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Research and Development

Appliance Performance in Production: "Hobart" Electric Char Broiler Model CB51

Customer Systems
Report 008.1-92.4

Project Manager: Bettie Ferlin

PG&E Food Service Technology Center
(Production-Test Kitchen)

Final Report, December 1992

Prepared by:

Mark Selden

Prepared for:

Pacific Gas and Electric Company
Department of Research and Development
3400 Crow Canyon Road
San Ramon, California 94583

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PREFACE

Historically, performance testing of commercial cooking appliances has been conducted by food service equipment manufacturers and research organizations under controlled laboratory conditions. However, key decision makers in the food service industry have long seen a need to evaluate appliance performance under real-life conditions. Pacific Gas and Electric Company (PG&E) is providing this opportunity at its Food Service Technology Center (FSTC) in San Ramon, California.

The FSTC has three components. The first, the Production-Test Kitchen, is a unique combination of a real food service operation and a testing laboratory at PG&E's corporate Learning Center dining facility. As a testing lab, it is equipped to measure the energy consumed by gas and electric cooking appliances as they are used for menu production. As a production kitchen, operated by the staff of a contract food service management company, the 162-seat dining facility provides cafeteria-style breakfast and lunch and table service dinner for the students and staff at PG&E's Learning Center.

The second is a 6,700-square-foot appliance research laboratory, which complements the Production-Test Kitchen by supporting the development and application of standard methods of tests for commercial food service equipment. The laboratory also provides an arena for identification and investigation of environmental issues related to food service facilities.

Technology transfer is the third component. *Restaurants & Institutions* magazine publishes the results of FSTC research in a national subscription service called the *Kitchen Monitor*. Other technical reports produced by the FSTC are also available through the *Kitchen Monitor*. For more information write or call Corinne Zollars, *Kitchen Monitor*, 1350 East Touhy Avenue, Des Plaines, IL 60018 (708-390-2086; fax 708-635-6856).

ACKNOWLEDGMENTS

The establishment of a state-of-the-art Food Service Technology Center reflects PG&E's commitment to the hospitality industry. The goal of the research project is to provide PG&E's food service customers with information to help them evaluate technically innovative cooking appliances and make informed equipment purchases regarding advanced technologies and energy sources. The project was the result of many people and departments working together within PG&E and the overwhelming support of the commercial equipment manufacturers who loan the cooking appliances for testing. Specific appreciation is extended to Hobart Corporation for supplying PG&E with an electric broiler for controlled conditions testing in the Appliance Laboratory and subsequent installation and monitoring in the Production-Test Kitchen.

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

EXECUTIVE SUMMARY

This study documents the performance and energy use of the 12-kW Hobart Electric Char Broiler, model CB51, as it was used for routine menu production in PG&E's Production-Test Kitchen, and during tests under controlled conditions. The broiler has two 16"-by-16" cooking grates with a 20-minute, high-temperature pyrolytic cleaning cycle for each side.

The broiler's energy consumption and time of use was consistent from day to day, typically consuming 61 kWh, and averaging 7.6 hours of operation. The average rate of production-energy consumption was 8.1 kW, which represents the most likely contribution to the building billing demand (assuming the appliance is operating when the billing demand is set). A typical day energy consumption profile is shown in Figure ES-1.

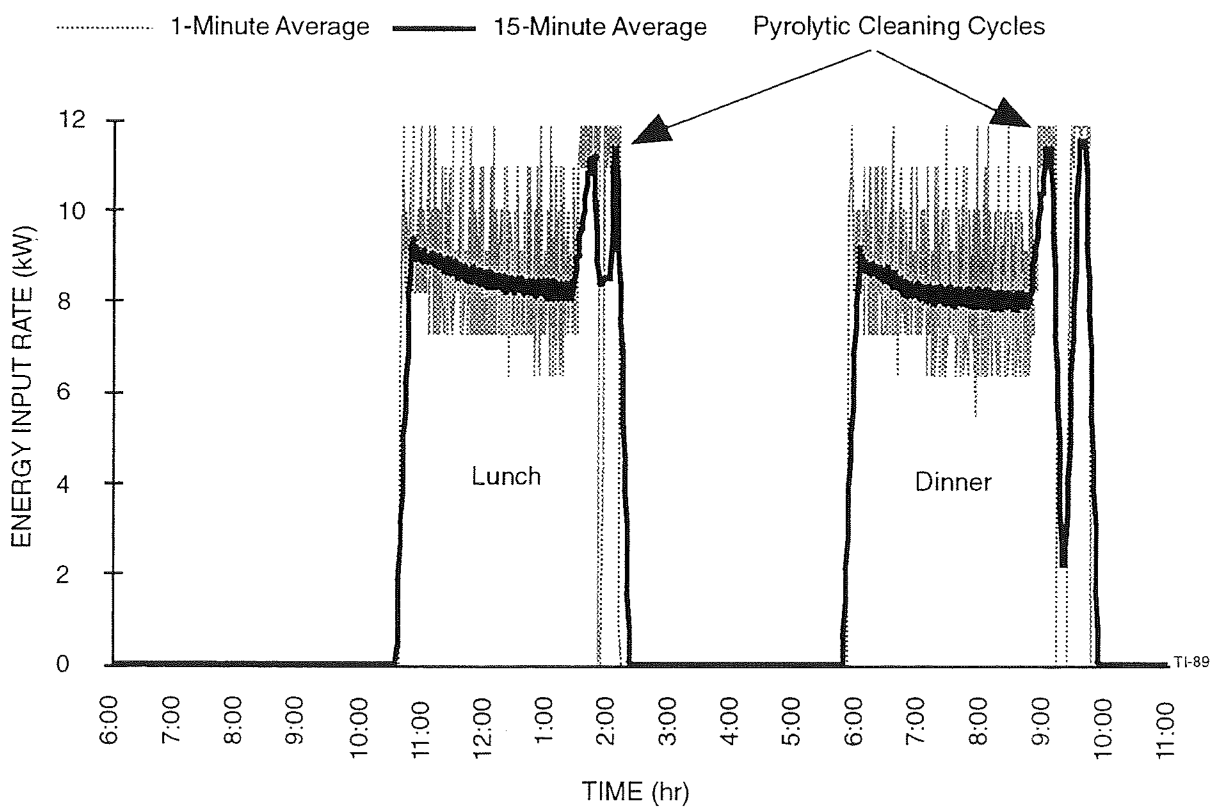

Figure ES-1. Typical day energy consumption profile.

Based on a year-round, five-day food service operation, the broiler would consume an estimated 15,900 kWh per year, and would increase monthly billing demands for the facility by an average of 8.1 kW. Based on these amounts, the estimated total annual energy would cost $1,675; broiler energy consumption would be $1,354 and demand charge would be $321. These costs were calculated using PG&E's non-time-of-use rate (PG&E rate designation A-10), which would be applicable if the Production-Test Kitchen were billed separately.

Of the total energy consumed by the broiler, the pyrolytic cleaning cycle used a surprising 21% (13.1 kWh). Typically, both sides were cleaned twice—after lunch and dinner. If they were cleaned once per day, the average rate of energy consumption could be decreased from 8.1 kW to roughly 7.8 kW, and the total daily energy consumption could be reduced from 61 kWh to 54 kWh. Thus, the annual electric cost of operation would be reduced by 9%—from $1,680 to $1,510 per year.

