Toastmaster Accu-Miser, Model AM36SS
Electric Griddle
In-Kitchen Appliance Performance Report

FSTC Report 5011.99.57

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The information in this report is based on data generated at PG&E's Food Service Technology Center.

Acknowledgments

The establishment of the Food Service Technology Center reflects PG&E's commitment to the food service industry. The goal of the research project is to provide PG&E's customers with information to help them evaluate technically innovative cooking appliances and make informed equipment purchases regarding advanced technologies and energy sources. The project was the result of many people and departments working together within PG&E and the overwhelming support of the commercial equipment manufacturers who supplied the cooking appliances for testing.

PG&E's Food Service Technology Center is supported by the National Advisory Group that includes:

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Specific appreciation is extended to Toastmaster for supplying the Food Service Technology Center with a model AM36SS electric griddle for controlled testing in the appliance laboratory and subsequent installation and monitoring in the production-test kitchen.

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Contents

Contents

Executive Summary

This PG&E Food Service Technology Center (FSTC) research report presents the results of monitoring the Toastmaster Accu-Miser, Model AM36SS Electric Griddle as it was used for routine menu production in PG&E's production-test kitchen and during tests under controlled laboratory conditions. The Toastmaster Accu-Miser griddle was equipped with infrared heat panels. These panels heat over a larger surface than standard elements, allowing the griddle to perform the same amount of work with a lower input rating. Griddle performance parameters included the measured energy input rate, preheat energy requirement and time, production energy consumption rate, idle energy consumption rate, and production duty cycle. The griddle was monitored in the production-test kitchen over a 10-month test period. A summary of the test results is presented in Table ES-1.

Table ES-1 Griddle Performance Summary.

Rated Energy Input (kW)	9.30
Measured Energy Input Rate (kW)	9.27
Preheat:	
Time to 375°F (min)	11.6
Energy Input (kWh)	1.72
Idle Energy Rate @ 375°F (kW):	2.31
Production Energy Use (kW/day)[a]	18.67
Appliance On-Time (h/d)	8.36
Average Production Energy Rate (kW)	2.23
Production Duty Cycle (%)	24.0

[a] Includes preheat and idle energy over the hours of operation when griddle was in use.

Executive Summary

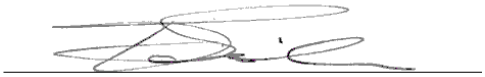
To supplement monitoring information acquired during actual production conditions, controlled energy tests were also conducted.[1] Griddle performance was characterized by temperature uniformity, preheat time and energy consumption, idle energy consumption rate, cooking energy efficiency and production capacity. The measured peak energy input rate was 9.27 kW, which was 0.3% lower than its 9.30 kW nameplate input. This griddle consumed 1.72 kW of energy over the 11.6-minute preheat period (the time required to heat the griddle surface from room temperature to 375°F). The rate of idle energy use averaged 2.31 kW.

Energy use data for the test period was reduced to include only days that reflected typical griddle usage in the production-test kitchen (i.e., days when the griddle was used for two-meal periods). The hours of operation over the day averaged 8 hours, during which time the griddle consumed 18.67 kW/day. Based on the aggregate preheat, idle, and cooking energy for the entire day of appliance operation, the average rate of production energy use was 2.23 kW, resulting in a production duty cycle of 24%.

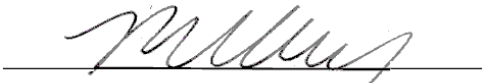
Based on a 5-day per week, 52-week-per-year food service operation, the griddle would consume 4,854kWh per year. The total yearly cost to operate the griddle would be $507. This calculation is based on PG&E's A-10 Schedule for commercial electric rates ($0.08097/kW) dated January 1,1998, and a year-round, five-day-per-week food service operation.

The griddle was one of the most frequently used appliances in the production-test kitchen; it was used heavily to prepare a wide variety of items for breakfast and lunch. At breakfast, it was used to fry eggs and cook omelets, French toast, pancakes, and hash brown potatoes. At lunch it was used to grill sandwiches, hamburgers and hamburger buns. Occasionally, the griddle was used to toast hamburger buns or made to order grilled sandwiches. Over a typical day, the operators cooked about 30 pounds of food.

Although the daily quantity of food cooked would be considered “light” compared to high-volume fast food restaurants, it was considered to be representative of many corporate / commercial cafeteria operations offering a diverse menu mix to a broad customer base.

