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 bring the griddle surface to a temperature of 375°F was 15.7 minutes, during which the griddle consumed 21,449 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 18,711 Btu/h.

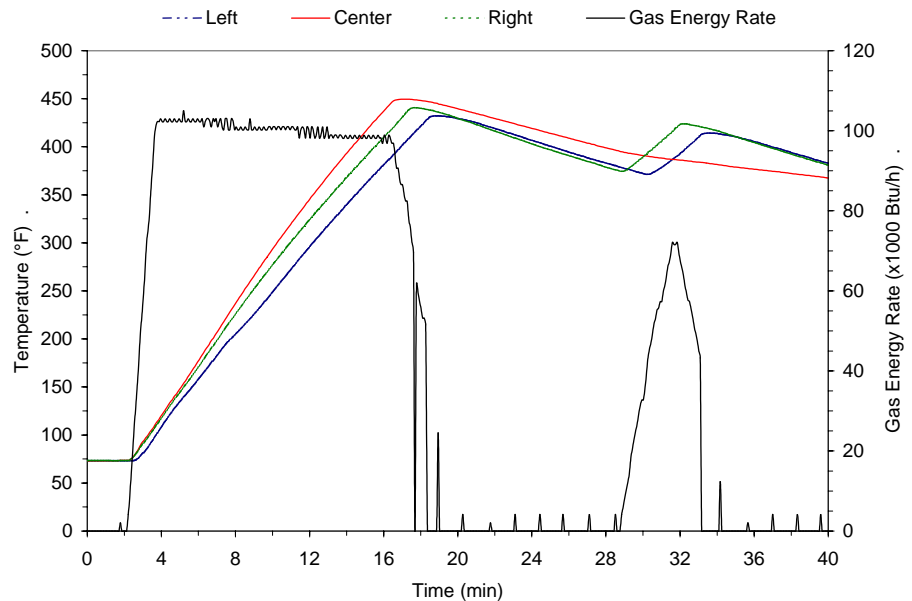


Figure 3-3.
Preheat characteristics.

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)	96,000
Measured Energy Input Rate (Btu/h)	96,829
Percentage Difference (%)	0.86
Preheat	
Time to 375°F (min)	15.7
Energy (Btu)	21,449
Rate to 375°F (°F/min)	19.2
Idle Energy Rate @ 375°F (Btu/h)	18,711

Cooking Tests

The griddle was tested under three loading scenarios: extra-heavy (30 hamburger patties), 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.

Results

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

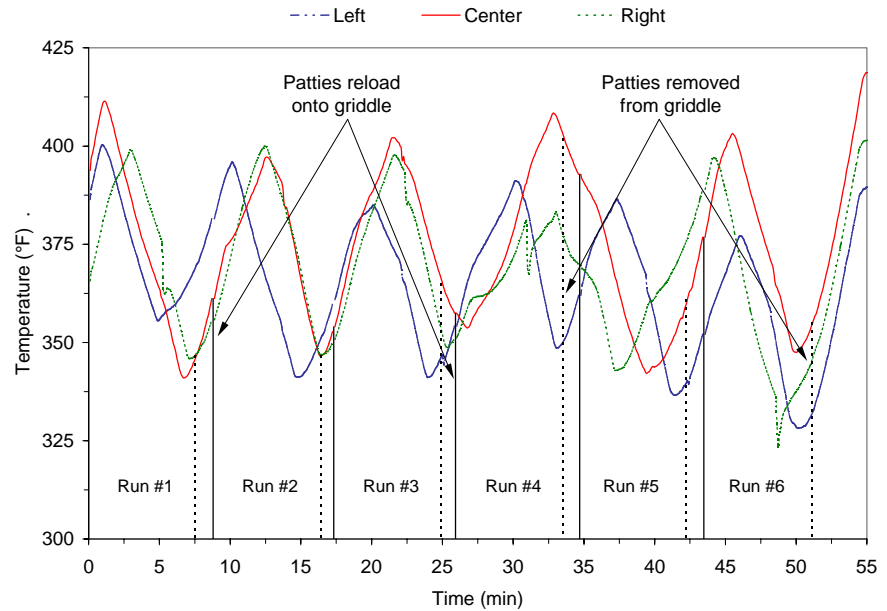


Figure 3-5 illustrates the griddle's temperature response while a heavy load of frozen hamburger patties was cooked. Production capacity includes the time required for the cooking surface to recover to 350°F (recovery time).

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, the light-load efficiency can be used to estimate griddle performance in an actual operation. Since the entire griddle was heated to 375°F, the energy consumed during the light-load test includes radiant heat losses from the unused portion of the griddle.

