

**AccuTemp Accu-Steam EG2083A36
Electric Griddle Performance Test**

Application of ASTM Standard
Test Method F 1275-03

FSTC Report 5011.05.18

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Specific appreciation is extended to AccuTemp for supplying the FSTC with a 3-foot electric griddle, Accu-Steam for controlled testing in the appliance laboratory.

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Executive Summary



*Figure ES-1.
AccuTemp Accu-Steam
electric 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.

AccuTemp's Accu-Steam griddle features a hermetically-sealed chamber that produces high temperature steam for heating the griddle 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 two different loading scenarios (heavy—30 hamburgers and light—4 hamburgers). The cook time for the heavy-load cooking scenarios was 7.20 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 (kW)	14.25
Measured Energy Input Rate (kW)	14.91
Temperature Uniformity (°F) ^a	± 3.6
Useable cooking surface area (in ²) ^b	1,008
Preheat Time to 375°F (min)	19.2
Preheat Energy to 375°F (kWh)	4.76
Idle Energy Rate @ 375°F (kW)	2.44
Heavy-Load Cooking-Energy Efficiency (%)	72.7 ± 3.3
Light-Load Cooking-Energy Efficiency (%)	28.2 ± 0.9
Production Capacity (lb/h) ^c	57.3 ± 2.2
Cooking Surface Reload Time (min) ^c	< 1.0

^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 Due to the logistics of loading the griddle cooking surface, reload time includes 30 seconds to remove the cooked patties and 30 seconds to scrap the griddle surface before reloading the next heavy-load test.

The Accu-Steam electric griddle incorporates a unique design to heat the griddle surface. High temperature steam condenses on the upper surface of a hermetically-sealed chamber, which is located underneath the griddle cooking surface. The design provides a very responsive and flexible cooking platform. Food service operators can expect a 19.2 minute preheat to 375°F and a competitive idle energy rate of 2.44 kW with a duty cycle of 16.4%. Temperature uniformity across the griddle-cooking surface was incomparable, with a maximum range of 7.2°F and a useable cooking surface area of 1,008 in².

The electric griddle demonstrated competitive cooking-energy efficiencies while being tested at the Food Service Technology Center with a heavy-load cooking-energy efficiency of 72.7% and a production capacity of 57.3 lb/h. Most food service operations cook under less than full-load scenarios with

Executive Summary

light-loads being more representative of real world operations. The Accu-steam posted a respectable light-load cooking-energy efficiency of 28.3%.

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 (kWh/day)	4.76
Idle Energy (kWh/day)	16.7
Cooking Energy (kWh/day)	28.4
Annual Energy (kWh/year)	18,210
Annual Cost (\$/year)^a	1,821

^a Griddle energy costs are based on \$0.10/kWh for electric appliances.

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. ²⁻¹⁷

Introduction

The Accu-Steam griddle heats the cooking surface with high temperature steam, which condenses on the upper surface of a hermetically-sealed chamber, which is located underneath the cooking surface. The AccuTemp electric 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 Accu-Steam electric 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 thermostat set at a calibrated 375°F.
5. Document the cooking energy consumption and efficiency under two hamburger loading scenarios: heavy (30 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

AccuTemp's Accu-Steam electric griddle features a hermetically sealed chamber that produces high temperature steam located directly beneath the cooking surface. The heating elements, located within the chamber, heat the water inside the chamber into high temperature steam. The steam condenses on the

Introduction

underside of the griddle plate, quickly transferring heat to the cooking surface. One solid-state thermostat with a temperature range between 200°F to 400°F controls the griddle while operating (Figure 1-1).



*Figure 1-1.
AccuTemp Accu-Steam
electric griddle.*

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

Introduction

Table 1-1. Appliance Specifications.

Manufacturer	AccuTemp Products, Inc.
Model	Accu-Steam EG2083A36
Generic Appliance Type	Thermostatically Controlled Electric Griddle
Rated Input	14.25 kW
Dimensions	36 3/8" x 33 3/8" x 12 3/4"
Construction	The stainless steel griddle features a hermetically-sealed chamber that produces high temperature steam for heating the cooking surface.
Control	Solid-State thermostat with a temperature range of 200°F to 400°F.

2 Methods

Setup and Instrumentation

FSTC researchers installed the griddle 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 24-gauge Type K thermocouples to measure cooking surface temperatures. For the temperature uniformity test, 56 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.

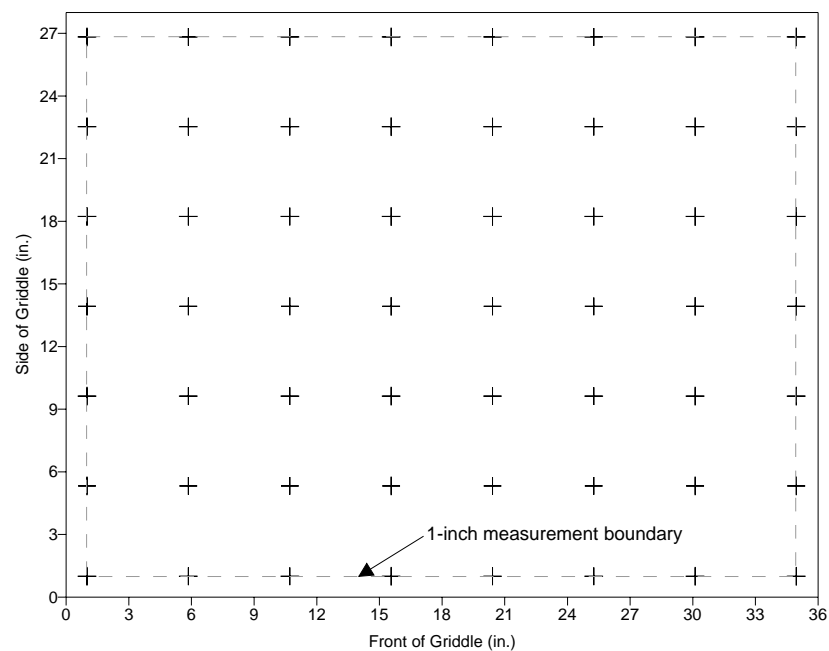


Figure 2-1.
Thermocouple grid for
temperature uniformity
test.