FSTC Manager 

Donald R. Fisher

Senior Program Manager 

Peter W. Turnbull

[1]Food Service Technology Center. In Press. Toastmaster Accu-Miser Model Am36SS. *Application of ASTM Standard Test Method Designation F1275-95. Report 5011.96.34*, Consumer Energy Management Department. San Francisco, California: Pacific Gas and Electric Company.

1 Introduction

Background

Griddles are used throughout the hospitality industry to prepare a variety of menu items. Operators are becomingly increasingly sophisticated in their choice of equipment, with special emphasis not only on energy efficient equipment that meets their production capacity requirements, but also on the uniformity of cooking surface temperature and the amount of food that can be cooked in a given period of time. Studies have been conducted on the performance characteristics of electric griddles to assist food service operators with the selection of high performance, energy-efficient commercial cooking equipment.

PG&E's Food Service Technology Center monitored the Toastmaster Accu-Miser, Model AM36SS electric griddle under both laboratory and in-kitchen conditions. It was used for routine menu production in PG&E's production-test kitchen from August 1995 through July 1996. Four other griddles have been monitored at the PG&E facility. To supplement production energy monitoring data, controlled energy test data were also documented.

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

Objective

The objective of this appliance performance report was to document the energy consumption characteristics of the Toastmaster Accu-Miser griddle during the ten months it was in operation at the production-test kitchen. The report documents griddle usage in relationship to its energy consumption and cost while in production. Therefore, the reader should bear in mind that this information is specific to PG&E's production-test kitchen, a corporate, cafeteria-style operation.

The Production Test Kitchen

The 1,500-square-foot kitchen is an integral component of the campus-style dining facility at PG&E's Learning Center in San Ramon, California. Nine cooking appliances are centrally located on two sides of a utility distribution system (UDS). The UDS functions as a central "spine" that contains all plumbing, wiring, and natural gas distribution lines. A 16-foot, double-sided canopy exhaust hood ventilates the equipment island at a design air flow of 9,600 cfm. Grilles along the front face of the hood direct makeup air into the kitchen.

The UDS was designed to accommodate quick connection and disconnection of the appliances as they are rolled in or out of the "line," with the flexibility to accommodate either a gas or an electric model in each appliance slot. Gas and electric meters interface with a remote data acquisition and processing system. Appliance monitoring and performance evaluations are conducted by the FSTC research team, independent of the food service operation.

Figure 1-1 is a floor plan of the production-test kitchen and appliance lineup.

Appliance Description and Operation

Toastmaster developed the Accu-Miser griddle with infrared heat panels. These panels spread heat over a larger surface than standard elements allowing the griddle to perform the same amount of work with a lower input rating. It is powered by three 12 inch infrared heat panels which route electricity through a filament wound back and forth though a ceramic composite block. An 1/8 inch aluminum plate is sandwiched between the heat panels and a 3/8 inch steel cooking surface to further distribute the heat. Appliance specifications are presented in Table 1-1 and the manufacturer's product literature appears in Appendix B.