Results

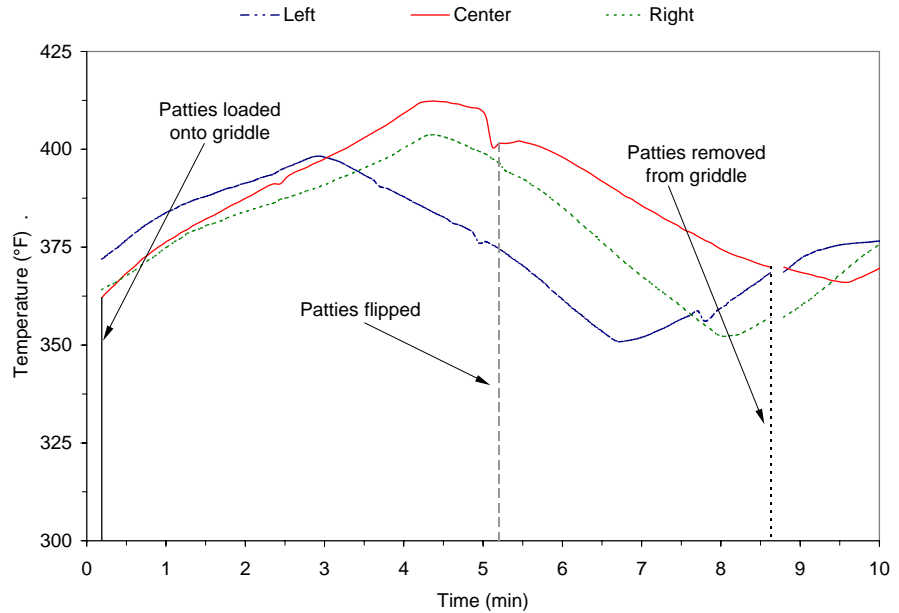


Figure 3-5.
Griddle temperature signature while cooking a heavy-load of hamburgers.

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.

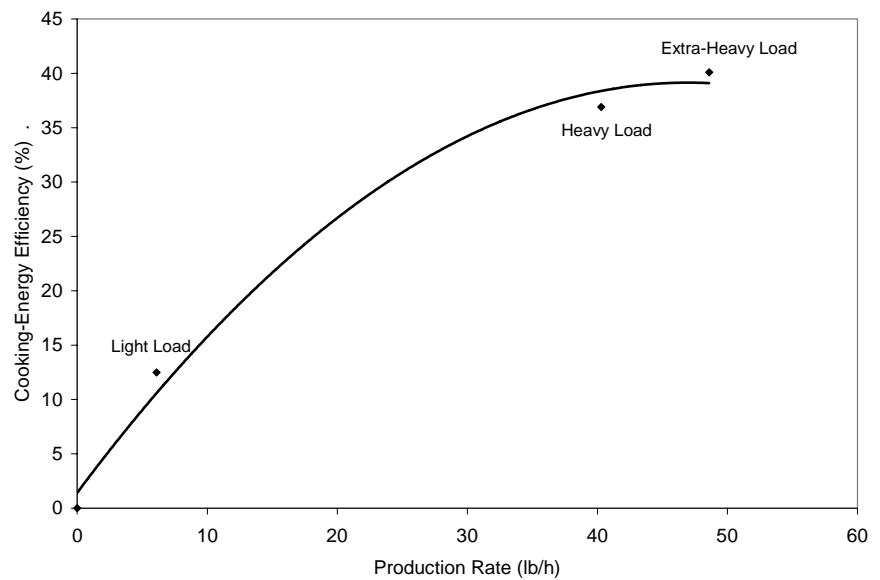
Cooking-energy efficiency results for the heavy-load tests were 36.3%, 37.5%, 37.3%, and 36.3 yielding a maximum uncertainty of 2.9% in the test results. Additional tests were run under an extra-heavy load condition. Researchers squeezed an extra row of hamburger patties onto the 24-inch deep cooking surface for a total extra-heavy load of 30 frozen hamburgers. Cooking-energy efficiency improved to 40.1%, and the production capacity increased to 48.6 lb/h. Table 3-3 summarizes the results of the ASTM cooking-energy efficiency and production capacity tests.

Results

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

	Extra-Heavy	Heavy-Load	Light-Load
Hamburger Cook Time (min)	7.75	7.68	9.38
Average Recovery Time (min)	1.37	1.14	< 1.0
Production Rate (lb/h)	48.6 ± 2.9	40.3 ± 1.1	6.1 ± 0.5
Energy per Pound of Food Cooked (Btu/lb)	1,232	1,326	3,906
Cooking Energy Rate (Btu/h)	59,827	53,442	24,792
Cooking-Energy Efficiency (%)	40.1 ± 3.2	36.0 ± 1.1	12.5 ± 0.8

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.

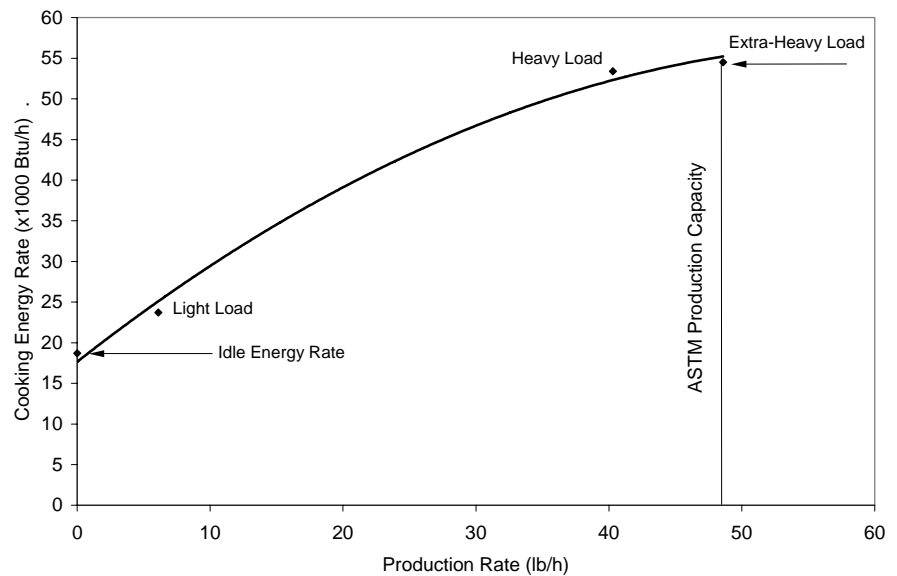


*Figure 3-6.
Griddle part-load cooking-energy efficiency.*

Note: Light-load = 4 hamburgers/load; heavy-load = 24 hamburgers/load; extra-heavy load = 30 hamburgers/load

Results

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 29,440 Btu/h, 39,120 Btu/h, and 46,690 Btu/h, respectively.