Methods

Power and energy were measured with a watt/watt-hour transducer that generated an analog signal for instantaneous power and a pulse for every 10 Wh. A voltage regulator, connected to the griddle, maintained a constant voltage for all tests. Control energy was monitored with a watt-hour transducer that generated a pulse for every 0.00001 watt-hours. The energy meters and thermocouples were connected to a data logger which recorded data every five seconds.

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 elements are fully energized (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 (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 to allow for scraping (cleaning) of the griddle-cooking surface. 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

Methods

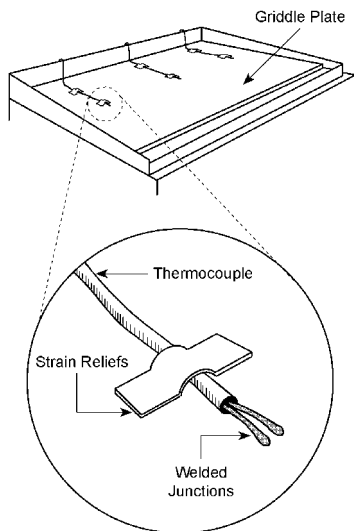


Figure 2-2.
Thermocouple placement for testing.

does not significantly lower the average cooking surface temperature over the cooking cycle, nor does it extend the cook time. The griddle was reloaded 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 $\pm 10\%$. 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

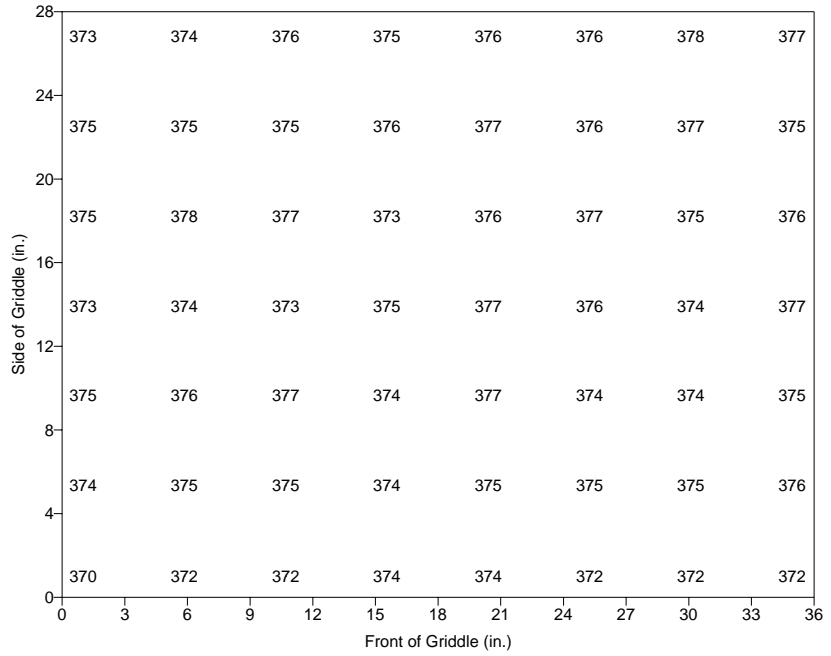
Energy Input Rate

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 14.91 kW (a difference of 4.6 % from the nameplate rating).

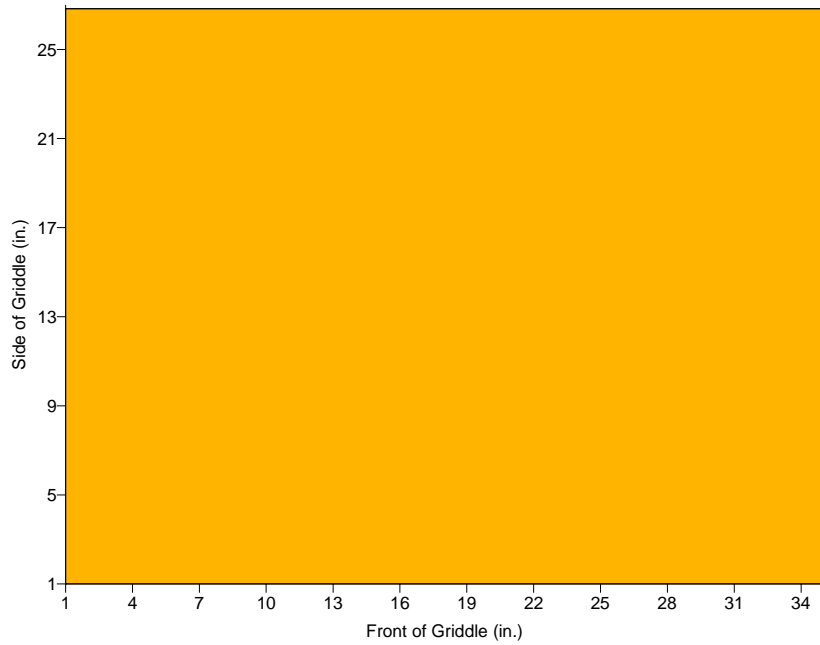
Temperature Uniformity

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 56-point grid with no more than 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)	375
Maximum Temperature Difference Across Plate (°F) ^b	7.2
Useable Cooking Surface (in ²) ^c	1,008
Standard Deviation of Surface Temperatures (°F)	1.63

^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 .