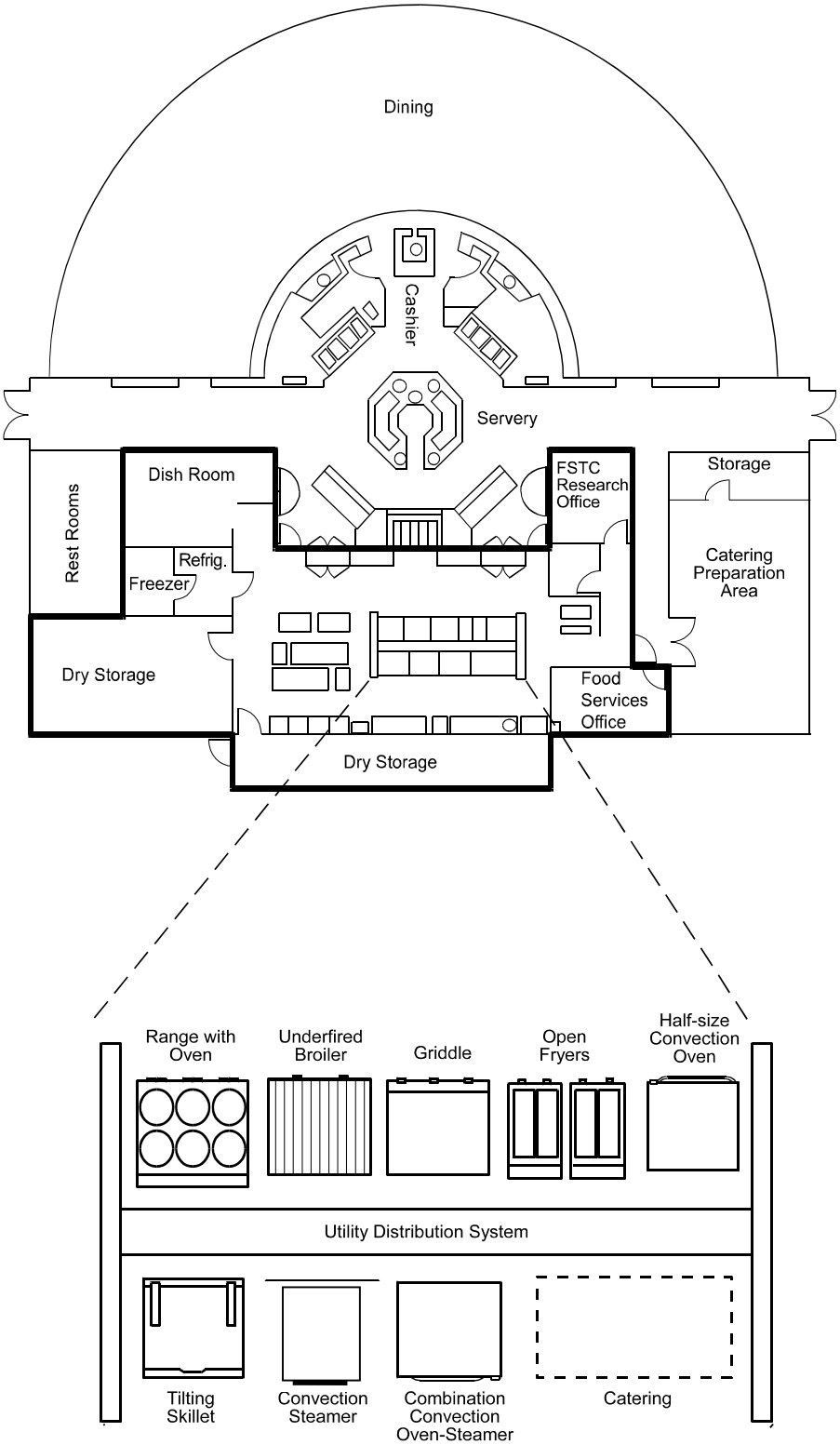


Figure 1-1.
Production-test kitchen,
PG&E Learning Center.

Table 1-1 Appliance Specifications.

Generic Appliance Type:	Thermostatically Controlled Electric Griddle
Manufacturer:	Toastmaster
Model:	AM36SS
Rated Energy Input:	9.30 kW
Dimensions:	36” x 28 ½” x 15”
Construction:	3/8” -thick steel cooking surface bonded to an 1/8’ - thick aluminum plate
Heat Transfer:	Three 12 inch infrared heat panels
Controls:	Three operating zones, each controlled by snap acting thermostat adjustable from 150 to 450°F
Accessories:	Stand with stainless steel bottom shelf.

2 Controlled Energy Tests

Purpose

The purpose of conducting energy tests under controlled, or lab-style conditions is to:

1. Verify that the appliance operates at the manufacturer's rated energy input.
2. Characterize preheat and idle energy use under select operating conditions.

Methods and Results

FSTC researchers operated the Toastmaster Accu-Miser griddle under controlled laboratory conditions and in accordance with the *ASTM Standard Test Method for the performance of Electric Griddles* (Designation F1275-95).[2] For a detailed discussion of the development of the procedures and test results, refer to PG&E's *Development and Application of a Uniform Testing Procedure for Griddles* (Report 008.1-89.2).[3] A complete application of the Standard Test Method was applied to the Toastmaster's Accu-Miser electric griddle.

The controlled energy tests were conducted with the thermostat at the calibrated 375°F set point. The energy input rate was determined as part of the preheat test. Energy consumption was monitored for the preheat period, after the griddle was first turned on. Preheat was considered complete when the temperature on the griddle surface measured by the thermocouple welded to the cooking surface directly above the thermostat sensing probes reached 375°F. For the idle test, the cooking surface was allowed to stabilize at 375°F for one hour. After the griddle had stabilized, the energy was monitored over a 2-hour idle period.

Results of the controlled testing are summarized in Table 2-1. Figure 2-1 shows the preheat and idle test energy consumption profiles along with the average cooking surface temperature.

Table 2-1 Summary of Controlled Energy Test Results.