*Figure 3-7.
Griddle cooking energy
consumption profile.*

Note: Light-load = 4 hamburgers/load; heavy-load = 24 hamburgers/load; extra-heavy load = 30 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

Results

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) ^a	21.5
Idle Energy (kBtu/day) ^a	94.7
Cooking Energy (kBtu/day) ^a	210.0
Annual Energy (kBtu/year) ^a	118,990
Annual Cost (\$/year) ^b	714

^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 Blodgett B36N-TTT gas griddle was successfully tested in accordance with ASTM standard test method, exhibiting respectable performance when compared to other griddles in its class. During heavy-load cooking tests, the griddle demonstrated a 37% cooking-energy efficiency, while producing 40 lb/h of cooked hamburgers. The griddle's heavy-load cooking energy rate was 53,442 Btu/h (a duty cycle of 55%), suggesting that a greater amount of frozen hamburgers could be cooked. An optional extra-heavy load test (30 patties) was performed, which increased the cooking-energy efficiency to 40% and raised the production capacity to 48.6 lb/h. Light-load tests represent more of a real world application and the Blodgett B36N-TTT griddle demonstrated an economical part-load cooking-energy efficiency of 13%.

The Blodgett griddle surface was preheated in a very fast 15.7 minutes. The griddle exhibited a competitive idle energy rate of 18,711 Btu/h when compared to other griddles of the same class, despite a high input rate of 96,000 Btu/h. During temperature uniformity testing, the griddle produced a respectable 470 in² of useable cooking surface with a maximum temperature difference across the plate of $\pm 55^{\circ}\text{F}$.

The cost model estimates showed that the Blodgett griddle, when used to cook 100 pounds of hamburgers a day, 365 days a year, would consume 118,990 kBtu of energy. Assuming an energy cost of 60 cents per therm, 118,990 kBtu (1,189 therms) translates to an annual operating cost of 714 dollars.

5 References

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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 pre-heat.

Heating Value (Btu/ft³) 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 ($75 \pm 5^\circ\text{F}$) 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.

Useable Cooking Surface (in²)

The area of griddle surface with a temperature that falls between 360°F and 390°F .

B Appliance Specifications

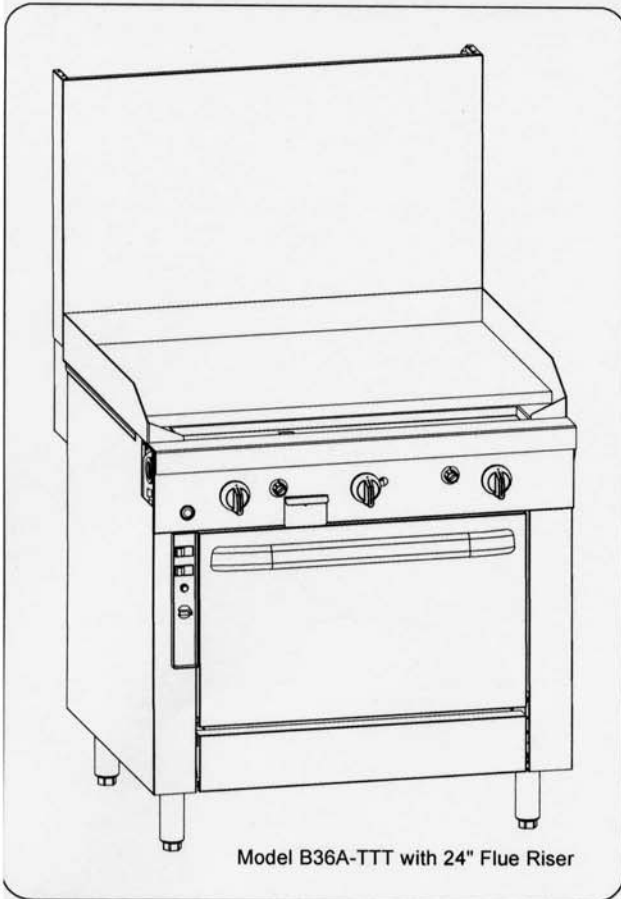
Appendix B includes the product literature for the Blodgett griddle.

Appliance Specifications

Manufacturer	Blodgett
Model	B36N-TTT
Generic Appliance Type	Counter Top Thermostatically Controlled Griddle
Rated Input	96,000 Btu/h
Dimensions	36" x 35 3/4" x 17 1/4"
Construction	1-inch thick steel plate with stainless steel construction on the sides, landing ledge and front. The griddle features four adjustable legs and a built in grease trough with a large-capacity, removable grease container.
Controls	Individual 110V snap-action thermostats for each 1-foot cooking zone adjustable from 100 to 450°F.