Preheat and Idle Tests

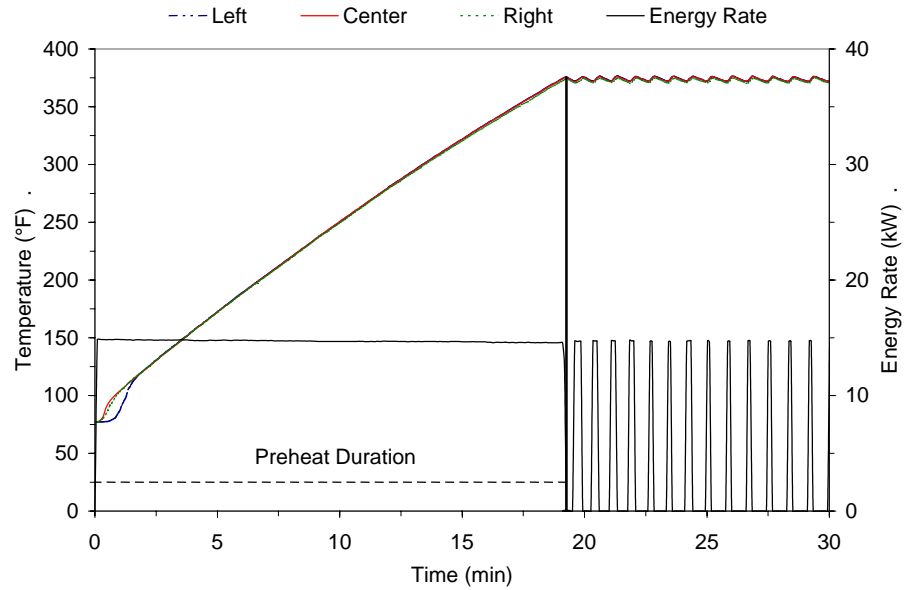
Preheat Energy and Time

Researchers removed the additional thermocouples, leaving only the points at the center of each linear foot. The cooking surface temperature was an average of 77°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 19.2 minutes, during which the griddle consumed 4.76 kWh. 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 2.44 kW.

Results



*Figure 3-3.
Preheat characteristics.*

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 (kW)	14.25
Measured Energy Input Rate (kW)	14.91
Percentage Difference (%)	4.60
Preheat	
Time to 375°F (min)	19.2
Energy (kWh)	4.76
Rate to 375°F (°F/min)	15.6
Idle Energy Rate @ 375°F (kW)	2.44

Results

Cooking Tests

The griddle was tested under two loading scenarios: heavy- (30 hamburger patties) and light- (4 hamburger patties) loads. 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 30 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.

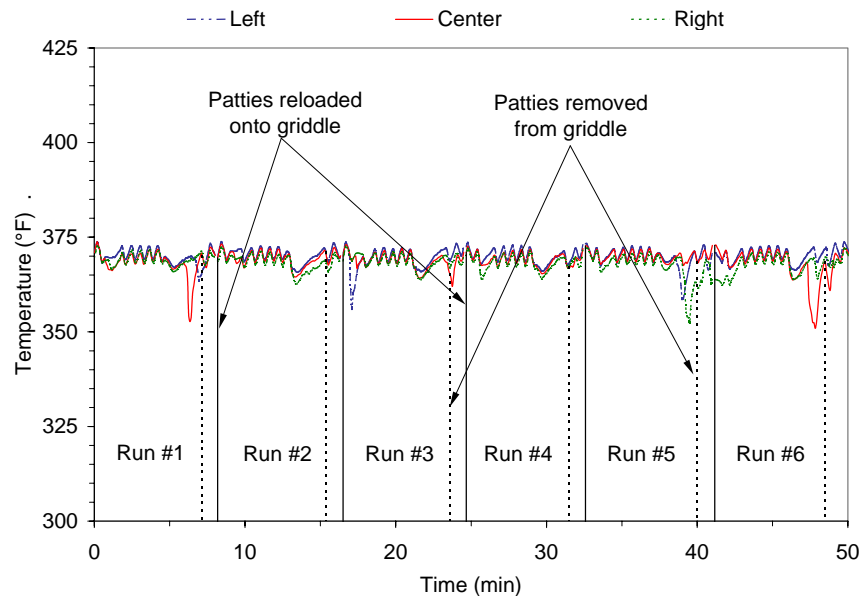


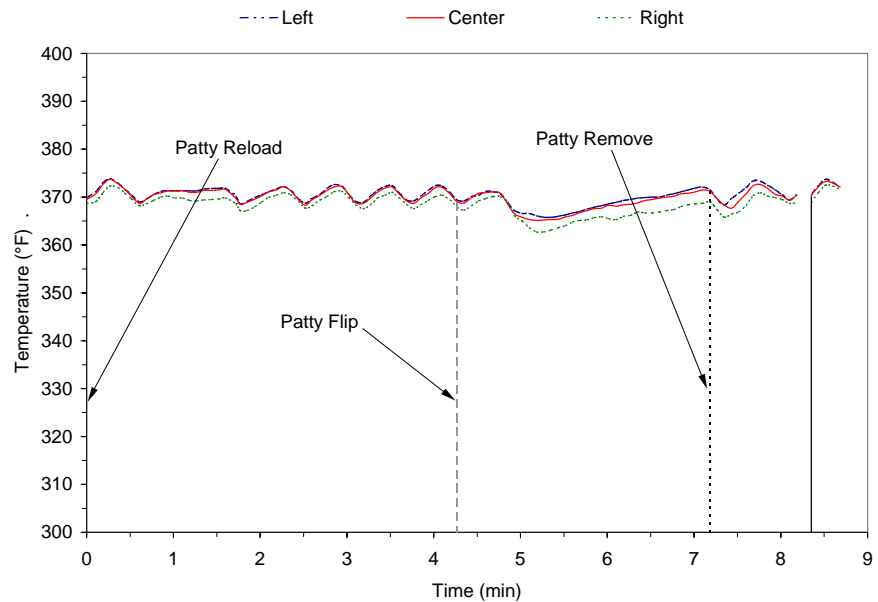
Figure 3-4.
Average heavy-load cooking surface temperatures.

Results

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 to remove the cooked hamburgers and scrape the cooking surface (reload time) or 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.



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

Results

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 71.2%, 73.1%, and 73.8% yielding a maximum uncertainty of 3.3% in the test results. A single heavy-load test required 7.20 minutes to cook 30 frozen hamburger patties. Since the cooking surface temperature did not drop below 350°F at any point during the cooking tests, the effective recovery time was zero. 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.