The appliance could also add the full 12 kW to a 15-minute billing demand if the cleaning cycle is coincident with the building peak demand (see Figure ES-1). This situation applies to the afternoon cleaning at the Production-Test Kitchen because the building peak demand often occurred in the early afternoon. A food service manager should ensure that the cleaning cycle is scheduled when the building demand is low.

Hobart's more recent version of this broiler has a 10-kW rated input. This input would not affect the cooking capacity or cooking energy consumption, but it would reduce the pyrolytic cleaning cycle energy consumption and, more importantly, the pyrolytic cleaning cycle contribution to billing demand.

Project Manager ______________________
Bettie Ferlin

Research Director ______________________
David A. Christensen

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FIGURES

TABLES

Section 1

INTRODUCTION

BACKGROUND

The Hobart 12-kW Electric Char Broiler, model CB51, was selected for production-energy monitoring and performance evaluation for the second phase of the PG&E Production-Test Kitchen research program (the first phase appliance line included a Magikitch'n model FM-SMB, 120,000-Btu/h underfired gas broiler).[1] It was used for routine menu production in the PG&E food service operation from February 1989 to September 1990. Hobart's more recent version (same model) has a 10-kW rated input instead of 12 kW. The potential energy cost consequences of this change are discussed in Section 4. Terms used in this report are defined in Appendix A.

OBJECTIVE

This study documents the energy consumption patterns of the Hobart Electric Char Broiler as it was used in daily food production and during tests under controlled conditions. Typical uses of the broiler are also reported.

THE PRODUCTION CENTER

The 1,500-square-foot kitchen is an integral component of the campus-style dining facility at PG&E's Learning Center (Figure 1-1). Nine cooking appliances are centrally located on two sides of a utility distribution system (UDS; Figure 1-2). 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 production center 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 an interdisciplinary research team independent of the food service operation.

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[1]PG&E. 1990. *PG&E Production-Test Kitchen: Cooking Appliance Performance Report.* Report No. 008.1-90.8 prepared for the Department of Research and Development. San Ramon, California: PG&E.

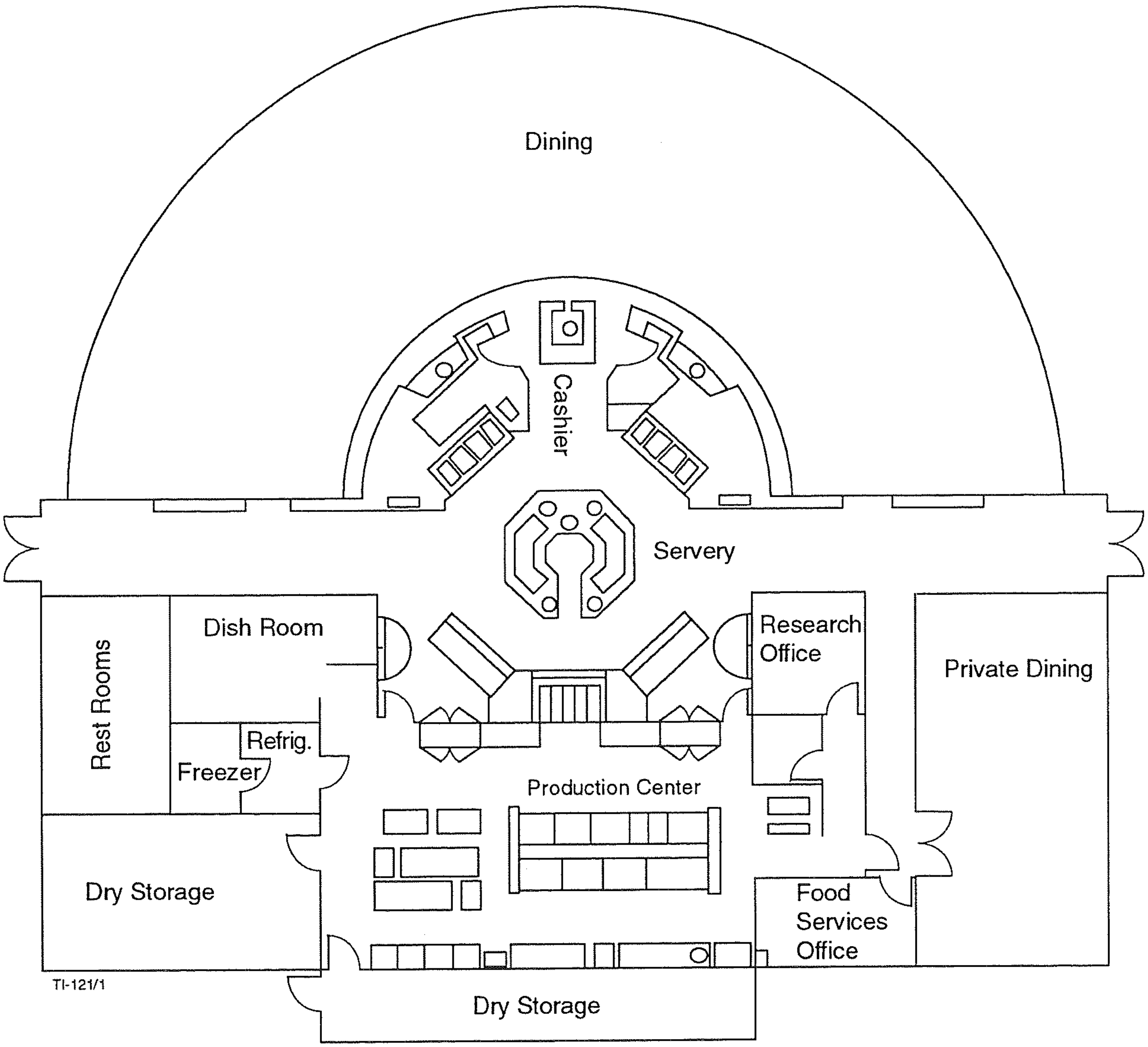


Figure 1-1. Dining facility, PG&E Learning Center.

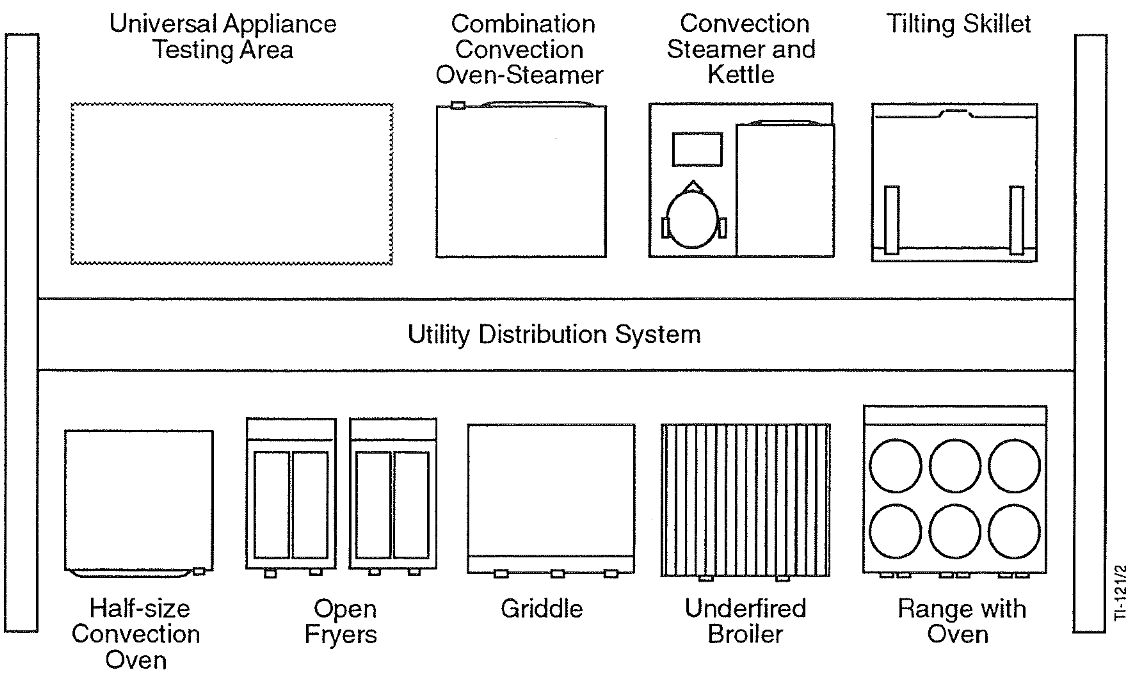


Figure 1-2. The production center.

