Appliance Performance in Production: Blodgett Model DFG-50 Gas Half-Size Convection Oven

Customer Systems

Report 008.1-91.11

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Appliance Performance in Production: Blodgett Model DFG-50 Gas Half-Size Convection Oven

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

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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 the Blodgett Oven Company, Inc., for supplying PG&E with a half-size convection oven for installation 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

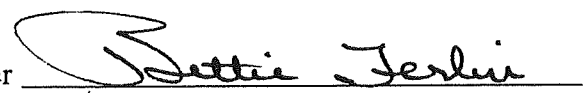
The objective of this report is to describe the energy-use patterns of the Blodgett DFG-50 gas convection oven as it was used for routine menu production in PG&E's Production-Test Kitchen from September 19, 1988 to September 28, 1989. The results of this report are based on the analysis of data for 205 days, during which time three meals were served each day.

The model DFG-50, rated at 34.5 kBtu/h, is a free-standing, half-size convection oven designed to circulate a portion of its flue products to recover usable energy. On average, the oven was operated four hours per day, which resulted in a daily energy consumption of 55.2 kBtu. For the days included in the analysis, an average of 21 pounds of food were cooked per day, and the average daily customer count for the dining facility was 392. During its daily operation, which included periods of preheat, cooking, and idle, the oven consumed gas at an average rate of 13.8 kBtu/h—approximately 43% of its rated input.

To supplement monitoring information acquired during production when uncontrolled conditions prevailed, a controlled energy test was done on the empty oven operated at 350°F. The test results showed that 5.9 kBtu of gas were consumed over 10.9 minutes during the preheat period. Energy was consumed at a rate of 7.6 kBtu per hour during the 2-hour idle period that followed.

Based on a 5-day food service operation, it was estimated that the oven would consume 138 therms per year, costing $79. This cost was calculated using PG&E's applicable commercial gas rate (in effect January 1, 1992), which would apply if the Production-Test Kitchen were metered separately.

The model DFG-50 was the second half-size convection oven to be monitored in the Production-Test Kitchen. The first was the Baker's Pride model X-300 electric oven rated at 9.9 kW.

Project Manager 
Bettie Ferlin

Research Director 
David A. Christensen

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Section 1

INTRODUCTION

The Blodgett gas convection oven was selected for production-energy monitoring and performance evaluation for the PG&E Production-Test Kitchen research program. It was used for routine menu production in the PG&E food service operation for 12 months from September 19, 1988 to September 28, 1989. Terms used in this report are defined in Appendix A.

OBJECTIVE

The objective of this appliance performance report is to describe the basic energy consumption characteristics of the Blodgett half-size gas convection oven and its consumption patterns during 12 months of operation in the PG&E Production-Test Kitchen. This report also describes how the oven was used and the relationship of its energy consumption to its operating characteristics while in "production." It is important to recognize that the information presented is specific to PG&E's Production-Test Kitchen, a corporate, cafeteria-style food service operation.

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.

APPLIANCE DESCRIPTION AND INSTALLATION

A summary of the oven specifications is presented in Table 1-1, and a copy of the manufacturer's specification sheet is provided in Appendix B. A detailed description of the cooking modes and controls is in Appendix C.