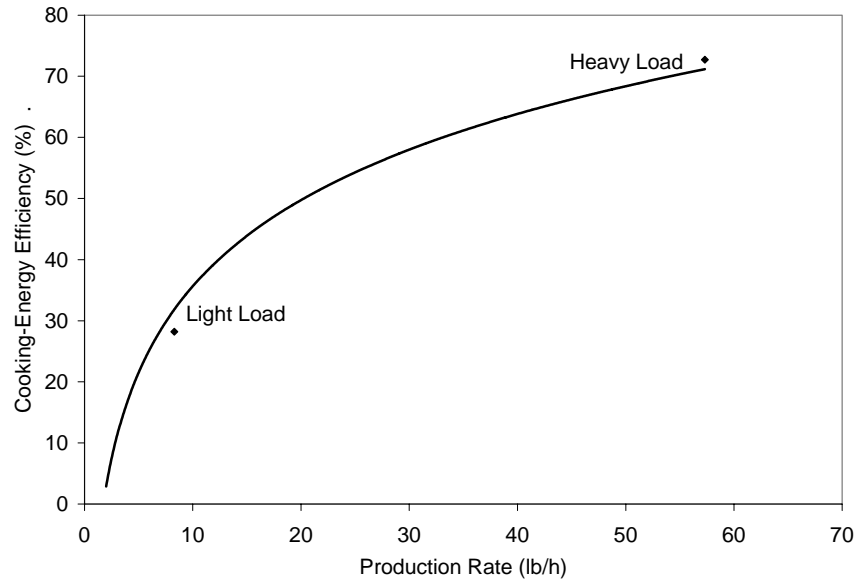
	Heavy-Load	Light-Load
Hamburger Cook Time (min)	7.20	7.17
Average Reload Time (min) ^a	< 1.0	< 0.33
Production Rate (lb/h)	57.3 ± 2.2	8.3 ± 0.1
Energy per Pound of Food Cooked (Btu/lb)	658	1,694
Electric Energy Rate (kW)	11.1	4.12
Cooking-Energy Efficiency (%)	72.7 ± 3.3	28.2 ± 0.9

^a Due to the logistics of loading the griddle cooking surface, reload time includes 30 seconds to remove the cooked patties and 30 seconds to scrap the griddle surface before reloading the next heavy-load test.

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.

Results

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



Note: Light-load = 4 hamburgers/load; heavy-load = 30 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 daily energy consumption and probable demand for the griddle in a real-world operation. End-use monitoring studies have shown that an electric appliance's probable contribution to the building's peak demand is equal to the appliance's average energy consumption rate during a typical day.³ Average energy consumption rates at 10, 20, and 30 pounds per hour are 4.10 kW, 5.59 kW, and 7.08 kW, respectively.

Results

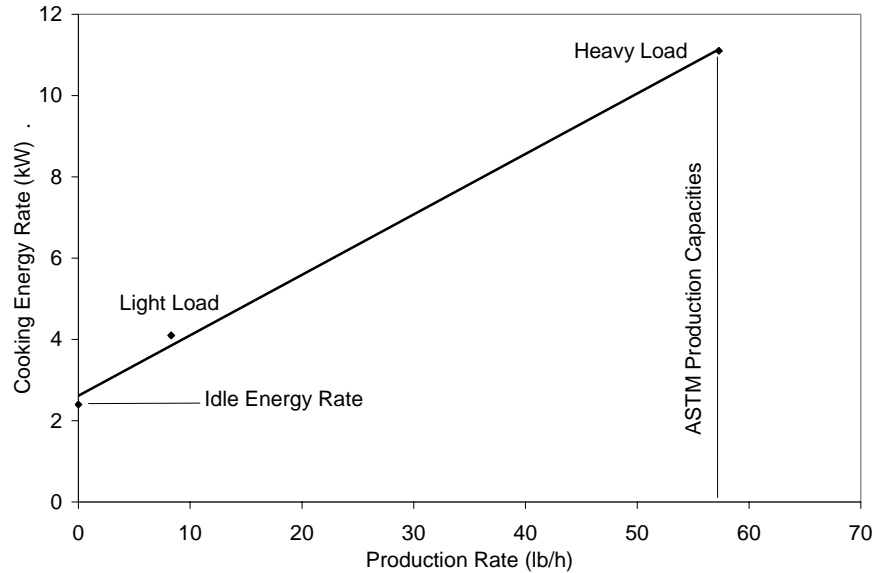


Figure 3-7.
Griddle cooking energy consumption profile.

Note: Light-load = 4 hamburgers/load; 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 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.

Results

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

Preheat Energy (kWh/day)	4.76
Idle Energy (kWh/day)	16.7
Cooking Energy (kWh/day)	28.4
Annual Energy (kWh/year)	18,210
Annual Cost (\$/year)^a	1,821

^a Griddle energy costs are based on \$0.10/kWh for electric appliances.

4 Conclusions

AccuTemp's Accu-Steam electric griddle was successfully tested in accordance with ASTM standard test method, exhibiting impressive cooking performance during heavy-load testing and its unique edge-to-edge temperature uniformity.

During heavy-load testing the griddle required 7.20 minutes to cook 30 frozen hamburgers and was ready to cook another load of burgers immediately following the removal of the previous load. The minimum amount of time to remove the cooked patties and scrape the griddle surface clean is one minute. With the griddle surface never dropping below 350°F the recovery time was effectively zero, but due to the logistics of removing and scraping there is a one-minute period between cooking cycles during heavy-load tests. The griddle exhibited an impressive cooking-energy efficiency of 72.1% and an equally impressive production capacity of 57.3 lb/h. Light load tests represent more of a real world application and the AccuTemp Accu-Steam griddle demonstrated an economical part-load cooking-energy efficiency of 28.2%.

The AccuTemp griddle surface was preheated in 19.2 minutes, while exhibiting a competitive idle energy rate of 2.44 kW. During temperature uniformity testing, the griddle demonstrated its edge-to-edge temperature uniformity with 1,008 in² of useable cooking surface with a maximum temperature difference across the plate of 7.2°F. While idling in a ready-to-cook state the griddle surface was within 3.6°F of thermostat set point.

The cost model estimates showed that the AccuTemp griddle, when used to cook 100 pounds of hamburgers a day, 365 days a year, would consume 18,210 kWh of energy. Assuming an energy cost of \$.10 cents per kWh, 18,210 kWh translates to an annual operating cost of \$1,821 dollars. The Accu-Steam griddle couples excellent cooking efficiencies with remarkable

Conclusions

cooking surface temperature uniformity into a powerful and flexible combination for an end-user.

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 AccuTemp griddle.

Appliance Specifications

Manufacturer	AccuTemp Products, Inc.
Model	Accu-Steam EG2083A36
Generic Appliance Type	Thermostatically Controlled Electric Griddle
Rated Input	14.25 kW
Dimensions	36 3/8" x 33 3/8" x 12 3/4"
Construction	The stainless steel griddle features a hermetically-sealed chamber that produces high temperature steam for heating the cooking surface.
Control	Solid-State thermostat with a temperature range of 200°F to 400°F.