APPLIANCE DESCRIPTION AND INSTALLATION

The 12-kW electric broiler has two independently operated 16"-by-16" cooking grates with a high-temperature pyrolytic cleaning cycle. The cleaning cycles are manually initiated, and they automatically terminate after 20 minutes. Only one side may be cleaned at a time. Appliance specifications are given in Table 1-1. The manufacturer's specification sheet is in Appendix B. The heating elements are not thermostatically controlled. They are energized and de-energized at intervals determined by the setting of the temperature control dials. Each grid has one dial. This broiler chars or brands the food on the hot grates. Drippings do not ignite, as occurs with broilers using hot briquettes.

Table 1-1

Appliance Specifications

Generic Appliance Type:	Free-standing electric counter char broiler with pyrolytic cleaning cycle
Manufacturer:	Hobart Corporation
Model:	CB51
Rated Input:	12 kW
Grid Cooking Area:	2 16"-by-16" grates, separately controlled
Dimensions:	Width: 37.5" Depth: 23.5"
	Height (including stand with casters): 36"
Accessory:	Stand with casters (p/n CX404)

Section 2

CONTROLLED ENERGY TESTING

PURPOSE

This test determined the following operating characteristics of the broiler under controlled conditions:

1. Peak energy input rate
2. Preheat energy consumption and duration
3. Energy consumption rate with both sides set at 10 (maximum)
4. Energy consumption rate with one side set at 10
5. Energy consumption rate with both sides set at 7 (typical setting)
6. Energy consumption rate with one side set at 7
7. Energy consumption and duration of the pyrolytic cleaning cycle

Energy consumption rates with the controls set at 7 were of particular interest because this was the typical setting used by the Learning Center cooking staff.

METHODS AND RESULTS

The broiler was operated at the various settings under laboratory conditions without a food load on the cooking surface. Because the broiler is not thermostatically controlled, these energy consumption rates are identical to those with a food load. Energy consumption rates for the different cooking settings are illustrated in Figure 2-1. The preheat, conducted with both sides set at maximum power, was deemed complete when the grate surface temperature reached 600°F. A grate surface temperature profile during preheat is shown in Figure 2-2. Controlled energy test results are summarized in Table 2-1.

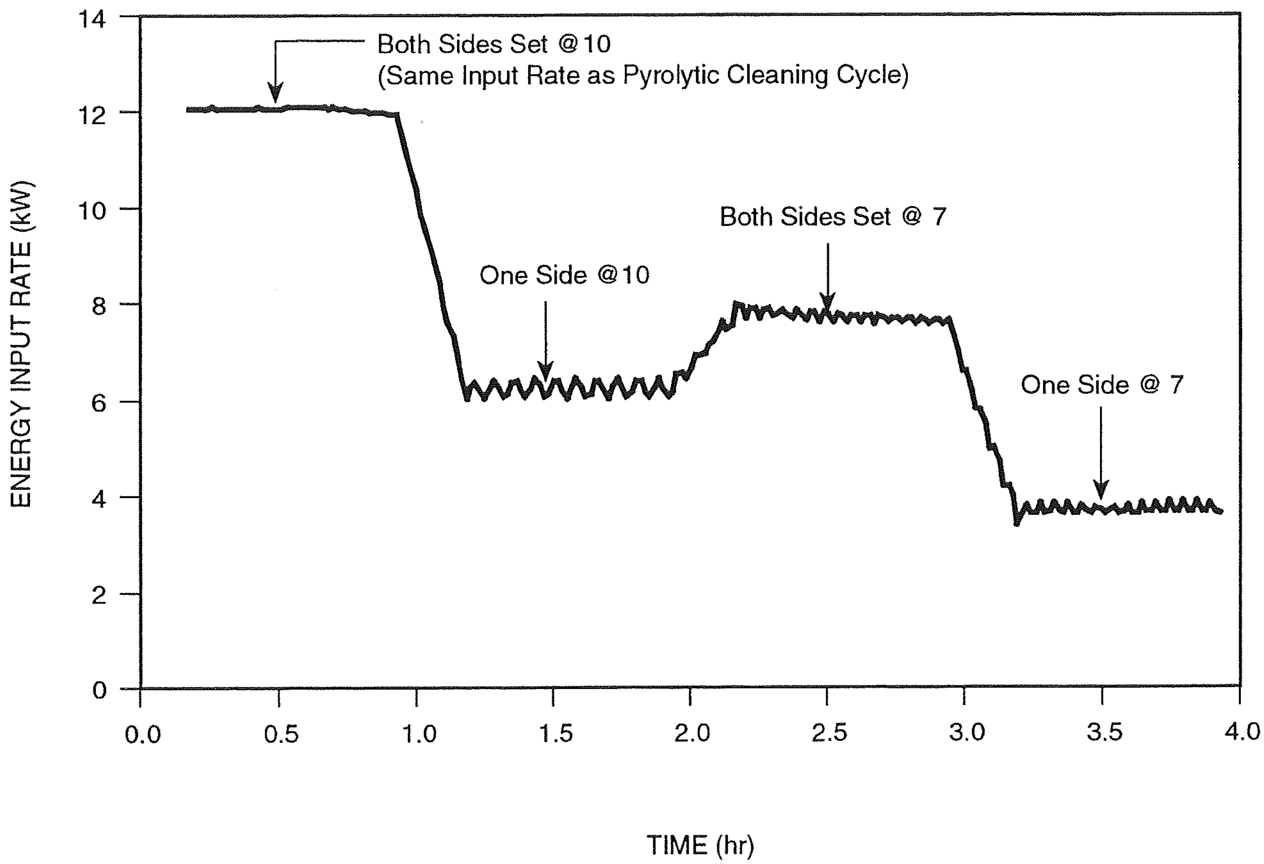


Figure 2-1. Controlled energy test (15-minute average power at various settings).