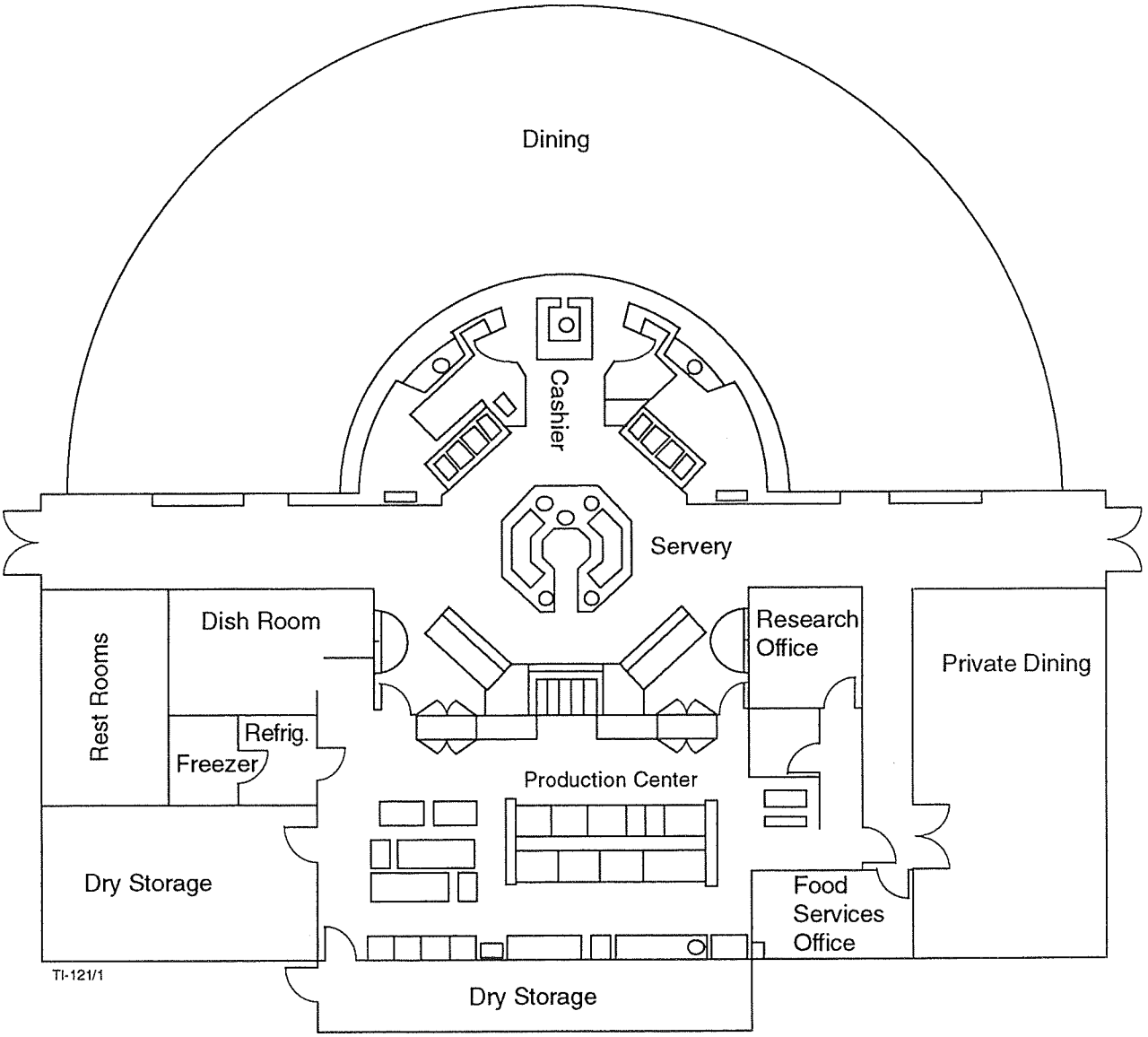


Figure 1-1. Dining facility, PG&E Learning Center.