Rated Energy Input Rate (kW)	9.30
Measured Energy Input Rate (kW)	9.27
Preheat:	
Time to 375°F (min)	11.60
Energy to 375°F (kW/h)	1.72
Rate to 375°F(°F/min)	27
Idle Energy Rate (kW/h):	2.31

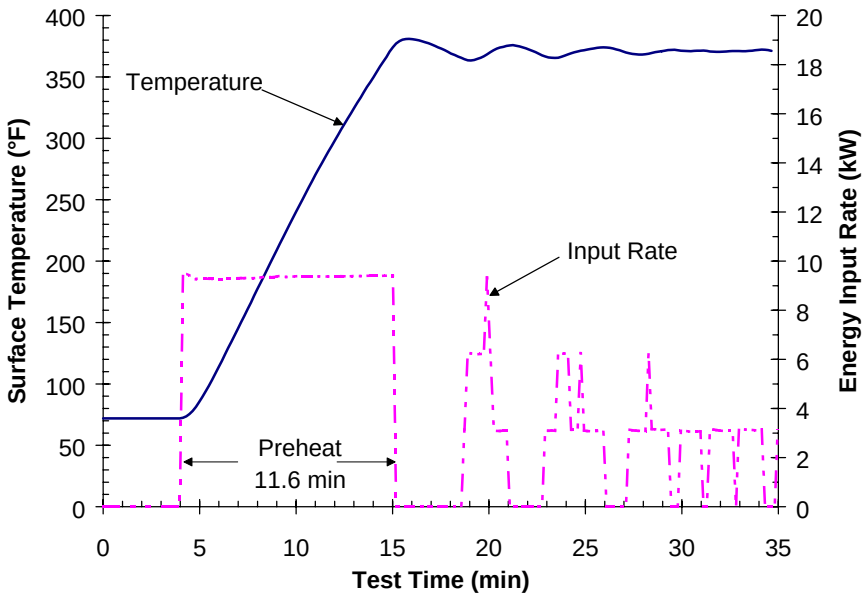


Figure 2-1.
Preheat and idle energy test at 375°F.

3 Production Monitoring

Energy

In establishing the typical day production energy use, the day-to-day energy data for the 10-month test period were reduced to include only those days when the griddle was used for two meal periods breakfast and lunch. The average daily production energy performance of the Toastmaster Accu-Miser electric griddle is summarized in Table 3-1. Note that the average production energy use includes the aggregate preheat, idle, and cooking energy only for the hours of operation. The production energy consumption rate was derived by dividing the total daily energy consumption by the corresponding hours of griddle operation. Duty cycle was calculated by dividing the production energy consumption rate by the appliance's measured energy input rate.

Table 3-1 Summary of Average Daily Production Energy Use.

Measured Peak Energy Input Rate (kW)	9.27
Daily Production Energy Use[a] (kW/d)	18.67
Appliance On-Time (h/d)	8.36
Production Energy Consumption Rate (kW)	2.23
Production Duty Cycle (%)	24

[a] Includes preheat and idle energy over the hours of operation when the griddle was in use.

The energy consumption profile plotted in Figure 3-1 characterizes the typical day energy use for the griddle in the production test kitchen. The energy consumption data are presented on a 1-minute basis (dotted line plot) and a 15 minute "sliding window" average (solid line plot). The energy consumption plot illustrates that the griddle was used for two distinct meal periods (breakfast and lunch) for a total time of about 8 hours. The higher energy consumption peaks at the beginning of each operation reflect the energy

required to preheat the griddle to a set operating temperature. Following each preheat period, the intermittent spikes above the idle or base rate of energy use reflect the incremental energy required to cook the food product loaded into the griddle.

Energy consumption varied from 16 to 22 kWh per day, and appliance on-time varied from 8 hours to 9 hours per day. The frequency distributions for daily production energy use and hours of operation for the griddle are presented in Appendix D.