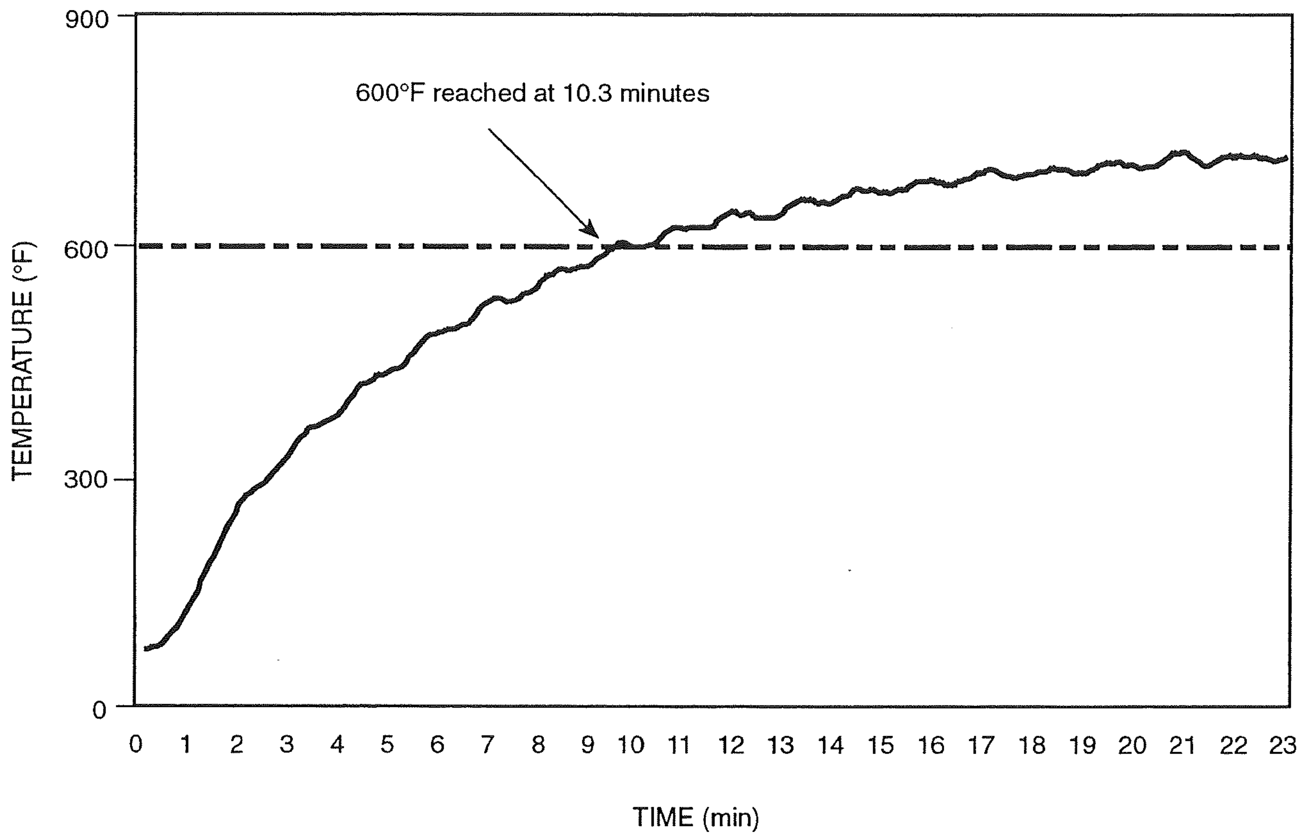


Figure 2-2. Controlled energy test (grate surface temperature during preheat).

Table 2-1

Controlled Energy Test Results

Rated Input (kWh/Day):	12
Measured Peak Energy Input Rate (kW):	12.0
Preheat:	
Energy (kWh)	2.1
Duration (min)	10.3
Energy Rate with Both Sides Set at 10 (kW):	12.0
Energy Rate with One Side Set at 10 (kW):	6.2
Energy Rate with Both Sides Set at 7 (kW):	7.8
Energy Rate with One Side Set at 7 (kW):	3.7
Pyrolytic Cleaning Cycle:	
Energy Rate (kW)	12.0
Duration (min)	20
Energy (kWh)	4.0

Section 3

PRODUCTION MONITORING

ENERGY

The dataset from which typical day characteristics were quantified covers July 9, 1990, through August 1990. All Fridays, Saturdays, Sundays, and holidays were eliminated because they were not three-meal food service days. The total number of days in the reduced dataset is 30.

A summary of average daily energy performance parameters is presented in Table 3-1. The production-energy use includes both cooking and cleaning energy. Cooking time is when the controls are set to broil (food is not necessarily being cooked). Cleaning time is the time that the elements are energized during the pyrolytic cleaning cycle. On time includes both cooking and cleaning time. The average production-energy consumption rate represents the appliance's most likely contribution to the building billing demand, assuming the appliance is operating when the billing demand is set. See Appendix A for definitions of other terms.

Table 3-1

Average Daily Energy Performance

Daily Production-Energy Use (kWh/d):	61
Daily Cooking Energy Use (kWh/d):	48
Daily Cleaning Energy Use (kWh/d):	13
Daily Cooking Time (h):	6.5
Daily Cleaning Time (h):	1.2
Daily On Time (h):	7.6
Average Production-Energy Consumption Rate (kW):	8.1
Measured Maximum Input Rate	12
Production Factor (%):	68
Estimated Average Quantity of Food Cooked/Day (lb):	65

The day-to-day values deviated very little because the unit was turned on and off at the same time every day, and because the appliance consumed the same amount of energy regardless of the quantity of food cooked.

Both cooking grates were run through the pyrolytic cleaning cycle two times a day—after lunch and dinner. A statistical description of the data is given in Appendix C.

Figure 3-1 shows the energy consumption profile of a typical day. The slight drop in energy consumption rate during operation was found to be a characteristic of the controls, and was not related to the quantity of food cooked. The cooks did not notice the decreased energy rate. The energy rate spikes after both meal periods represent the pyrolytic cleaning cycles.

Estimated Annual Energy Cost

Based on a year-round five-day food service operation, the broiler would consume an estimated 15,900 kWh per year, and would increase monthly billing demands for the facility by an average of 8.1 kW. This estimated average broiler contribution to demand assumes that the broiler was operating when the maximum building demand occurs. The annual energy costs based on these amounts are shown in Table 3-2. These costs were calculated using PG&E's non-time-of-use rate, which would be applicable if the Production-Test Kitchen was billed separately. This rate includes one charge for energy consumption and another charge for the maximum occurring 15-minute demand. See Appendix D for the calculation of annual electricity cost, as well as the projected annual energy cost using PG&E's applicable time-of-use rate. All calculations were based on rates in effect on July 1, 1990.

Table 3-2

Estimated Annual Energy Costs ($)

Energy Consumption (15,938 kWh per year)	$1,354
Demand Charge (Based on average demand of 8.1 kW)	$321
Total	$1,675

FOOD PRODUCTION

Actual use of the broiler was observed in an ongoing fashion as well as one full day and evening. We also interviewed the cooks, who were satisfied with the broiler's cooking performance. They never had to increase the temperature control setting beyond 7. They found the grates quicker and easier to clean than those that did not have a pyrolytic cleaning cycle, and the drippings drawers were easy to clean.