BLODGETT RANGE

36" SECTIONAL RANGE WITH FULL-WIDTH GRIDDLE



Model B36A-TTT with 24" Flue Riser

Standard Features (All Models)

- Three 32,000 BTU 12" sections with separate controls
- 1"-thick steel surface with side-splashes
- Grease drawer holds 3/4 gallon
- 7" stainless-steel front rail with "belly bar"
- Battery end-units have solid side (no manifold cover plate)
- Stainless-steel front and sides
- Fully insulated lining and burner boxes
- 6" adjustable legs (except on modular range-top model)
- 1-1/4" front-manifold (optional 1" rear gas connection)
- Warranty: one year parts and labor from date of purchase

Standard Features of Thermostatic Griddle Models

- Thermostatic temperature control of griddle surface

Standard Features of Oven Models

- 45,000 BTU oven with electronic pilot ignition
- Cool-to-the-touch oven handle

- Model B36A-GGG (Standard with Convection Oven)
- Model B36D-GGG (Standard with Standard Oven)
- Model B36C-GGG (Standard with Cabinet Base)
- Model B36N-GGG (Standard, Modular Range-Top)
- Model B36A-TTT (Thermostatic with Convection Oven)
- Model B36D-TTT (Thermostatic with Standard Oven)
- Model B36C-TTT (Thermostatic with Cabinet Base)
- Model B36N-TTT (Thermostatic, Modular Range-Top)

The Blodgett Range 36"-wide sectional-range with a full-width griddle is available with a choice of three types of base (a convection oven, a standard oven, or a storage cabinet) or with no base (for mounting as a modular range-top). Three flue-riser heights are available, and the flue riser can support up to 250 pounds (for an optional shelf, salamander-broiler, or cheese melter). An optional rearward-extending flue riser is available to increase the overall depth to match a deep battery. Free battery-design assistance is available!

Specify:

- Gas Type: natural gas propane
- Flue Riser Height: 5" 24" 36"
- Range Depth: standard deep
- Position in Battery: left end right end not at end
- Electric Power (oven models): 120V 208/240V

Options & Accessories

- Single-shelf (mounts on 24" flue riser; specify either solid or tubed shelf)
- Double-shelf (mounts on 36" flue riser; specify either solid or tubed shelves)
- Stainless-steel back
- Rear gas connection (1", external regulator required)
- If operating altitude will be above 2000 ft (700 meters), specify operating altitude:
- Additional oven racks:
- Casters (in lieu of legs, front two casters have locks)
- Cable restraint kit (to restrict movement when on casters)
- Open-frame base with casters

Blodgett Range can often accommodate special or custom requirements! Contact your Blodgett Range representative.

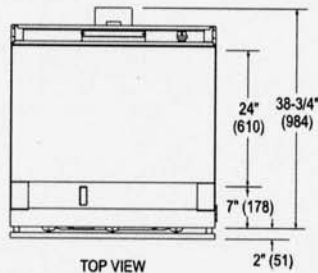
- Convection-oven models have 1/3 hp, two-speed blower

Standard Features of Cabinet-Base Model

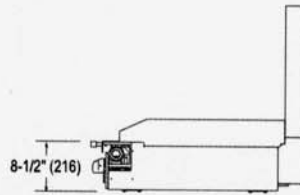
- Dual side-by-side stainless-steel doors

DIMENSIONS

BLODGETT RANGE 36" SECTIONAL RANGE WITH FULL-WIDTH GRIDDLE



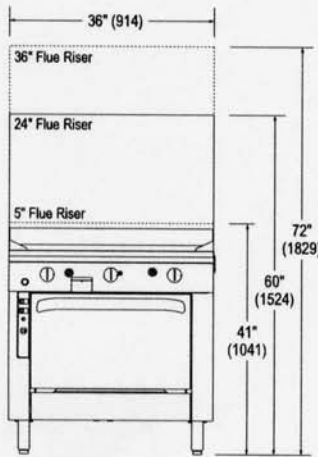
TOP VIEW



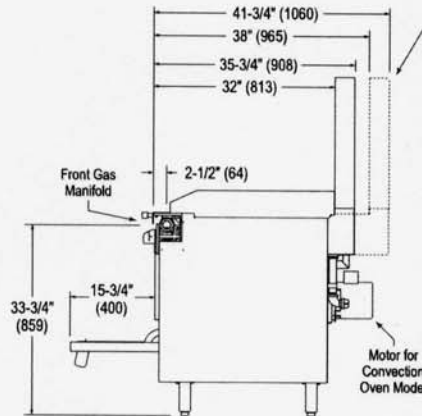
SIDE VIEW of MODULAR MODEL

SHIPPING CRATE DIMENSIONS & WEIGHT (Door-entry clearance when uncrated is 36.5")					
Model	Width	Height	Depth	Volume	Weight
B36A-GGG B36A-TTT	45.5 (1156)	45.0 (1143)	55.0 (1397)	65.2 cu ft (1.85 cu m)	840 lbs (381 kg)
B36D-GGG B36D-TTT	44.0 (1118)	43.0 (1092)	45.5 (1156)	49.8 cu ft (1.41 cu m)	790 lbs (358 kg)
B36C-GGG B36C-TTT	44.0 (1118)	43.0 (1092)	45.5 (1156)	49.8 cu ft (1.41 cu m)	590 lbs (268 kg)
B36N-GGG B36N-TTT	44.0 (1118)	22.0 (559)	45.5 (1156)	25.5 cu ft (0.72 cu m)	530 lbs (240 kg)

Dimensions are in inches and (millimeters)

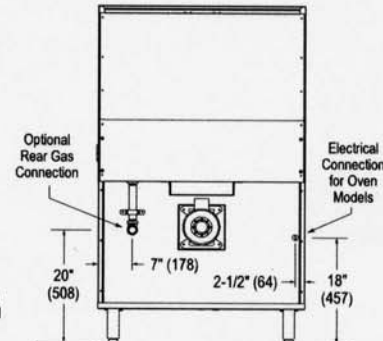


FRONT VIEW



SIDE VIEW

Flue riser for "deep" depth-option extends rearward 6" (cooking surface area is same as for "standard" depth).