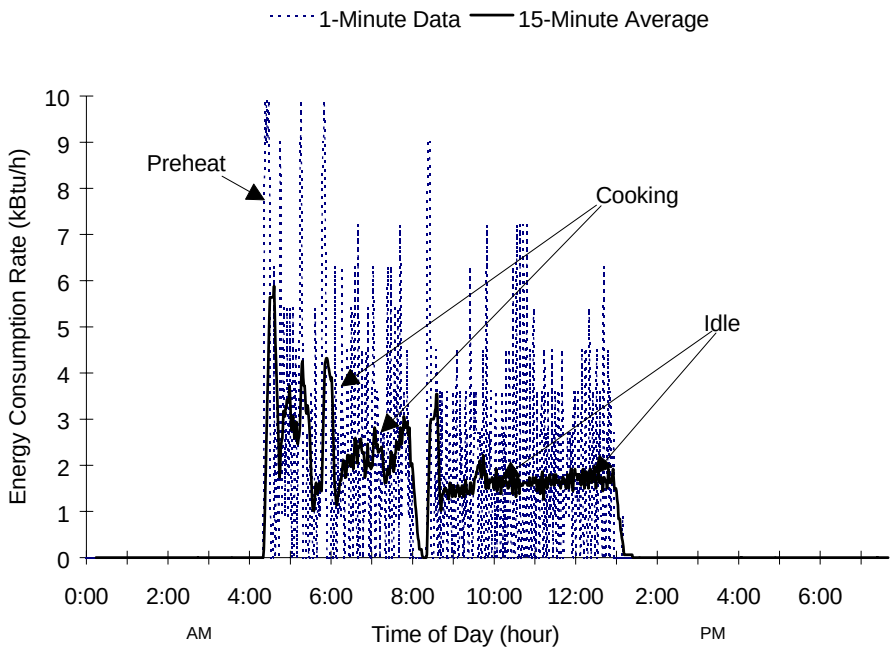


Figure 3-1.
Typical day energy consumption profile.

Note: The energy consumption profile for the typical day is plotted on a 1-minute basis and a 15-minute average. The 1-minute plot reflects the instantaneous input of energy into the appliance during preheat and subsequent element cycling during idle, while the 15-minute plot better characterizes the average rate of energy use (see Appendix C).

Estimated Annual Energy Cost

Based on the average daily energy consumption and assuming a 5-day per week, 52-week-per-year food service operation, the griddle would consume an estimated 4,854 kW per year and increase the monthly billing demand for the facility by 2.23 kW. This estimated average contribution to demand assumes that the appliance is operating when the maximum building demand occurs. At a cost of $0.08097/ kWh and a demand charge of $4.175/kW per month, the total cost to operate the griddle would be $505 per year, production accounting for $393 and demand accounting for $112.

These costs of operation, as shown in Table 3-2, were calculated using a seasonally weighted average of PG&E's electric rates (Schedule A-10) for small commercial customers, which would be applicable if the production test kitchen were billed separately (Appendix E).

Table 3-2 Estimated Annual Energy Costs.

Annual Production Energy Consumption[a] (18.67 kW/d x 5 days x 52 weeks per year) ($0.08097/kW):	$393
Probable Contribution to Billing Demand[b] (2.23kW)($4.175/kW/mo X 12 months):	$112
Annual Energy Cost[c]	$505

[a] Estimates are based on PG&E's A-10 rate schedule in effect on January 1,1998 (See Appendix E)

[b] The demand charge based on the assumption that the griddle was used during the period of time that the billing demand was likely to be set. The actual contribution to billing demand by operating this griddle in other food service operations may vary significantly depending on its usage pattern (operating schedule, quantity of food cooked, etc.) in relation to that of other electric equipment in the facility.

[c] Does not include customer charges.

Food Production

The griddle was frequently used for the preparation of many breakfast and lunch items in the production-test kitchen. An FSTC researcher observed the griddle during several periods of normal operation and interviewed the

cooks. The cooks' daily worksheets were also reviewed to obtain a list of the food items prepared and to determine how the griddle was being used.

Items Cooked

The griddle was used to cook breakfast and lunch menu items. At breakfast it was used to fry eggs, omelets, French toast, pancakes and hash brown potatoes. At lunch it was used to grill sandwiches, hamburger buns, and Mexican style filings for tacos and burritos. Occasionally, the griddle was used to toast hamburger buns or for made-to-order grilled sandwiches. Using the quantity (pounds) of cooked food from the cook's production worksheets, it was estimated that, on average, approximately 30 pounds of food was cooked on the griddle over a day's operation.

In-Kitchen Observations

In-kitchen observations provided information about actual kitchen staff usage of the griddle over a typical day of operation. It was operated for around 8 hours over two distinct periods (breakfast and lunch). For breakfast, the griddle was typically on at 4:30AM. The left thermostat was set at 370°F and the right at 380°F. It was used to cook eggs, omelets, hash browns and French toast. During the lunch period the left thermostat was set at 380°F and the right at 350°F. The griddle was used to grill ham and cheese sandwiches and hamburger buns, until 1:30 P.M. when it is turned off. The griddle was not typically used during the dinner period.