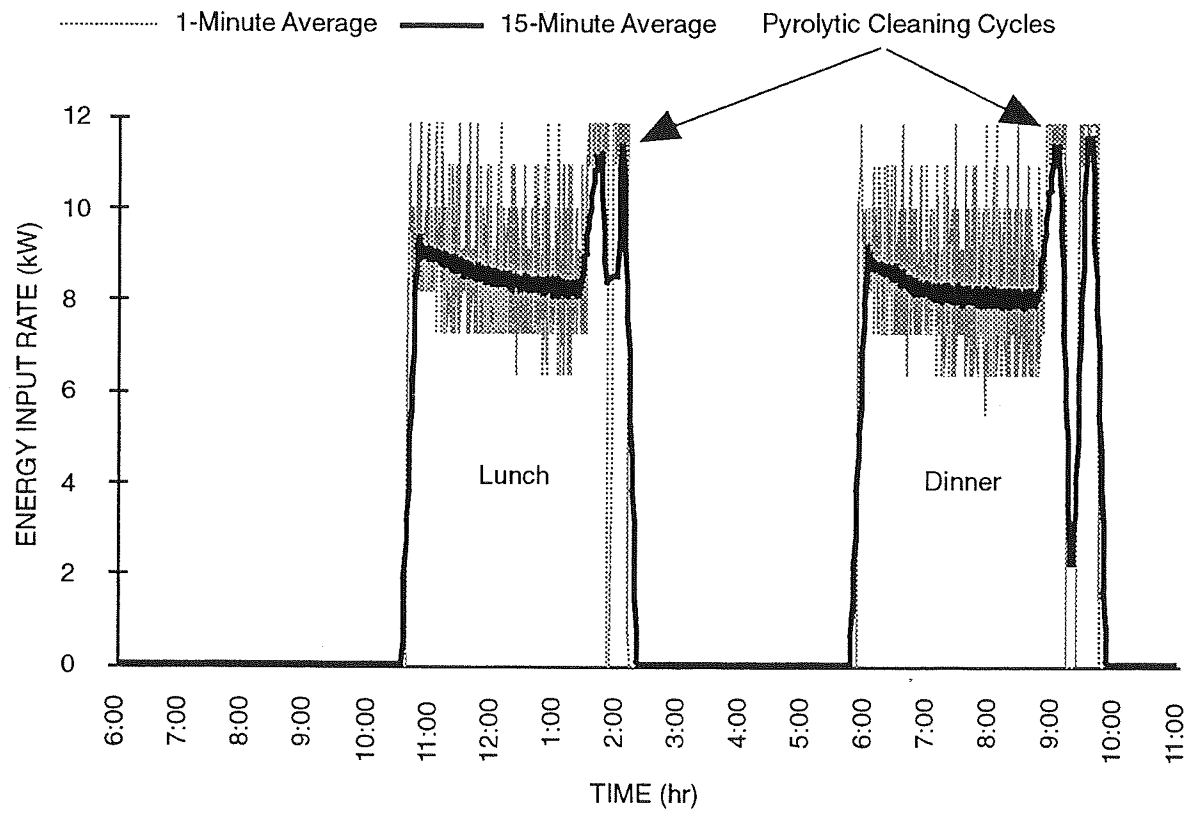


Figure 3-1. Typical day energy consumption profile.

Note: See Appendix E for an explanation of the 1-minute average.

Lunch

Lunch started at 11:00 A.M. Both sides of the broiler were typically turned on at 10:30 A.M., and the temperature control dial was set to 7 (the dial could be set from 1 to 10). The broiler was primarily used for cook-to-order hamburgers and chicken breast sandwiches. One side was sometimes used prior to lunch for charring assorted menu items, such as marinated beef fajita strips or flank steaks.

Cooking typically stopped at or before 1:00 P.M. The broiler was typically cleaned a few minutes afterwards by putting the grates through a pyrolytic cleaning cycle (one side at a time) and then quickly brushing them down.

Dinner

The broiler was usually started between 5:30 and 6:00 P.M. Both sides were set at 7 on the temperature control dial. The most common dinner items were steaks, ribs, chicken breasts, hamburgers, and fish. The cleaning cycles were generally started at about 9:00 P.M.

Section 4

CONCLUSIONS AND RECOMMENDATIONS

ENERGY

Because the broiler usage at this installation was typical of food service operations catering to a mixed customer base, the opportunities for reducing energy costs pertain to other operations as well.

Pyrolytic Cleaning Cycle

Of the total energy consumed by the broiler, the pyrolytic cleaning cycle used a surprising 21% (13.1 kWh). By reducing the frequency of pyrolytic cleanings, energy consumption can be reduced. Typically, both sides were cleaned twice per day—after lunch and dinner. If they were cleaned once per day, the average rate of energy consumption could be decreased from 8.1 kW to roughly 7.8 kW, and the total daily energy consumption could be reduced from 61 kWh to 54 kWh. Thus, the annual electric cost of operation would be reduced by 9%—from $1,680 to $1,510 per year.

The appliance could add the full 12 kW to a 15-minute billing demand if the cleaning cycle is coincident with the building peak demand (see Figure 3-1). This situation applies to the afternoon cleaning at the Production-Test Kitchen because the building peak demand often occurred in the early afternoon. A food service manager should ensure that the cleaning cycle is scheduled when the building demand is low.

"Standby" Temperature Setting

Typically, both sides were turned on and set to cooking temperature just prior to the start of the meal period. Some energy could be saved by setting only one side to the cooking temperature and the other side to a lower "standby" temperature, which could be turned up when needed.

PRODUCTION

The broiler was satisfactory from an operational standpoint. The numbered dial controls were easy to use and remained cool during cooking. The grates were much easier and quicker to clean than broilers without a pyrolytic cleaning cycle.

NEWER MODEL DIFFERENCE

Hobart's more recent version of this broiler has a 10-kW rated input. This input would not affect the cooking capacity or cooking energy consumption for this operation, but it would reduce the pyrolytic cleaning cycle energy consumption and, more importantly, the pyrolytic cleaning cycle contribution to billing demand.

Appendix A

GLOSSARY

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.

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

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.

$$\text{Average Production Energy Consumption Rate} = \frac{\text{Production Energy Consumption}}{\text{Operating Time}}$$

Baseload Energy Consumption (kWh 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 Energy Factor (%)
Idle Factor
Idle Load Factor

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

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

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)
Pilot Energy Consumption Rate
Average Pilot Energy Rate
Average Pilot Energy Use 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 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.

Production Energy Factor (%)
Duty Cycle
Load 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.

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

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.

Appendix B

MANUFACTURER'S PRODUCT SPECIFICATIONS

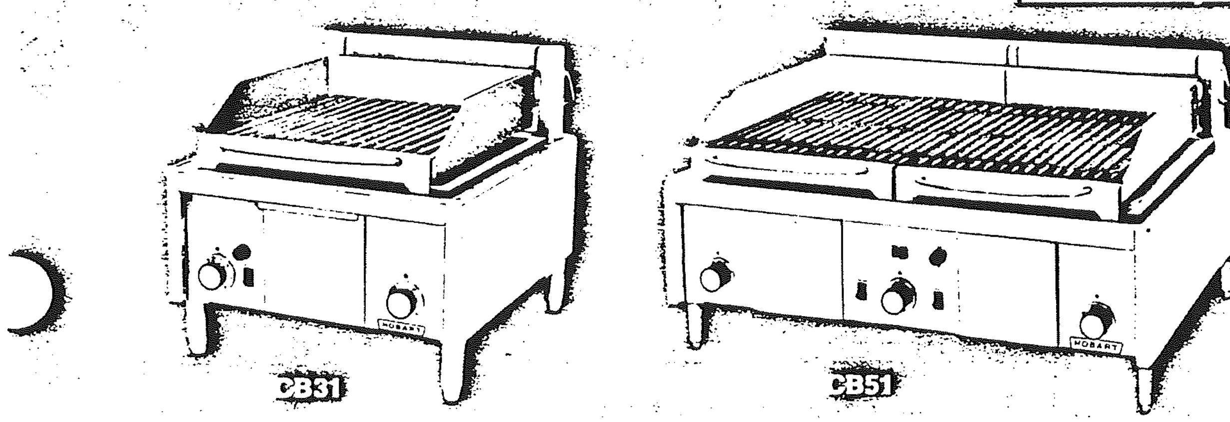
HOBART

FOOD EQUIPMENT

free-standing counter char broilers

CB31 — 1 grid
CB51 — 2 grids

ENERGY GUIDE
Preheat:
CB31 — 5.5 min. to 400F
CB51 — 13 min. to 600F



with exclusive high-temperature pyrolytic cleaning cycle

SPECIFICATIONS

GENERAL: Electric counter-type Char Broilers are free standing models designed for direct grid-to-food product contact. **Model CB31** has a single 16" x 16" grid. **Model CB51,** with two independently operated 16" x 16" grid cooking areas, doubles the capacity of the **CB31.** A single 16"x16" grid preheats to 400F in 5.5 minutes.