ACCU-STEAM™ GRIDDLE EG SERIES

Electric/Steam-Heated, Stand-Mounted Griddle

Cooking Surface: 24" 36" 48" Wide; 29" 24" Deep

Short Specification

Griddle shall be an AccuTemp Model EG

Specify:

Volt	20" D* 24" W	20" D* 36" W	20" D* 48" W	24" D* 24" W	24" D* 36" W	24" D* 48" W
208	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
240	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
480	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*specify "A" for 29", and "B" for 24" depth.

electric-heated unit, with a hermetically-sealed vacuum chamber that produces steam and heats the 8-gauge stainless steel griddle plate. Efficient steam heat transfer provides 200–400°F (93–204°C) operating temperature range and uniform griddle surface temperatures of ±2°F (±1°C). Griddle fabricated from cold-rolled stainless steel with 4.5" high back splash, sides that taper from 4.5" to 1.7", a 4" wide by 1" deep full front grease trough and 1½–2 gallon grease drawer. Unit to be NSF and U.L. listed and manufactured in the U.S.A.

Construction Features

- Cold-rolled and annealed stainless steel griddle plate with polished stainless steel body and stand
- 8 gauge griddle plate with 4.5" high rear splash and 4.5 to 1.7" tapered side walls
- 4" wide by 1" deep full front grease trough
- 2' x 4" drop chute to 1½–2 gallon capacity grease drawer inside enclosed compartment
- Heavy tubular open leg stainless steel stand with bottom shelf (optional)
- 5" heavy-duty casters standard, front are locking type (optional)

Performance Features

- Hermetically-sealed vacuum chamber mounted to and below griddle plate
- 9.6-kW [24"] or 14.25-kW total power, long-life low watt density heating elements mounted inside vacuum chamber and immersed in chemically pure water (Water never needs replacement)

- Steam transfers heat evenly to entire pan surface with only ±2°F (±1°C) in temperature variation
- Rapid surface temperature recovery [10 seconds or less] allows turning product to same spot
- Smooth cold-rolled stainless steel griddle surface speeds and simplifies cleaning

Standard Control Features

- Power-On switch & indicator light
- Heating indicator light
- 200–400°F (93–204°C) solid state thermostat—Never needs calibration
- Easy front service access to controls

Cooking Capacity & Applications

Effective Cooking Area

Depth	24" Wide	36" Wide	48" Wide
29"	677 sq. in.	1017 sq. in.	1358 sq. in.
24"	558 sq. in.	838 sq. in.	1119 sq. in.

Typical Burger Production (29" Deep Model)

Type	24" Wide	36" Wide	48" Wide
Frozen	40 lbs./hour	60 lbs./hour	80 lbs./hour
Fresh	60 lbs./hour	90 lbs./hour	120 lbs./hour

Griddle Applications include

- Pancakes, Eggs, Sausage, French Toast
- Burgers, Grilled Onions, Toasted Buns
- Grilled Cheese, Monte Cristo & Ruben Sandwiches
- Fried Potatoes, Fish, Chicken Breasts, Sandwich Steaks, Liver and MORE

Approvals

- Griddle to be NSF Listed
- Griddle to be U.L. Listed



Installation Requirements

- 208/3 240/3 480/3 240/1 Power Source (See other side for AMP requirements.)
- 6' power cord with plug comes standard

Options & Accessories

- Tabletop model with 4" legs and adjustable bullet feet
- "U" Channel for connecting two griddles
- Front mounted condiment board/prep shelf—5" wide stainless steel
- Heavy tubular open leg stainless steel stand with bottom shelf with 5" casters
- Heavy tubular open leg stainless steel stand with 2 shelves with 5" casters

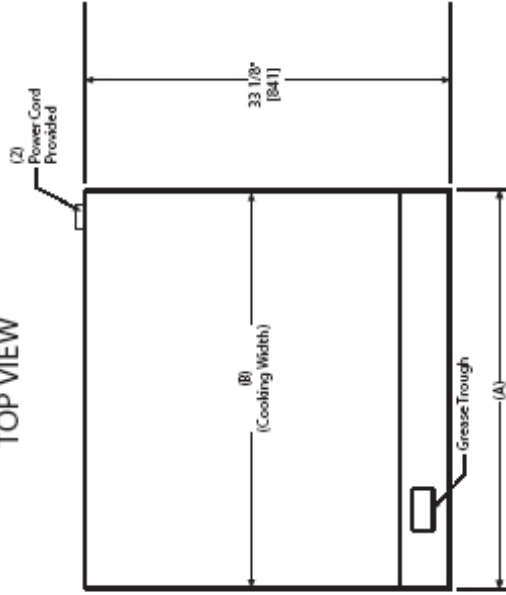


EG-A36 Model Shown with Optional Stand

MM5205-0505

ACCU-STEAM™ GRIDDLE EG SERIES
 Electric/Steam-Heated, Stand-Mounted Griddle
 Cooking Surface: 24" 36" 48" Wide; 29" 24" Deep

TOP VIEW

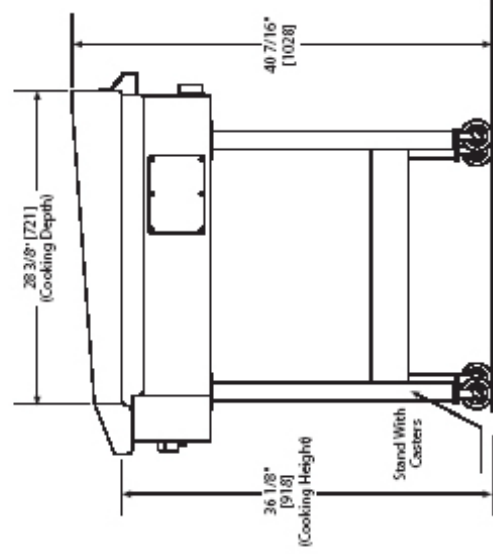


EG-A & EG-B Series Griddle Specifications						
Model	EG-A24	EG-B24	EG-A36	EG-B36	EG-A48	EG-B48
KW Input	9.6 kW		14.25 kW		14.25 kW	
208/3 Amp Load	26.68		39.56		39.56	
240/1 Amp Load	40		not available		not available	
240/3 Amp Load	39.58		34.28		34.28	
480/3 Amp Load	15.41		22.87		22.87	
Unit Width (A)	24 1/4" [616]		36 1/4" [921]		48 1/4" [1226]	
Cooking Width (B)	23 3/8" [606]		35 3/8" [911]		47 3/8" [1216]	
Cooking Depth (C)	28 3/8" [721]	23 3/8" [594]	28 3/8" [721]	23 3/8" [594]	28 3/8" [721]	23 3/8" [594]
Effective Cooking Area	677sq.in.	558sq.in.	1017sq.in.	838sq.in.	1358 sq.in.	1119 sq.in.
Grease Pan Capacity	1 1/2 gal.		2 gal.		2 gal.	
NEMA Plug (208/240)	15-50P		15-50P		15-50P	
NEMA Plug (480)	L16-20P		L16-30P		L16-30P	