4 Conclusions and Recommendations

Production

The energy performance of the Toastmaster Accu-Miser electric griddle was successfully monitored and documented as it was operated in the production-test kitchen. In-kitchen observations were beneficial to understand how the appliance was used by the food service staff. Griddle usage was typical of many food service operations in that the operators grilled such standard food items such as eggs, omelets, pancakes, french toasts and sandwiches. Although the quantity of food cooked (an average of 30 pounds per day) would be considered "light" compared to high volume fast food restaurants, it was considered representative of many corporate/commercial cafeteria operations offering a diverse menu mix to a broad customer base. The griddle was operated on an average of 8 hours per day during breakfast and lunch. The griddle thermostats were set at temperatures ranging from 250°F to 375°F, depending on the food being cooked.

Although future griddle monitoring conducted in the Production Test-Kitchen may include energy conservation, no measures were implemented during the test period for the Toastmaster Accu-Miser griddle.

Controlled Energy Testing

Conducting controlled preheat and idle tests helped characterize the griddle's input rate, preheat time and idle rate under real life production conditions. For example, based on the controlled energy test data, the FSTC researchers were able to quantify the energy that would have been consumed by the griddle if food had not been cooked (i.e., the base load or idle component of the daily energy). To facilitate the energy conservation initiative, future griddle testing could include monitoring the preheat time and energy use and the rate of idle energy at various temperature settings generally used in the industry (e.g., 250°F and 325°F).

Production Energy Monitoring

The production energy consumption for the Toastmaster Accumiser electric griddle was relatively stable over the 10-month test period, averaging 18.67 kWh per day. Based on the average operating time of 8.36 hours over the two meal periods (breakfast and lunch), this represented an average production energy consumption rate of 2.23 kW. Earlier monitoring of the two other electric griddles in the production test kitchen showed data for a two-meal period operation with production energy consumption of 2.96 kW and 2.24 kW.[4]

5 References

1. Food Service Technology Center. 1996. *Toastmaster Accu-Miser Model AM36SS Electric Griddle Performance Test.* Report 5011.96.34. Products and Services Department. San Francisco, California: Pacific Gas and Electric Company.

2. American Society of Testing and Materials. ASTM F275-95. *Standard Test Methods for the Performance of Griddles.* In Annual Book of ASTM Standards. Philadelphia: American Society for Testing and Materials.

3. Food Service Technology Center. 1989. *Development and Application of Uniform Testing Procedure for Griddles*. Report 088.1-89.2. Department of Research and Development. San Ramon, California: Pacific Gas Company and Electric

4. Food Service Technology Center. 1990. *Cooking Appliance Performance Report*. Report 008.1-90.8. Department of Research and Development. San Ramon, California: Pacific Gas and Electric Company.

A Glossary

Appliance On-Time (minute, hour)
Hours of Operation
Operating Period
Operating Time
The total period of time that an appliance is operated (from the perspective of food service staff) from the time it is turned "on" to the time it is turned "off." Appliance on-time excludes any "off" periods between the first and last appliance operation.

Average Daily Production Energy Consumption Rate (kW or kBtu/h)
The average rate of production energy consumption based on the daily production energy consumption and the appliance operating or "on" time.

Average Daily Production Energy Rate =

$$\frac{\text{Daily Production Energy Consumption}}{\text{Appliance On - Time}}$$

Note: By basing the total daily production energy consumption on a 24-hour period, the total quantity of pilot energy (if applicable) is considered within the average production energy consumption rate and is based on the actual period of appliance usage.

Average Production Energy Consumption Rate (kW or kBtu/h)
Average Production Energy Rate
Average Production Energy Use Rate
The average rate of production energy consumption based on the production energy consumption and the appliance operating or "on" time for a specified period of appliance operation.

Average Production Energy Consumption Rate =

$$\frac{\text{Production Energy Consumption}}{\text{Operating Time}}$$

Baseload Energy Consumption (Btu or kBtu)
Baseload Energy
The total amount of energy that would be consumed over the operating period of an appliance if it had never been used to cook food.

Baseload Energy Consumption Rate (kW or kBtu/h)
Base Rate
Baseload Energy Rate
Baseload Rate
The lowest rate of energy consumption reflected by the energy consumption profile (based on a 15-minute sliding window average) recorded during appliance operation. Generally, this definition is not extended to include the rate of pilot energy consumption. It is typically equal to the lowest value of idle energy consumption rate.