CAPACITY: Model CB31: 16" x 16" grid area (256 sq. in.) accepts nine 5" dia. ½" thick hamburger patties per load, produces up to 154 medium-done hamburgers per hour. Device accommodates sixteen 3½" dia. hamburger patties, turning out up to 260 medium done hamburgers per hour. It handles twelve ½" thick strip steaks per load, producing 78-85 steaks (medium-done) per hour. **Model CB51:** With a 16" x 32" grid area (512 sq. in.), the foregoing outputs are doubled by using both grids.

DESIGN: Units mount on removable, adjustable 4" plastic legs (furnished) or on optional 4" stainless steel legs. Exclusive, high-temperature pyrolytic cleaning cycle assures fast, effortless grid cleanup at 10KW; (average imput for broiling foods is 4.8 KW). Both models impart immediate "brand" and "char" to meats without flame or flare-up. **Model CB31** has a single grease drawer, splash guard and funnel-shaped drip receptacle. **Model CB51** has two of each of these items. All are removable for easy cleaning. Drip receptacle(s), positioned beneath grid(s) channels grease into grease drawer(s).

CONSTRUCTION: Heating units are high nickel chromium alloy stainless steel. Grid(s) are polished finish cast iron with cool-to-the-touch lift-up handle(s). Legs are plastic or optional stainless

(specifications continued on reverse)

DESIGN HIGHLIGHTS

- **EASY TO CLEAN** - Exclusive grid design incorporates 900 degree high-temperature pyrolytic self-cleaning cycle. Each drip receptacle, grease drawer and splash guard easily removed for sink cleaning.
- **HIGH RELIABILITY**- Full one-year warranty on tubular heating elements which are shielded and sheltered from exposure to fats, greases and corrosive acids found in many sauces. These drippings cause corrosion and eventual element failure.
- **FLAVOR CHAR BROILING** - True char flavor and grid "brand" are imparted to food. Because of the easy-to-use self-cleaning feature, carry-over taste from such things as burned-on juices and greases is eliminated.
- **EFFICIENT GREASE DRAINAGE** - Funnel-shaped drip receptacle, positioned beneath grid, channels grease into grease drawer.
- **PROTECTIVE FEATURES** - Isolated heating element design prevents flame, flare-up. Top design shields grease drawer from heat; grease temperature remains low. Fused control circuit.

ACCESSORIES

CX354	Set (4) of 4" adjust. s/s legs
CX359	Extra set (4) of 4" adjust. plastic legs
CX403	Stand w/ or w/o casters **(CB31)**
CX404	Stand w/ or w/o casters **(CB51)**

free-standing counter char broilers

GENERAL & DIMENSIONAL DATA

MODEL	OVERALL EXTERNAL DIMENSIONS W		D		H (LESS LEGS)		GRID COOKING AREA		GREASE DRAWER CAPACITY	COOKING CAPACITY (MEATS AT ROOM TEMP.) 3½" DIA., 2½" OZ. HAMBURGERS		8" x 3" x ½" NEW YORK STRIP STEAKS		WEIGHTS SHIP		NET	
	IN.	MM.	IN.	MM.	IN.	MM.	IN.	MM.		MAX. PER HOUR	MAX. PER LOAD	MAX. PER HOUR	MAX. PER LOAD	LBS.	KILOS	LBS.	KILOS
CB31	21	533	23.5	597	16.09	409	16 x 16	406 x 406	5 qts.	260	16	75-85	12	128	58	110	50
CB51	37.5	953	23.5	597	16.09	409	16 x 32	406 x 813	10 qts.	520	32	150-170	24	230	104	215	98

ELECTRICAL DATA

MODEL	TOTAL KW	GRID PREHEAT TIME (FROM COLD START CONTROL AT "HI")	NOMINAL AMPERES PER LINE: 3-PHASE LOADING KW PER PHASE L1-L2	L2-L3	L1-L3	3-PHASE 208 VOLTS L1	L2	L3	240 VOLTS L1	L2	L3	1-PHASE 208 VOLTS	240 VOLTS
CB31	10	5.5 min. to 400F	5.0	0.0	5.0	41.6	24.0	24.0	36.0	20.8	20.8	48.1	41.7
CB51	10	13 min. to 600F	LEFT SIDE			LEFT SIDE			LEFT SIDE			48.1	41.7
			5.0	5.0	0.0	24.0	41.6	24.0	20.8	36.0	20.8		
			RIGHT SIDE			RIGHT SIDE			RIGHT SIDE				
			5.0	0.0	5.0	41.6	24.0	24.0	36.0	20.8	20.8		

Rated voltages: 208, 240 VAC, 1- or 3-phase, 60Hz

(specifications continued)

steel. Units are constructed so that legs need not be used, providing all other applicable NSF standards are followed.

ELECTRICAL: Rated power input is 10 KW(both models). Units are wired for _______ volt _______ phase power supply. See "Electrical Data" block for phase loadings.

CONTROLS: Grid(s) controlled from the front by heavy-duty infinite heat switch(es). Automatic 20-minute cleaning cycle (on the **CB51**, each grid cleaned separately) is initiated by raising grid and actuating timer on front panel. Switch has "OFF," "BROIL" and "CLEAN" settings. Broiling control dial has "LO," "HI," and "OFF" settings. Signal light, located above the broiling control, cycles "ON" and "OFF" during broiling operation.

PROTECTIVE FEATURES: Exclusive top design maintains grease in drawer at low temperature without the need for cooling water. Ambient temperature during burn-off cycle is 300F at approximately 6" directly above grid(s). Grid handle(s) stays cool-to-the-touch with broiler at maximum operating temperature. Foods are broiled without the flame or flare-up characteristics of many char broilers.

UL/NSF REQUIREMENTS: Listed by Underwriters' Laboratories and meets standards of National Sanitation Foundation.

WARRANTY PERIOD: One-year warranty against defects covers parts and labor. See Product Service Guide (66-2774) for full warranty statement.

As continued product improvement is a policy of Hobart Chicago Heights, Inc., specifications may be changed without notice.

HOBART

HOBART CHICAGO HEIGHTS, INC.
14th & Arnold Streets · Chicago Heights, Illinois 60411
A SUBSIDIARY OF HOBART CORPORATION

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Appendix C

STATISTICAL DESCRIPTION OF DATASET

STATISTICAL DESCRIPTION OF DATASET

The frequency distributions of daily production energy consumption and daily on time are shown in Figures C-1 and C-2. Both distributions show very little variation about the mean. Figure C-3 shows the correlation of on time with production-energy consumption. The value of $r = .84$ would probably be much higher in installations where there is a greater variation of on times.