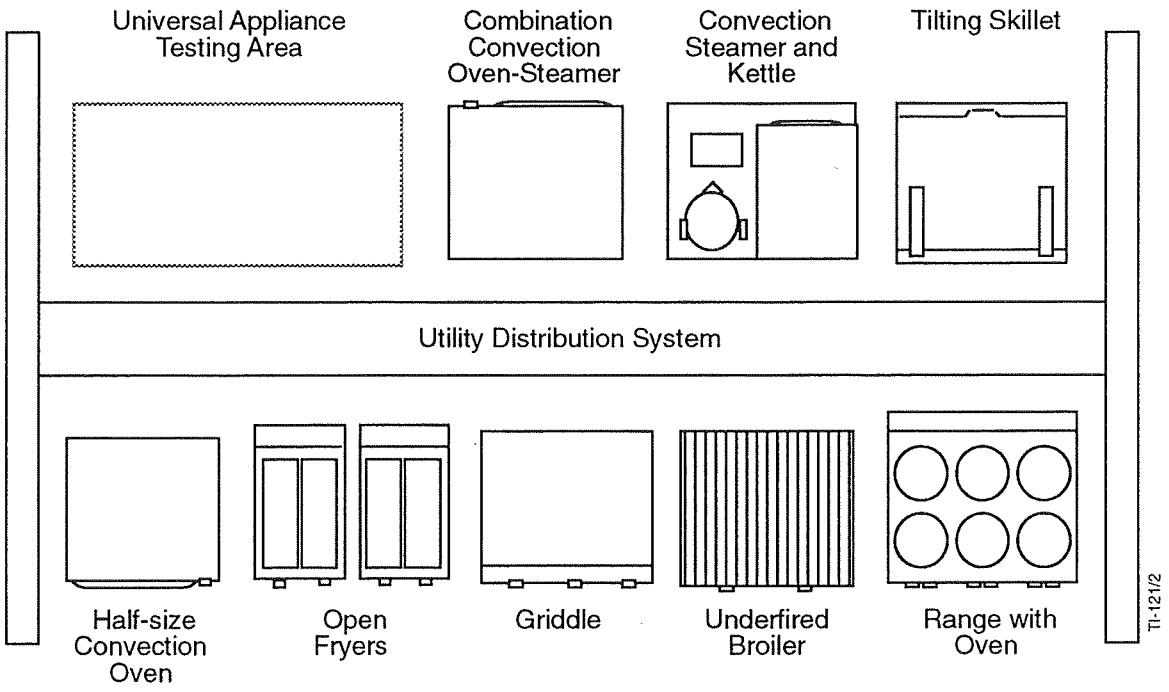


Figure 1-2. The production center.

Table 1-1

Appliance Specifications

Manufacturer:	Blodgett Oven Company
Model:	DFG-50
Generic Appliance Type:	Convection Oven
Rated Energy Input:	34,500 Btu/hour
Dimensions:	30-1/4 inches wide 25-1/8 inches deep 35-13/16 inches high (w/o legs & casters)
Oven Cavity:	15-1/4 inches wide 21 inches deep 20 inches high 3.7 cubic feet Space to hold 9 racks with a minimum spacing of 1-5/8 inches
Special Feature:	Heat transfer to oven cavity is by both indirect and direct means. Heat enters cavity by indirect means through oven walls as in standard convection oven. The "Dual Flow" design causes a portion of combustion products to circulate through the oven cavity (direct means) to extract a portion of the heat that would normally be lost up the flue.
Suggested Retail Price:	$4,180 as of May 1992

Section 2

CONTROLLED ENERGY TEST

PURPOSE

The controlled energy test was conducted to measure the following operating characteristics of the oven:

- Peak energy input rate
- Preheat time
- Preheat energy consumption
- Idle energy consumption rate

METHOD

The oven temperature was set at 350°F. The oven was turned on, allowed to preheat, and then idle for two hours. The oven was empty and the door was kept closed for the duration of the test.

RESULTS

Test results are shown graphically in Figure 2-1, while the oven operating characteristics are shown in Table 2-1. The idle energy factor was obtained by dividing the idle-energy consumption rate by the measured energy input rate.

Table 2-1

Summary of Controlled Energy Test

Rated Energy Input Rate (kBtu/h):	34.5
Measured Energy Input Rate (kBtu/h):	32.3
Preheat (@ 350°F):	
Time (min):	10.9
Energy (kBtu):	5.9
Idle Energy Consumption Rate (kBtu/h @ 350°F):	7.6
Idle Energy Factor (%):	23.6