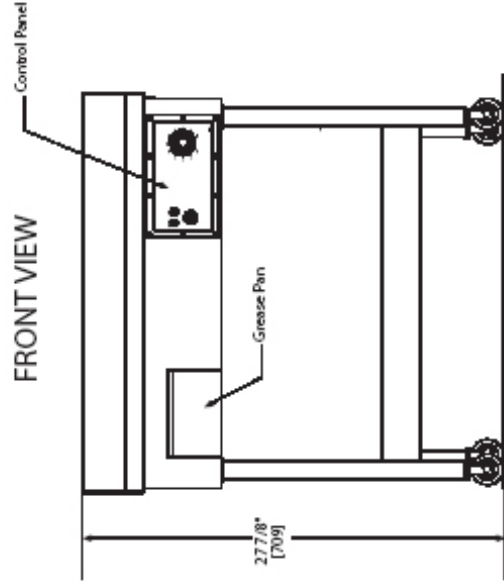
Notes:

1. Dimensions in brackets [] are metric.
2. 5' power cord with plug provided.

RIGHT SIDE VIEW



FRONT VIEW



EG-A36 Model Shown with Optional Stand

MMS205-0505

C Results Reporting Sheets

Manufacturer: AccuTemp Products, Inc.
Model: Accu-Steam EG2083A36
Serial Number: 3051
Date: December 2005

Test Griddle.

Description of operational characteristics: The Accu-Steam electric griddle features a hermetically-sealed chamber that produces high temperature steam for heating the cooking surface to a uniform temperature. The cooking surface temperature is controlled by a solid-state thermostat on the front control panel that has a temperature range of 200 °F to 400 °F.

Apparatus.

Check if testing apparatus conformed to specifications in section 6.

Deviations:

Energy Input Rate.

Rated (Btu/h)	14.25
Measured (Btu/h)	14.91
Percent Difference between Measured and Rated (%)	4.60

Results Reporting Sheets

Temperature Uniformity and Thermostat Accuracy^a

Thermostat Setting (°F)	375
Average Surface Temperature (F°)	375
Maximum Temperature Difference Across Plate (°F) ^b	7.2
Useable Cooking Surface (in ²) ^c	1,008
Standard Deviation of Surface Temperature (°F)	1.63

^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.

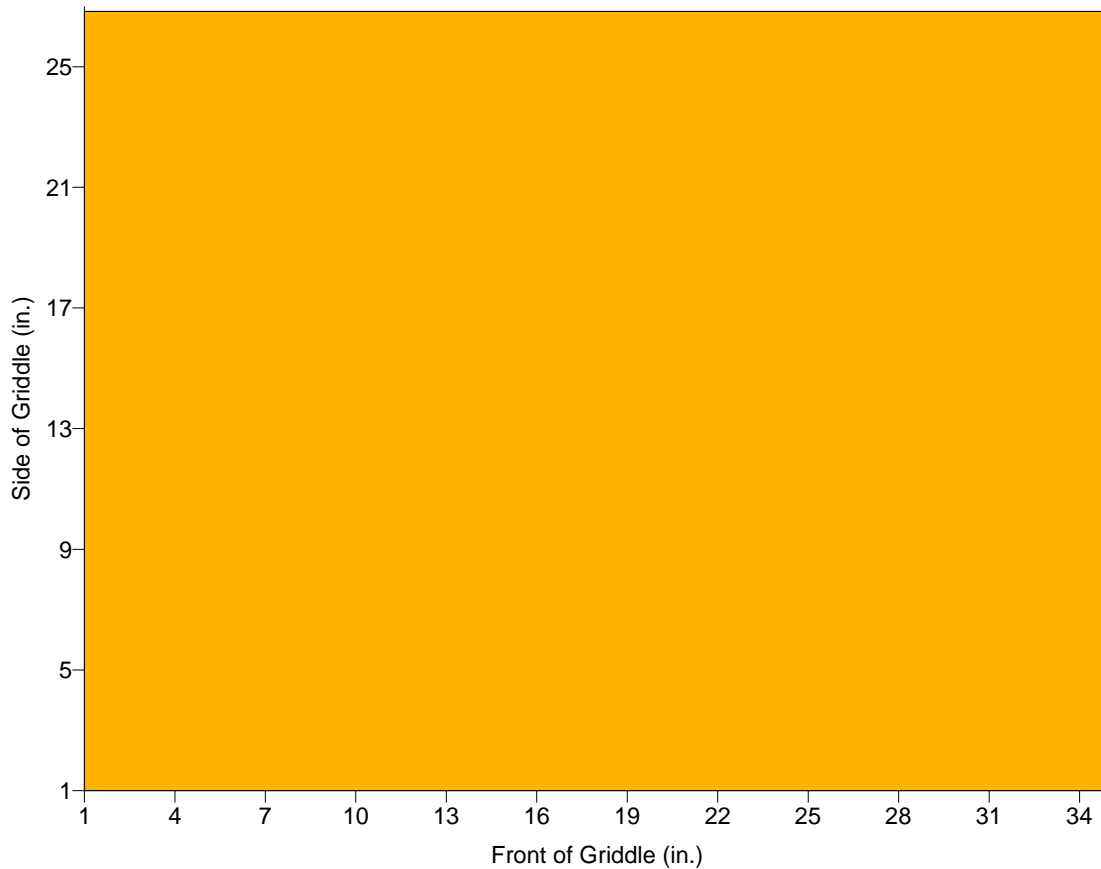


Figure C-1. Average cooking surface temperatures.