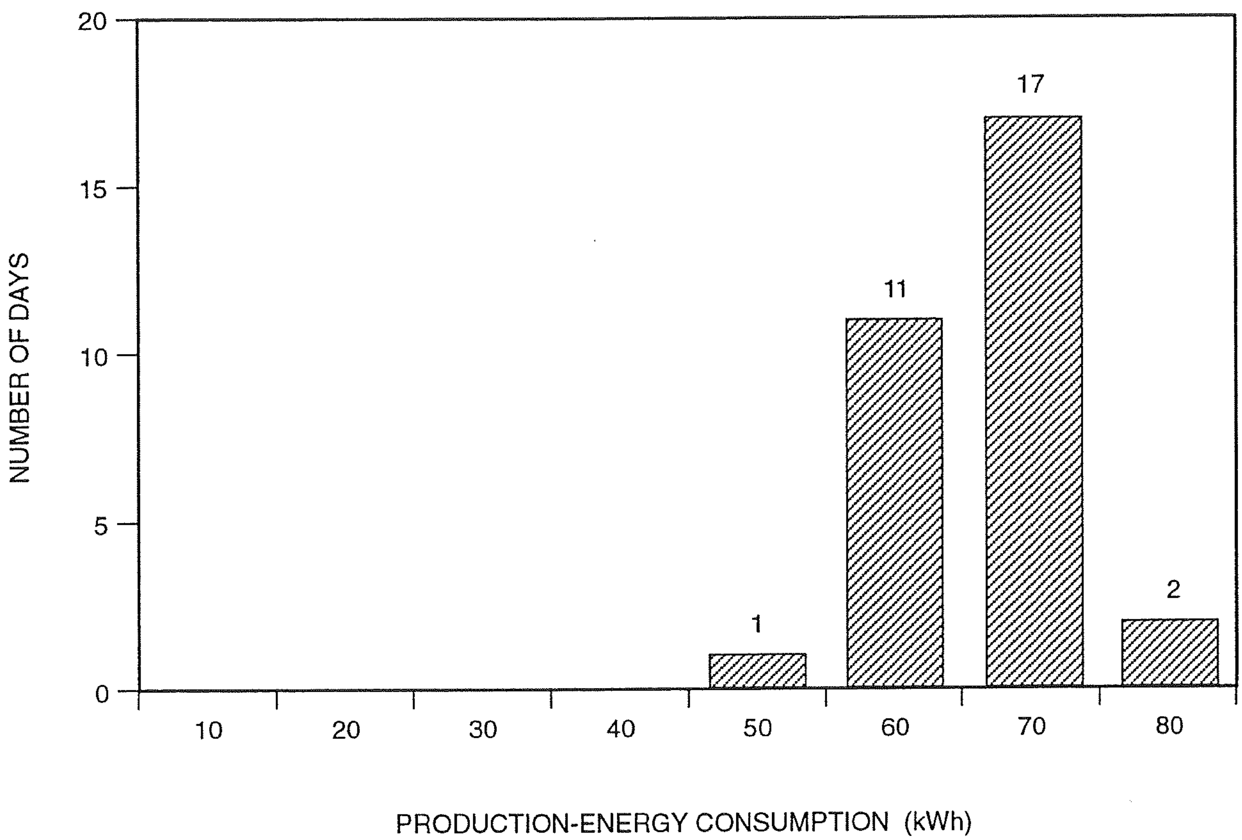


Figure C-1. Frequency of daily production-energy consumption.

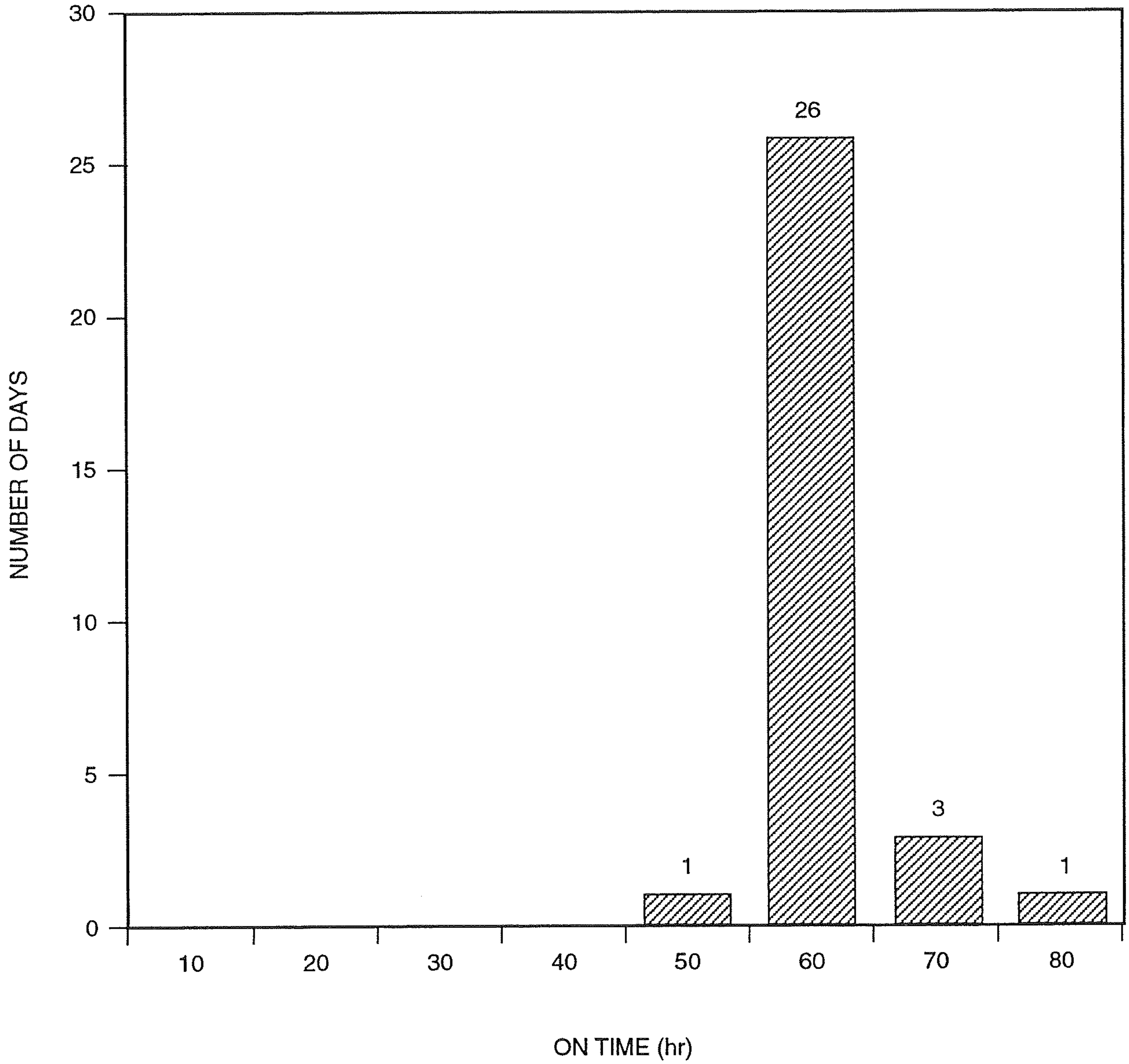
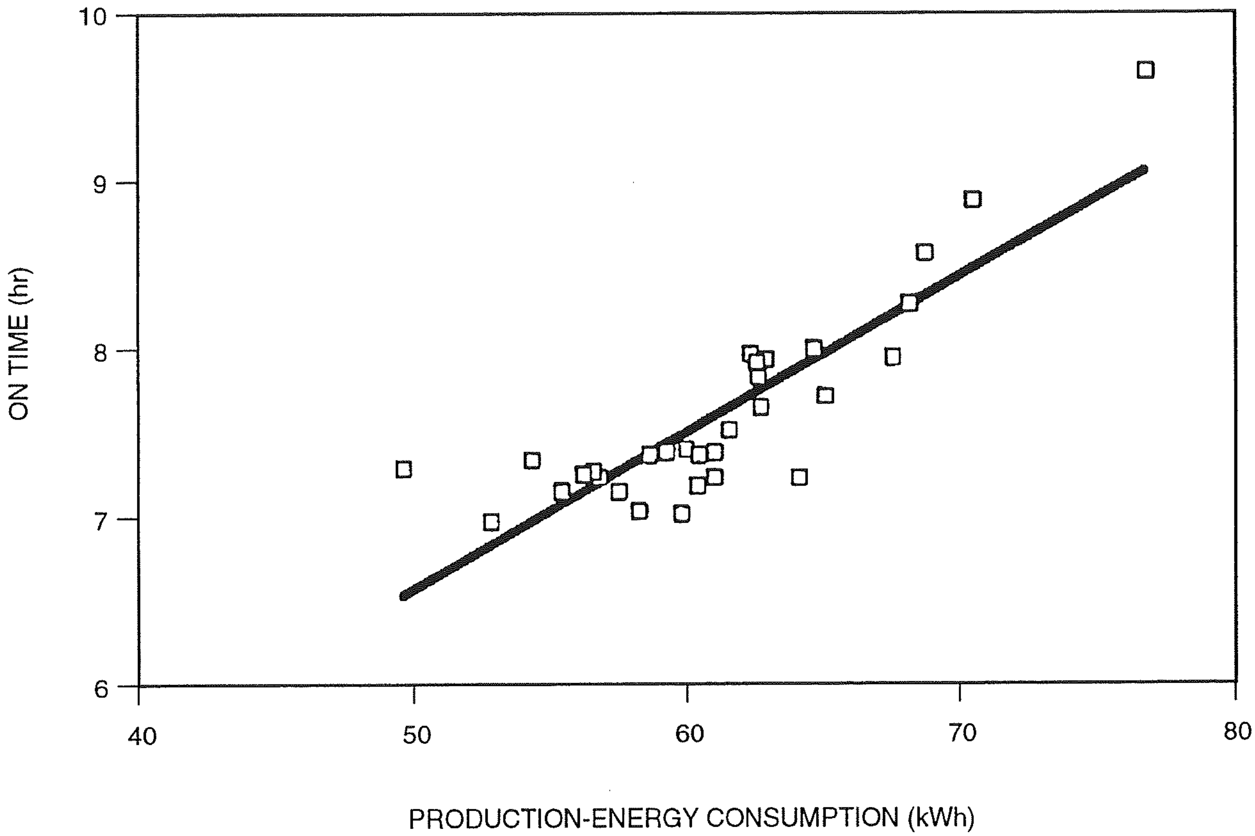