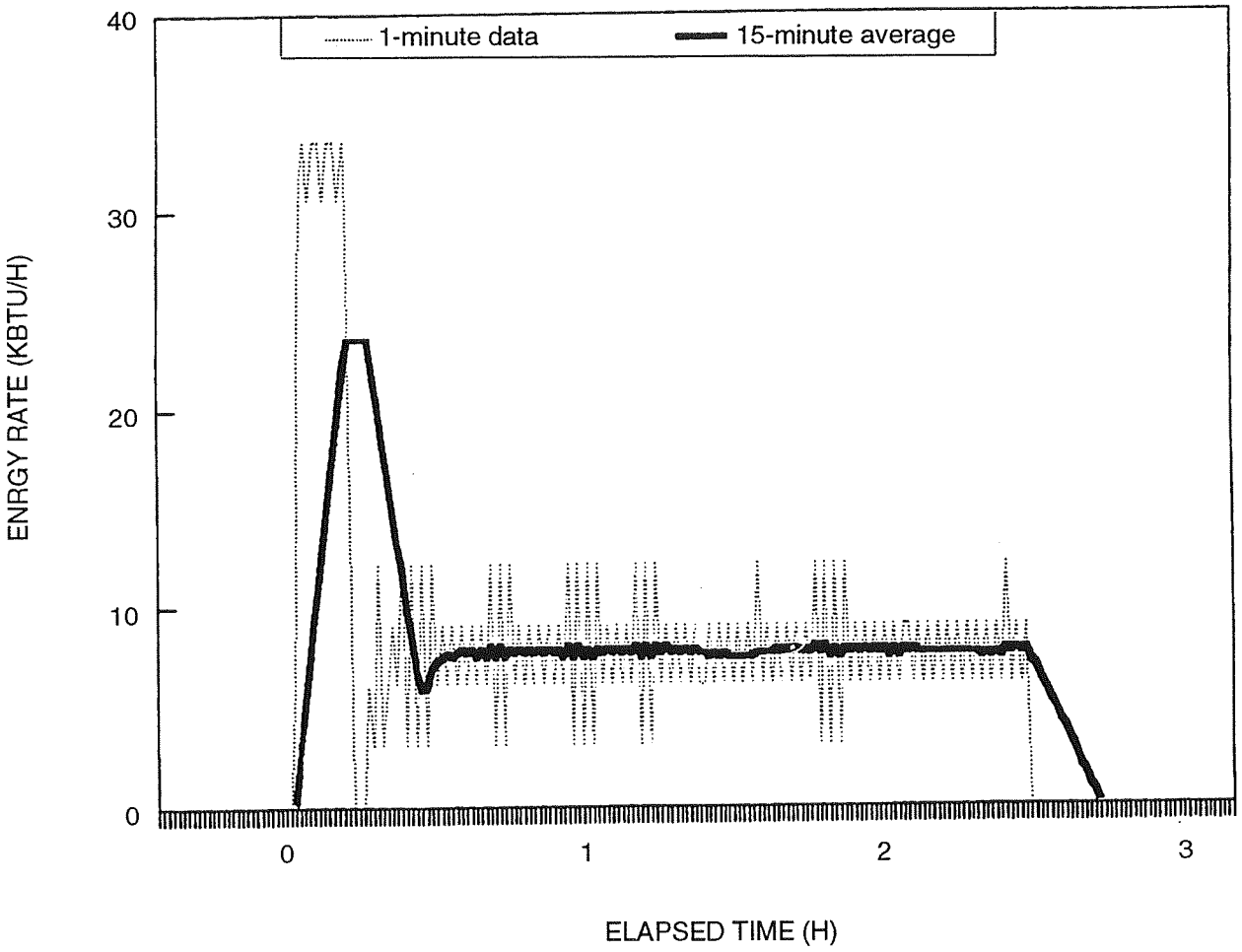


Figure 2-1. Controlled energy test.

Section 3

PRODUCTION MONITORING

ENERGY

Daily Consumption

The daily energy consumption data set for the oven consisted of 205 days. The data set includes Mondays through Thursdays only. Fridays, Saturdays, and Sundays were excluded because they were not typical of three meal per day food service in this kitchen.

Based on analysis of this data set, a summary of "typical" daily production energy use for the oven is presented in Table 3-1. The average production energy consumption rate is the total production energy consumption for the 205-day period described above, divided by the total operating hours for the same period. The production energy factor was calculated by dividing the average production energy consumption rate by the measured energy input rate.

Table 3-1

Summary of Daily Production Energy Use

Measured Energy Input Rate (kBtu/h):	32.3
Average Daily Energy Use (kBtu/d):	55.2
Average Daily Operating Hours (h/d):	4.0
Average Production Energy Consumption Rate (kBtu/h):[1]	13.8
Production Energy Factor (%):	42.7

[1]Includes preheat energy and idle energy over the day's operation.

March 8,1989, was chosen to represent typical oven use because the daily energy consumption, operating hours, and average production energy consumption rate closely matched the average values shown in Table 3-1. The energy consumption profile for the oven on this day is plotted in Figure 3-1.