Results Reporting Sheets

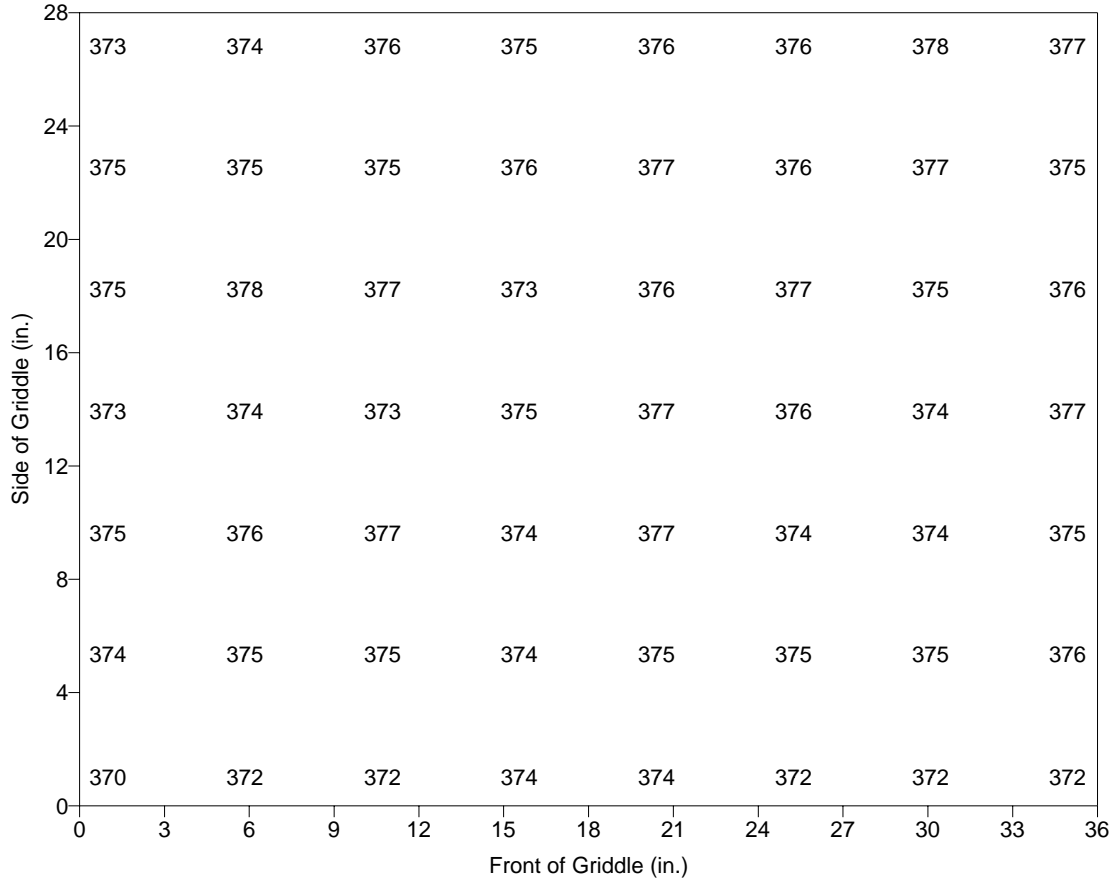


Figure C-2. Average cooking surface temperatures.

Preheat Energy and Time.

Starting Temperature (°F)	77.1
Energy Consumption (kWh)	4.76
Duration (min)	19.2
Preheat Rate (°F/min)	15.6

Idle Energy Rate.

Idle Energy Rate @ 375°F (kW)	2.44
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Results Reporting Sheets

Heavy-Load Cooking-Energy Efficiency Test Results.

Cooking Time (min)	7.20
Average Reload Time (min) ^a	< 1.0
Production Capacity (lb/h)	57.3 ± 2.2
Energy to Food (Btu/lb)	479
Electric Energy Rate (kW)	11.1
Energy per Pound of Food Cooked (Btu/lb)	659
Cooking-Energy Efficiency (%)	72.7 ± 3.3

^a Due to the logistics of loading the griddle cooking surface, reload time includes 30 seconds to remove the cooked patties and 30 seconds to scrap the griddle surface before reloading the next heavy-load test.

Light-Load Cooking-Energy Efficiency Test Results.

Cooking Time (min)	7.17
Average Reload Time (min) ^a	< 1.0
Production Capacity (lb/h)	8.3 ± 0.1
Energy to Food (Btu/lb)	477
Electric Energy Rate (kW)	4.12
Energy per Pound of Food Cooked (Btu/lb)	1,694
Cooking-Energy Efficiency (%)	28.2 ± 0.9

^a Due to the logistics of loading the griddle cooking surface, reload time includes 30 seconds to remove the cooked patties and 30 seconds to scrap the griddle surface before reloading the next heavy-load test.

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 (Wh)	9,180	8,900	8,820
Cook Time (min)	7.08	7.24	7.27
Total Test Time (min)	47.9	48.7	49.4
Weight Loss (%)	33.3	33.3	33.6
Initial Weight (lb)	46.399	46.494	46.435
Final Weight (lb)	30.952	31.025	30.837
Initial Fat Content (%)	16.3	16.3	16.3
Initial Moisture Content (%)	63.7	63.7	63.7
Final Moisture Content (%)	53.0	53.5	53.6
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	158	158	159
Calculated Values			
Initial Weight of Water (lb)	29.551	29.612	29.574
Final Weight of Water (lb)	16.389	16.592	16.535
Weight of Fat (lb)	7.568	7.583	7.574
Weight of Solids (lb)	9.280	9.299	9.287
Sensible to Ice (Btu)	473	474	473
Sensible to Water (Btu)	3,734	3,741	3,760
Sensible to Fat (Btu)	479	480	482
Sensible to Solids (Btu)	294	294	296
Latent - Water Fusion (Btu)	4,255	4,264	4,259
Latent - Fat Fusion (Btu)	310	311	310
Latent - Water Vaporization (Btu)	12,767	12,629	12,647
Total Energy to Food (Btu)	22,313	22,193	22,227
Energy to Food (Btu/lb)	481	477	479
Total Energy to Griddle (Btu)	31,331	30,376	30,103
Energy Per Pound of Food Cooked (Btu/lb)	675	653	648
Cooking-Energy Efficiency (%)	71.2	73.1	73.8
Cooking Energy Rate (Btu/h)	11.50	10.97	10.71
Production Rate (lb/h)	58.1	57.3	56.4
Average Reload Time (min)	< 1.0	< 1.0	< 1.0