Figure C-2. Frequency of daily on time.



r = .84

Figure C-3. Production-energy consumption vs. on time.

Appendix D

CALCULATION OF ANNUAL ELECTRICITY COST

CALCULATION OF ANNUAL ENERGY COST

APPLICABLE PG&E RATES

The Production-Test Kitchen would be considered a medium-sized food service facility in PG&E's service territory. If it were separately metered, the operator would have a choice of two electrical rate schedules for billing, both of which have a demand charge (See Table D-1). PG&E's rate A-10 is a demand, non-time-of-use rate schedule; rate A-11 is a time-of-use rate schedule that includes two demand charges. (The A-11 rate was discontinued and replaced by the E-19 demand, time-of-use rate schedule.) Table D-1 shows the rates in effect for these two schedules on July 1, 1990.

METHOD

The estimated annual cost of the broiler's energy consumption and the demands it created were determined by calculating their incremental costs above that of the other building electrical loads (lighting, ventilation, air conditioning, refrigeration, and other electrical cooking appliances). The cost of these other loads included both energy and demand charges. All costs were determined by calculating monthly bills using PG&E's rate schedules.

Monthly energy consumption and maximum demand inputs are required to calculate bills using both rate schedules. Rate A-10 requires total monthly consumption; rate A-11 requires monthly consumption totalled by time-of-use periods defined in Table D-1. Both require the "Maximum" demand for the month. In addition, rate A-11 billing requires the "on-peak" demand, which is measured between noon and 6:00 P.M. during the summer season.

It was assumed that the broiler was operating when the "maximum" demand for the month and the "on-peak" demand occurred, thereby contributing to both demands. The average rate of production-energy consumption (8.1 kW) was used for "maximum" demand. The average rate of energy consumption while the broiler operated between noon and 6:00 P.M. was used for the "on-peak" demand. The building and appliance energy values used in the calculation are given in Table D-2.

RESULTS

Table D-3 summarizes the estimated annual energy cost of the broiler for the A-10 and A-11 rate schedules.

Table D-1

Pacific Gas and Electric Company Small and Medium Size Customer Rates[1]

Rate	Season	On-Peak Demand	Maximum Demand	On-Peak Energy	Part-Peak Energy	Off-Peak Energy	Total Energy	Customer Charge	Meter Charge
A-11	Summer	$9.20	$3.30	$0.10344	$0.07904	$0.05305		$63.00	$5.10
	Winter		$3.30	$0.00000	$0.05941	$0.05145		$63.00	$5.10
A-10	Summer		$3.30				$0.09407	$63.00	
	Winter		$3.30				$0.07290	$63.00	

[1]Effective July 1, 1990, "Maximum demand" charge: per kW of maximum demand per month; "On-peak demand" charge: per kW of maximum peak period demand per month.

Time Periods

Summer (May 1 through October 31)

Peak period: 12:00 noon to 6:00 P.M., Monday through Friday (except holidays)
Partial peak period: 8:30 A.M. to 12:00 noon and 6:00 P.M. to 9:30 P.M., Monday through Friday (except holidays)
Off-peak period: 9:30 P.M. to 8:30 A.M., Monday through Friday, all day Saturday, Sunday, and holidays

Winter (November 1 through April 30)

Partial peak period: 8:30 A.M. to 9:30 P.M., Monday through Friday (except holidays)
Off-peak period: 9:30 P.M. to 8:30 A.M., Monday through Friday (except holidays), all day Saturday, Sunday, and holidays

Table D-2

Values Used for Calculation of Broiler Incremental Energy Costs Above Rest of Building Load Costs

Building	
Baseload Demand (kW):	40
Peak Period Energy Used Each Month (kWh):	5,280
Partial Peak Period Energy Used Each Month (kWh):	5,500
Off Peak Period Energy Used Each Month (kWh):	4,400
Broiler	
Peak Period Demand (kW):	7.2
Average Demand (kW):	8.1
Peak Period Energy Used Each Month (kWh):	492
Partial Peak Period Energy Used Each Month (kWh):	784
Off-Peak Period Energy Used Each Month (kWh):	75

Table D-3

Estimated Annual Energy Cost
Hobart Electric Broiler (CB51)

	PG&E Rate Schedule	
	A-10	**A-11**
Appliance load effect on energy charge:	1,354	1,180
Appliance load effect on demand charge - average demand case:	321	718
Appliance load total effect on annual cost:	1,675	1,898

Appendix E

ENERGY MONITORING SYSTEM

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. Electronic pulses are generated by the meter, which measures the flow of electricity or gas to the appliance. Each pulse corresponds to a specific quantity of electric or 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 noninteger 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.