REAR VIEW

Minimum clearance from noncombustible construction is zero, except the blower motor of a convection-oven model requires 2" rear clearance. Minimum clearance from combustible construction is 10" on sides and 12" on rear.

UTILITY INFORMATION

MODEL	GAS		ELECTRICITY		GAS: Each unit has a 1-1/4" front gas manifold that couples to the adjacent sectional unit(s), and can be ordered with an optional 1" rear gas connection with a male NPT connector. Minimum supply pressure is 7" W.C. for natural gas, 11" W.C. for propane. An external pressure regulator and shut off valve must be provided. If using a flexible-hose gas connection, the I.D. of the hose must not be smaller than the connector on the unit and must comply with ANSI Z21.69. Provide an adequate means of restraint to prevent undue strain on the gas connection. ELECTRICITY: Both standard-oven and convection-oven models require electric power (50Hz or 60Hz single-phase AC). 120V models have a 7-foot (2134 mm) power cord with a grounded plug. 208/240V models have a terminal block for connection to a single-phase 208/240V source. FLUE EXHAUST: Installation under a vented hood is recommended.
	Natural Gas BTU/hour	Propane BTU/hour	120V Amps	208/240V Amps	
B36A-GGG B36A-TTT	141,000	126,000	4.8	2.6	
B36D-GGG B36D-TTT	141,000	126,000	1.0	1.0	
B36C-GGG B36C-TTT	96,000	84,000	-	-	
B36N-GGG B36N-TTT	96,000	84,000	-	-	

OTHER TECHNICAL INFORMATION

Exterior surfaces are 430 stainless steel #3 polish, except the back is aluminized steel.

Each 12" section has a separate control knob located on the front panel. On oven models, a gas valve for the oven is located on the front panel above the oven. The oven control panel is located to the left of the oven door and includes an on-off switch, indicator light, thermostat knob, and (on convection ovens) a speed selector switch for the blower motor. The fan motor for convection ovens is 1/3 hp, 2-speed, 1725/1140 rpm, with overload protection.

Check local codes for fire and sanitary regulations. INTENDED FOR COMMERCIAL USE ONLY. NOT FOR HOUSEHOLD USE.

BIDDING SPECIFICATIONS

The item shall be a 36"-wide front-manifold sectional range with a full-width [thermostatic] griddle with three 32,000 BTU sections, a 1"-thick steel surface with side-splishers, and a grease drawer with a capacity of 3/4 gallon. The item shall have a 7" front rail and a belly bar. The item shall have 6" adjustable legs [casters]. The item shall have a [5" 24" 36"] flue riser able to support 250 pounds. The exterior (except for the back) shall be constructed of 430 stainless steel #3 polish. If the item is at the end of a battery, the end side shall be solid (rather than have a coverplate over the end of the front manifold).

C Results Reporting Sheets

Manufacturer: Blodgett Range
Model: B36N-TTT
Serial Number: 03F49385
Date: October 2003

Test Griddle.

Description of operational characteristics: 1-inch thick steel plate with stainless steel construction on the sides, landing ledge and front. Three 32,000 Btu/h steel burners are individually controlled by 110V snap-action thermostats 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: An optional extra-heavy load scenario (30 hamburgers) was applied to the griddle. Researchers squeezed an extra row of hamburger patties onto the 24-inch deep cooking surface for a total extra-heavy load of 30 frozen hamburgers.

Energy Input Rate.

Heating Value (Btu/scf)	1045
Rated (Btu/h)	96,000
Measured (Btu/h)	96,829
Percent Difference between Measured and Rated (%)	0.86

Results Reporting Sheets

Temperature Uniformity and Thermostat Accuracy^a

Left Thermostat (°F)	377
Center Thermostat (°F)	375
Right Thermostat (°F)	380
Maximum Temperature Difference Across Plate (°F) ^b	110.3
Useable Cooking Surface (in ²) ^c	470

^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.