Cold Zone
The volume in the fryer below the heating element(s) or heat exchanger surface designed to remain cooler than the fry zone and hot zone.

Cook Zone
Cooking Zone
The volume of oil in the fryer where the fries are cooked. Typically, the entire volume from the heating element(s) of a heat exchanger surface to the surface of the frying medium.

Cooking Energy Consumption (kWh or kBtu)
The total energy consumed by an appliance during the cooking period.

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 test.

Cooking Period (minute, hour)
The period of time (derived from in-kitchen monitoring or by interpreting the energy consumption profile) that an appliance is actually used for cooking.

Daily Energy Consumption (kWh or kBtu)
Daily Energy Use
Daily Production Energy Consumption
Daily Production Energy Use
The total amount of energy consumed by an appliance as it is used within the Production-Test Kitchen over a 24-hour period.
Note: By basing the total daily production energy consumption on a 24-hour period, the total quantity of pilot energy (if applicable) is considered within the average production energy consumption rate.

Energy Consumption Profile
Energy Use Profile
A plot of appliance energy consumption showing energy consumption rate on the Y-axis and time on the X-axis.
Note: The area under the curve (plot) represents the total energy consumption for the period of integration. For uniformity in production reports, use the following terms and units for the coordinate labels:

y-axis: Energy Rate (kW or kBtu/h)

x-axis: Time (AM & PM)**:** (Hour) (Min)

Energy Consumption Rate (kW or kBtu/h)
Energy Input Rate
Energy Rate
The rate of appliance energy consumption over a specified period of operation (see Energy Consumption Profile).

Energy Use Data Set
A set of daily energy consumption data compiled in accordance with typical day criteria.

Hot Zone
The area surrounding the heating element(s) or heat exchanger surface.

Idle Energy Consumption (kWh or kBtu)
Idle Energy Use
The amount of energy consumed by an appliance operating under an idle condition over the duration of an idle period.

Idle Energy Consumption Rate (kW or kBtu/h)
Idle Energy Input Rate
Idle Energy Rate
Idle Rate
The rate of appliance energy consumption while it is "idling" or "holding" at a stabilized operating condition or temperature.

Idle Duty Cycle (%)
Idle Energy Factor
Idle Load Factor
The idle energy consumption rate expressed as a percentage of the measured energy input rate.

Idle Energy Factor =

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

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 Time (minutes, hour)
Idle Period
A period of time that an appliance is consuming energy at its idle energy consumption rate while maintaining a specified stable operating condition or temperature.
Note: Idle time may include both necessary or unnecessary appliance "idling." This is simply differentiated by applying the appropriate adjective to the idle energy period term (e.g., needless idle time, necessary idle period.)

Measured Energy Input Rate (kW, W or kBtu/h, Btu/h)
Measured Input
Measured Peak Energy Input Rate
Peak Rate of Energy Input
The maximum or peak rate at which an appliance consumes energy, measured during appliance preheat or while conducting a water-boil test (i.e., the period of operation when all burners or elements are "on")

Pilot Energy Consumption (kBtu)
Pilot Energy Use
Standing or Constant Pilot Energy Consumption
Standing or Constant Pilot Energy Use
The amount of energy consumed by the standing pilot of an appliance over a specified period of time.

Pilot Energy Rate (kBtu/h)
Average Pilot Energy Rate
Average Pilot Energy Use Rate
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 Consumption (kWh or kBtu)
Preheat Energy
The total amount of energy consumed by an appliance during the preheat period.
Note: The reporting of preheat energy must be supported by the specified temperature/operating condition.

Preheat Energy Rate
The rate of appliance energy consumption while it is "preheating" to a predetermined temperature.

Preheat Time (minute, hour)
Preheat Period
The time required for an appliance to "preheat" from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

Production Day
Production Period
The time period when an appliance is used by the kitchen staff, typically between the hours of 5 A.M. and 8 P.M.

Production Duty Cycle (%)
Load Factor
Production Energy Factor
Production Factor
The average production energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

Production Duty Cycle =

$$\frac{\text{Average Production Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Production Energy Consumption (kWh or kBtu)
Production Energy Use
The total amount of energy consumed by an appliance as it is used within the Production-Test Kitchen over a specified time period (e.g., 10 A.M. to 1 P.M., dinner period). Production energy consumption is numerically equal to daily energy consumption if the production period is not specified.
Note: This integrated energy use includes preheat energy, idle energy, and pilot energy associated with the specified time period.

Rated Energy Input Rate (kW, W or kBtu/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.