Cooking-Energy Efficiency Data

Table D-4. Light-Load Test Data

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Total Energy (Wh)	3,060	3,080	3,080
Cook Time (min)	7.17	7.17	7.17
Total Test Time (min)	44.7	44.7	44.8
Weight Loss (%)	34.1	33.5	33.1
Initial Weight (lb)	6.214	6.166	6.195
Final Weight (lb)	4.096	4.100	4.142
Initial Fat Content (%)	16.3	16.3	16.3
Initial Moisture Content (%)	63.7	63.7	63.7
Final Moisture Content (%)	53.9	54.1	53.6
Initial Temperature (°F)	0	0	0
Final Temperature (°F)	160	159	158
Calculated Values			
Initial Weight of Water (lb)	3.957	3.927	3.945
Final Weight of Water (lb)	2.209	2.219	2.219
Weight of Fat (lb)	1.013	1.006	1.010
Weight of Solids (lb)	1.243	1.233	1.239
Sensible to Ice (Btu)	63	63	63
Sensible to Water (Btu)	508	499	497
Sensible to Fat (Btu)	65	64	64
Sensible to Solids (Btu)	40	39	39
Latent - Water Fusion (Btu)	570	566	568
Latent - Fat Fusion (Btu)	41	41	41
Latent - Water Vaporization (Btu)	1,696	1,658	1,675
Total Energy to Food (Btu)	2,983	2,929	2,947
Energy to Food (Btu/lb)	480	475	476
Total Energy to Griddle (Btu)	10,444	10,512	10,512
Energy Per Pound of Food Cooked (Btu/lb)	1,681	1,705	1,697
Cooking-Energy Efficiency (%)	28.6	27.0	28.0
Electric Energy Rate (kW)	4.11	4.13	4.12
Production Rate (lb/h)	8.3	8.3	8.3
Average Reload Time (min)	< 0.33	< 0.33	< 0.33

Cooking-Energy Efficiency Data

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

	Cooking-Energy Efficiency		Production Capacity
	Heavy-Load	Light-Load	
Replicate #1	71.2	28.6	58.1
Replicate #2	73.1	27.9	57.3
Replicate #3	73.8	28.0	56.4
Average	72.7	28.2	57.3
Standard Deviation	1.35	0.37	0.88
Absolute Uncertainty	3.34	0.91	2.18
Percent Uncertainty	4.59	3.23	3.81

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 an electric griddle yielded the following results:

Energy Cost Model

Table E-1: Electric Griddle Test Results.

Test	Result
Preheat Time (min)	19.2
Preheat Energy (kWh)	4.76
Idle Energy Rate (kW)	2.44
Heavy-Load Cooking Energy Rate (kW)	11.1
Light-Load Cooking Energy Rate (kW)	4.12
Production Capacity (lb/h)	57.3
Light-Load Production Rate (lb/h)	8.30

Step 1—The following appliance operation is assumed:

Table E-2: Griddle Operation Assumptions.

Operating Time (h)	12
Number of Preheats	1
Total Amount of Food Cooked (lb)	100
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:

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

$$t_h = \frac{70\% \times 100 \text{ lb}}{57.3 \text{ lb/h}},$$

$$t_h = 1.22 \text{ h}$$

Energy Cost Model

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

$$\begin{aligned}E_{elec,h} &= q_{elec,h} \times t_h \\E_{elec,h} &= 11.1 \text{ kW} \times 1.22 \text{ h} \\E_{elec,h} &= 13.54 \text{ kWh}\end{aligned}$$

Step 3—Calculate the total light-load energy.

The total time cooking light-loads is as follows:

$$\begin{aligned}t_l &= \frac{\%l \times W}{PRl}, \\t_l &= \frac{30\% \times 100 \text{ lb}}{8.30 \text{ lb/h}}, \\t_l &= 3.61 \text{ h}\end{aligned}$$

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

$$\begin{aligned}E_{elec,l} &= q_{elec,l} \times t_l \\E_{elec,l} &= 4.12 \text{ kW} \times 3.61 \text{ h} \\E_{elec,l} &= 14.87 \text{ kWh}\end{aligned}$$

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

The total idle time is determined as follows:

$$\begin{aligned}t_i &= t_{on} - t_h - t_l - \frac{n_p \times t_p}{60}, \\t_i &= 12.0 \text{ h} - 1.22 \text{ h} - 3.61 \text{ h} - \frac{1 \text{ preheat} \times 19.2 \text{ min}}{60 \text{ min/h}} \\t_i &= 6.85 \text{ h}\end{aligned}$$

The idle energy consumption is then calculated as follows:

$$\begin{aligned}E_{elec,i} &= q_{elec,i} \times t_i \\E_{elec,i} &= 2.44 \text{ kW} \times 6.85 \text{ h} \\E_{elec,i} &= 16.71 \text{ kWh}\end{aligned}$$

Energy Cost Model

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

$$E_{elec,daily} = E_{elec,h} + E_{elec,l} + E_{elec,i} + (n_p \times E_{elec,p})$$
$$E_{elec,daily} = 13.54 \text{ kWh} + 14.87 \text{ kWh} + 16.71 \text{ kWh} + (1 \times 4.76 \text{ kWh})$$
$$E_{elec,daily} = 49.88 \text{ kWh}$$

Step 6—Calculate the average demand as follows:

$$q_{avg} = \frac{E_{elec,daily}}{t_{on}},$$
$$q_{avg} = \frac{49.88 \text{ kWh}}{12.0 \text{ h}},$$
$$q_{avg} = 4.16 \text{ kW}$$

Step 7—The annual energy cost is calculated as follows:

$$Cost_{annual} = E_{elec,daily} \times R_{elec} \times Days$$
$$Cost_{annual} = 49.88 \text{ kWh/day} \times 0.10 \text{ \$/kWh} \times 365 \text{ days/year}$$
$$Cost_{annual} = 1,821 \text{ \$/year}$$