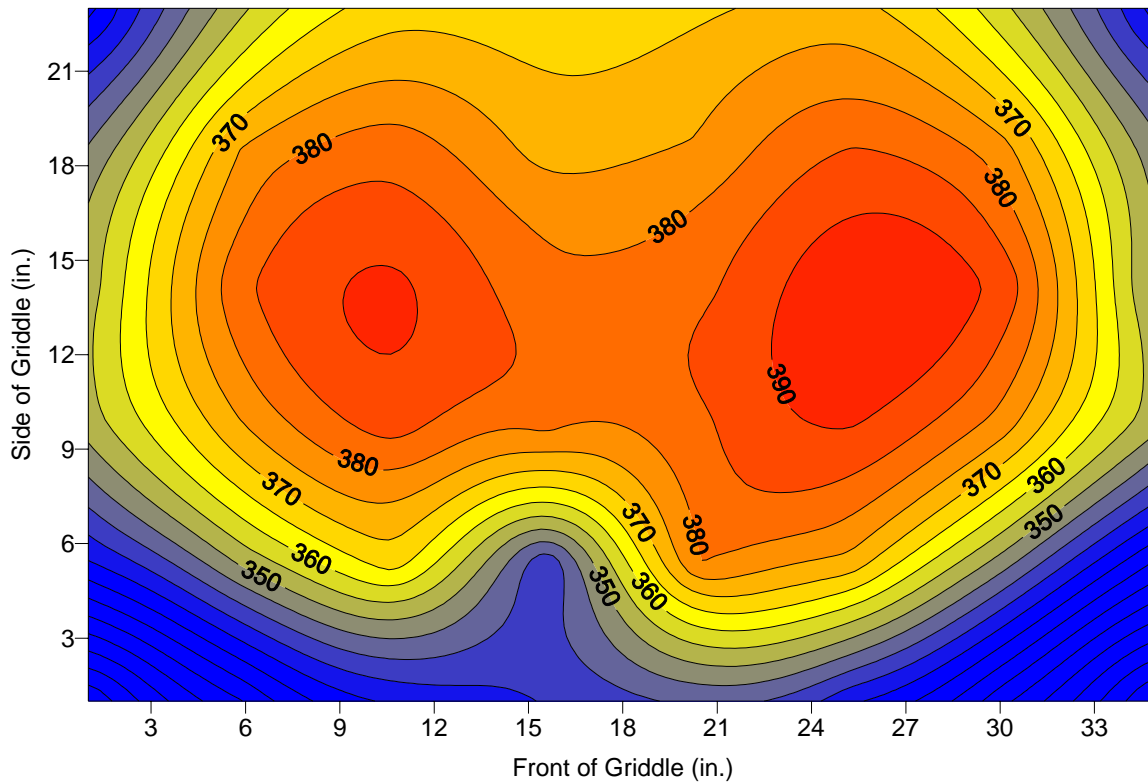


Figure C-1. Average cooking surface temperatures.

Results Reporting Sheets

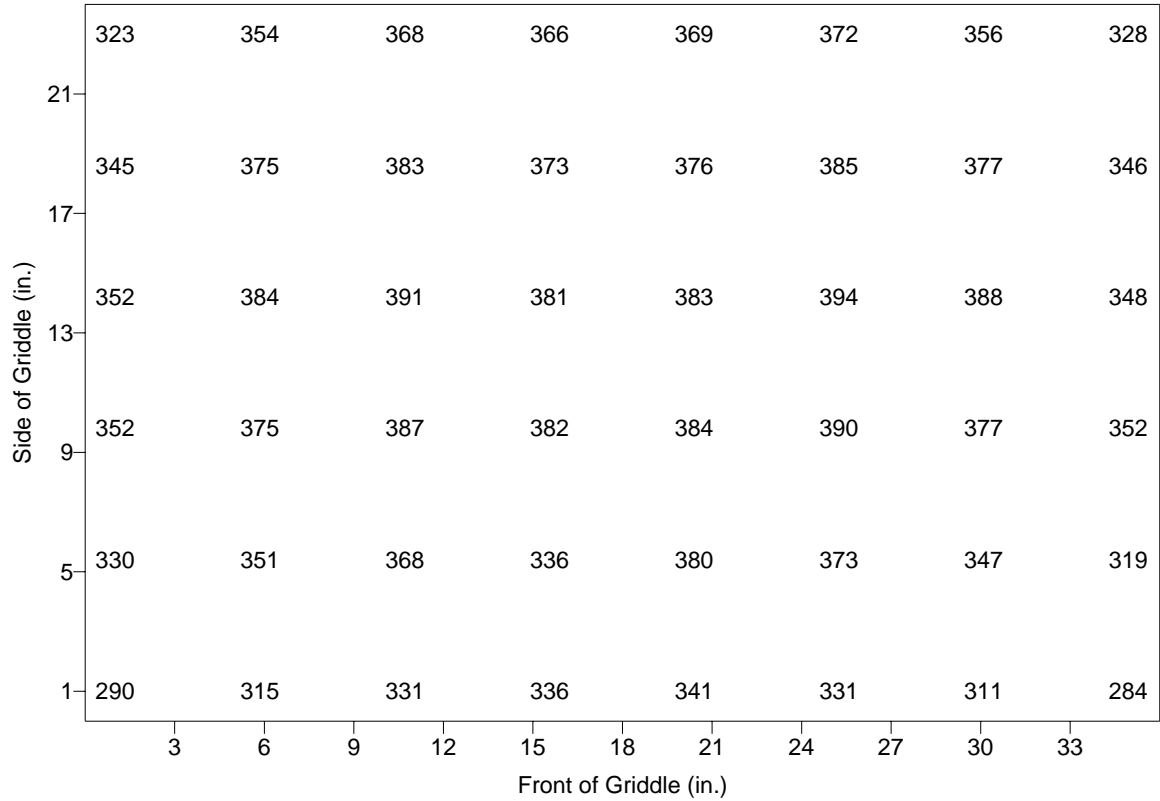


Figure C-2. Average cooking surface temperatures.

Preheat Energy and Time.

Heating Value (Btu/scf)	1022
Starting Temperature (°F)	73.1
Energy Consumption (Btu)	21,449
Duration (min)	15.7
Preheat Rate (°F/min)	19.2

Idle Energy Rate.

Heating Value (Btu/scf)	1022
Idle Energy Rate @ 375°F (Btu/h)	18,711

Results Reporting Sheets

Extra-Heavy Load Cooking-Energy Efficiency Test Results.