Typical Day

A selected day of energy usage based on predetermined criteria that will generate a production energy consumption profile reflecting typical production usage for a specific appliance. The typical day criteria may comprise:

- Typical day energy consumption should approximate average daily energy consumption for energy use data set.
- A specified number of appliance operations and/or cooking periods (e.g., lunch and dinner only).
- A specified range in operating hours.
- A specified mode of operation (or combination of modes) may be associated with a typical day's operation.

B Manufacturer’s Product Specifications

C Energy Monitoring System

Energy data are collected once each minute, which means that the highest resolution measurement of energy rate is a 1-minute average. This 1-minute average, shown as the dotted line on the graph of the typical day profile, differs from actual instantaneous power explained in the following paragraphs.

Short periods of full input are not reflected as full input. Heating elements and burners are usually either full on or off. A plot of 1-minute data may show some less-than-full-on 1-minute values because the elements or burners operate on full for only part of the minute.

Long periods of constant input rate are usually reflected as a sawtooth pattern. Gas pulses are generated by the meter, which measures the flow of gas to the appliance. Each pulse corresponds to a specific quantity of gas energy consumed. The system stores the number of pulses for each minute, but it only stores an integer value for the number of pulses even though the actual energy consumed during the period corresponds to a non-integer value. For example, if the actual consumption during a 1-minute period corresponds to 6.6 pulses, only the integer “6” will be stored for that minute. The “0.6” will be carried forward and added to pulses generated during the next minute. If the energy consumed during the next minute is also 6.6 pulses, then the pulse value stored will be the integer portion of 7.2 (6.6 + 0.6) and the 0.2 will be carried to the next time interval.

D Frequency Distribution Dataset

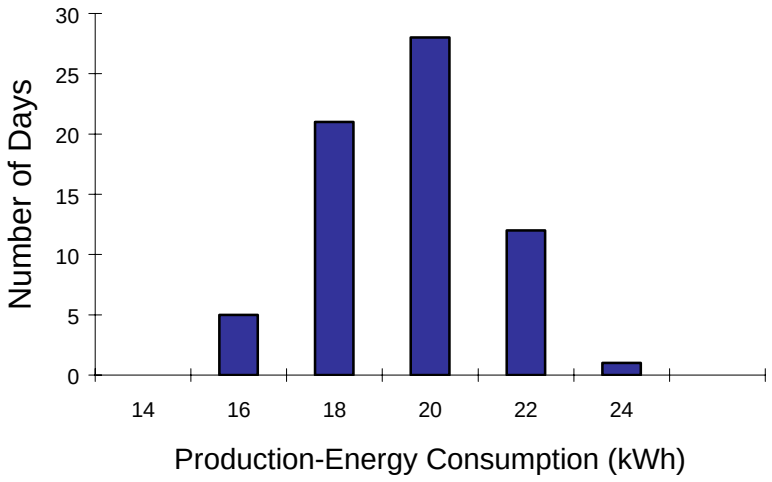


Figure D-1.
Frequency of electric griddle daily production energy consumption

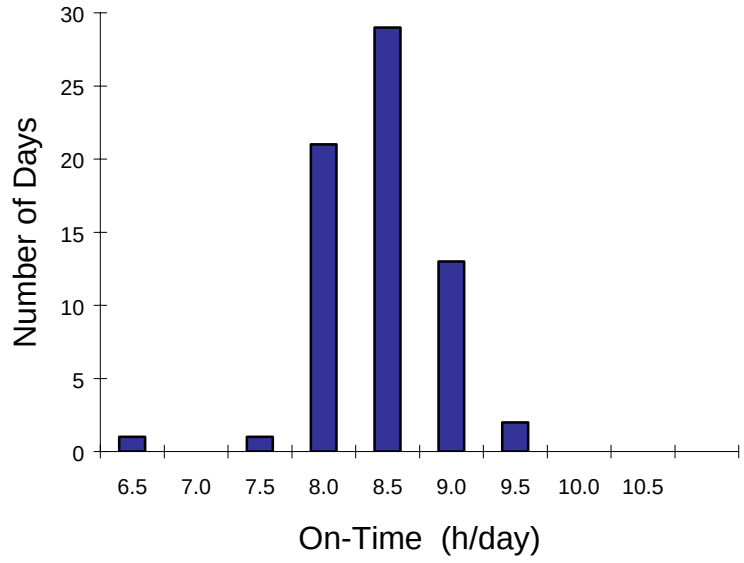


Figure D-2.
Frequency of electric griddle daily on time