Heating Value (Btu/scf)	1025
Cooking Time (min)	7.75
Average Cooking Surface Recovery Time (min)	1.37
Production Capacity (lb/h)	48.6 ± 2.9
Energy to Food (Btu/lb)	493
Cooking Energy Rate (Btu/h)	59,827
Energy per Pound of Food Cooked (Btu/lb)	1,232
Cooking-Energy Efficiency (%)	40.1 ± 3.2

Heavy-Load Cooking-Energy Efficiency Test Results.

Heating Value (Btu/scf)	1028
Cooking Time (min)	7.68
Average Cooking Surface Recovery Time (min)	1.14
Production Capacity (lb/h)	40.3 ± 1.1
Energy to Food (Btu/lb)	489
Cooking Energy Rate (Btu/h)	53,442
Energy per Pound of Food Cooked (Btu/lb)	1,326
Cooking-Energy Efficiency (%)	36.9 ± 1.1

Light-Load Cooking-Energy Efficiency Test Results.

Heating Value (Btu/scf)	1022
Cooking Time (min)	9.38
Average Cooking Surface Recovery Time (min)	< 1.0
Production Capacity (lb/h)	6.1 ± 0.5
Energy to Food (Btu/lb)	489
Cooking Energy Rate (Btu/h)	23,651
Energy per Pound of Food Cooked (Btu/lb)	3,906
Cooking-Energy Efficiency (%)	12.5 ± 0.8

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. Extra-Heavy Load Test Data

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (Btu)	53,623	53,375	56,652
Cook Time (min)	7.83	7.67	7.74
Total Test Time (min)	53.7	54.4	56.0
Weight Loss (%)	36.3	33.7	33.7
Initial Weight (lb)	42.445	45.001	45.470
Final Weight (lb)	27.032	29.843	30.139
Initial Fat Content (%)	17.0	17.0	17.0
Initial Moisture Content (%)	63.0	63.0	63.0
Final Moisture Content (%)	51.8	50.3	51.4
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	166	159	159
Calculated Values			
Initial Weight of Water (lb)	26.740	28.351	28.646
Final Weight of Water (lb)	14.003	15.011	15.491
Weight of Fat (lb)	7.216	7.650	7.730
Weight of Solids (lb)	8.489	9.000	9.094
Sensible to Ice (Btu)	428	454	458
Sensible to Water (Btu)	3,583	3,601	3,638
Sensible to Fat (Btu)	479	487	492
Sensible to Solids (Btu)	282	286	289
Latent - Water Fusion (Btu)	3,851	4,083	4,125
Latent - Fat Fusion (Btu)	307	324	328
Latent - Water Vaporization (Btu)	12,355	12,940	12,760
Total Energy to Food (Btu)	21,285	22,175	22,090
Energy to Food (Btu/lb)	501	493	486
Total Energy to Griddle (Btu)	53,623	53,375	56,652
Energy Per Pound of Food Cooked (Btu/lb)	1,263	1,186	1,246
Cooking-Energy Efficiency (%)	39.7	41.5	39.0
Cooking Energy Rate (Btu/h)	59,903	58,902	60,677
Production Rate (lb/h)	47.4	49.7	48.7
Average Recovery Time (min)	1.12	1.39	1.60

Cooking-Energy Efficiency Data

Table D-3. Heavy-Load Test Data

	Repetition #1	Repetition #2	Repetition #3	Repetition #4
Measured Values				
Total Energy (Btu)	46,939	46,155	45,785	49,715
Cook Time (min)	7.50	7.62	7.80	7.82
Total Test Time (min)	51.6	52.7	52.6	54.8
Weight Loss (%)	34.6	33.8	34.4	34.8
Initial Weight (lb)	35.308	35.598	35.278	36.042
Final Weight (lb)	23.085	23.582	23.130	23.498
Initial Fat Content (%)	17.6	17.6	17.6	17.6
Initial Moisture Content (%)	62.4	62.4	62.4	62.4
Final Moisture Content (%)	51.8	50.3	51.4	49.3
Initial Temperature (°F)	0	0	0	0
Final Temperature (°F)	162	160	161	162
Calculated Values				
Initial Weight of Water (lb)	22.032	22.213	22.013	22.490
Final Weight of Water (lb)	11.958	11.862	11.889	11.584
Weight of Fat (lb)	6.214	6.265	6.209	6.343
Weight of Solids (lb)	7.062	7.120	7.056	7.208
Sensible to Ice (Btu)	353	355	352	360
Sensible to Water (Btu)	2,860	2,834	2,847	2,930
Sensible to Fat (Btu)	402	400	401	412
Sensible to Solids (Btu)	229	227	228	234
Latent - Water Fusion (Btu)	3,173	3,199	3,170	3,239
Latent - Fat Fusion (Btu)	270	274	270	276
Latent - Water Vaporization (Btu)	9,772	10,041	9,821	10,578
Total Energy to Food (Btu)	17,058	17,330	17,089	18,029
Energy to Food (Btu/lb)	483	487	484	500
Total Energy to Griddle (Btu)	46,939	46,155	45,785	49,715
Energy Per Pound of Food Cooked (Btu/lb)	1,329	1,297	1,298	1,379
Cooking-Energy Efficiency (%)	36.3	37.5	37.3	36.3
Cooking Energy Rate (Btu/h)	54,570	52,548	52,236	54,413
Production Rate (lb/h)	41.0	40.5	40.2	39.4
Average Recovery Time (min)	1.10	1.16	0.97	1.32

Cooking-Energy Efficiency Data

Table D-4. Light-Load Test Data

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (Btu)	23,274	24,048	22,900
Cook Time (min)	9.41	9.67	9.06
Total Test Time (min)	59.6	61.2	57.4
Weight Loss (%)	34.2	34.7	33.4
Initial Weight (lb)	5.985	6.013	5.978
Final Weight (lb)	3.936	3.928	3.983
Initial Fat Content (%)	17.6	17.6	17.6
Initial Moisture Content (%)	62.4	62.4	62.4
Final Moisture Content (%)	50.3	51.4	49.3
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	161	162	159
Calculated Values			
Initial Weight of Water (lb)	3.735	3.752	3.730
Final Weight of Water (lb)	1.980	2.019	1.963
Weight of Fat (lb)	1.053	1.058	1.052
Weight of Solids (lb)	1.197	1.203	1.196
Sensible to Ice (Btu)	60	60	60
Sensible to Water (Btu)	481	488	472
Sensible to Fat (Btu)	68	69	67
Sensible to Solids (Btu)	38	39	38
Latent - Water Fusion (Btu)	538	540	537
Latent - Fat Fusion (Btu)	46	46	46
Latent - Water Vaporization (Btu)	1,702	1,681	1,714
Total Energy to Food (Btu)	2,933	2,923	2,934
Energy to Food (Btu/lb)	490	486	491
Total Energy to Griddle (Btu)	23,274	24,048	22,900
Energy Per Pound of Food Cooked (Btu/lb)	3,889	3,999	3,831
Cooking-Energy Efficiency (%)	12.6	12.2	12.8
Cooking Energy Rate (Btu/h)	23,434	23,564	23,954
Production Rate (lb/h)	6.0	5.9	6.3
Average Recovery Time (min)	< 1.0	< 1.0	< 1.0

Cooking-Energy Efficiency Data

Table D-6. Cooking-Energy Efficiency and Production Capacity Statistics

	Cooking-Energy Efficiency			Production Capacity
	Extra-Heavy Load	Heavy-Load	Light-Load	
Replicate #1	39.7	36.3	12.6	41.0
Replicate #2	41.5	37.5	12.2	40.5
Replicate #3	39.0	37.3	12.8	40.2
Replicate #4	--	36.3	--	39.4
Average	40.1	36.9	12.5	40.3
Standard Deviation	1.29	0.66	0.34	0.33
Absolute Uncertainty	3.20	1.05	0.84	0.82
Percent Uncertainty	7.98	2.85	6.72	2.57

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) 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 a gas griddle yielded the following results:

Energy Cost Model

Table E-1: Gas Griddle Test Results.

Test	Result
Preheat Time	15.7 min
Preheat Energy	21,449 Btu
Idle Energy Rate	18,711 Btu/h
Heavy-Load Cooking Energy Rate	53,442 Btu/h
Light-Load Cooking Energy Rate	23,651 Btu/h
Production Capacity	40.3 lb/h
Light-Load Production Rate	6.06 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:

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

$$t_h = \frac{70\% \times 100 \text{ lb}}{40.3 \text{ lb/h}},$$

$$t_h = 1.74 \text{ h}$$

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

$$\begin{aligned}E_{gas,h} &= q_{gas,h} \times t_h \\E_{gas,h} &= 53,442 \text{ Btu/h} \times 1.74 \text{ h} \\E_{gas,h} &= 92,989 \text{ Btu}\end{aligned}$$

Step 3—Calculate the total light-load energy.

The total time cooking light-loads is as follows:

$$\begin{aligned}t_l &= \frac{\%l \times W}{PRl}, \\t_l &= \frac{30\% \times 100 \text{ lb}}{6.06 \text{ lb/h}}, \\t_l &= 4.95 \text{ h}\end{aligned}$$

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

$$\begin{aligned}E_{gas,l} &= q_{gas,l} \times t_l \\E_{gas,l} &= 23,651 \text{ Btu/h} \times 4.95 \text{ h} \\E_{gas,l} &= 117,073 \text{ Btu}\end{aligned}$$

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

The total idle time is determined as follows:

$$\begin{aligned}t_i &= t_{on} - t_h - t_m - t_l - \frac{n_p \times t_p}{60}, \\t_i &= 12.0 \text{ h} - 1.73 \text{ h} - 4.95 \text{ h} - \frac{1 \text{ preheat} \times 15.7 \text{ min}}{60 \text{ min/h}} \\t_i &= 5.06 \text{ h}\end{aligned}$$

The idle energy consumption is then calculated as follows:

$$\begin{aligned}E_{gas,i} &= q_{gas,i} \times t_i \\E_{gas,i} &= 18,711 \text{ Btu/h} \times 5.06 \text{ h} \\E_{gas,i} &= 94,678 \text{ Btu}\end{aligned}$$

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

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

$$E_{gas,daily} = 92,989 \text{ Btu} + 117,073 \text{ Btu} + 94,678 \text{ Btu} + (1 \times 21,449 \text{ Btu})$$

$$E_{gas,daily} = 326,098 \text{ Btu/day} = 3.26 \text{ therms/day}$$

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

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

$$Cost_{annual} = 3.26 \text{ therms/day} \times 0.60 \text{ dollars/therm} \times 365 \text{ days/year}$$

$$Cost_{annual} = 714 \text{ dollars/year}$$