Statistical Description. A statistical description of the daily energy consumption and operating hours is presented in Figures 3-2 and 3-3, respectively. These figures show the how frequently various values of daily energy consumption and operating hours occurred on the days included in the data set.

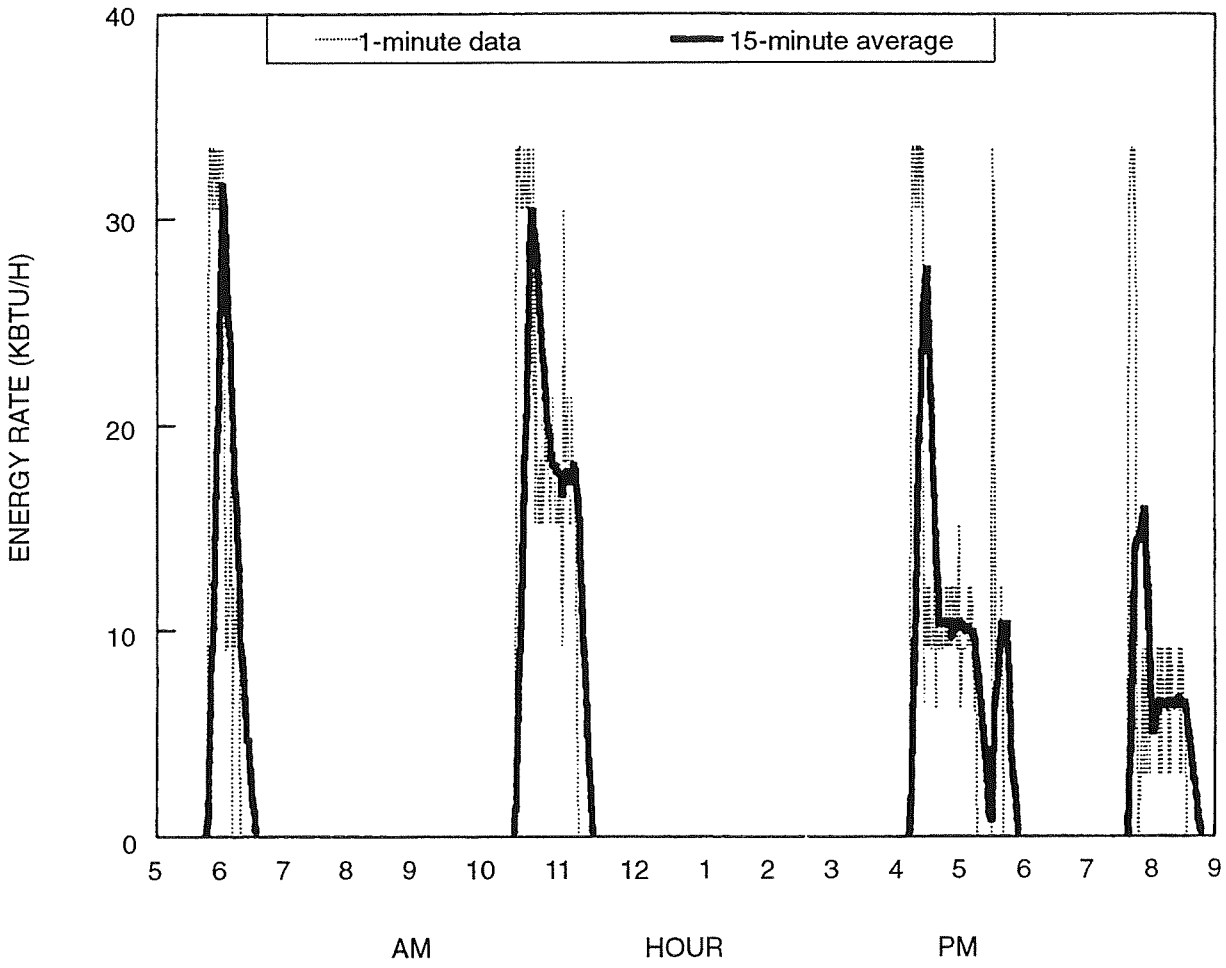


Figure 3-1. Typical day energy consumption profile.

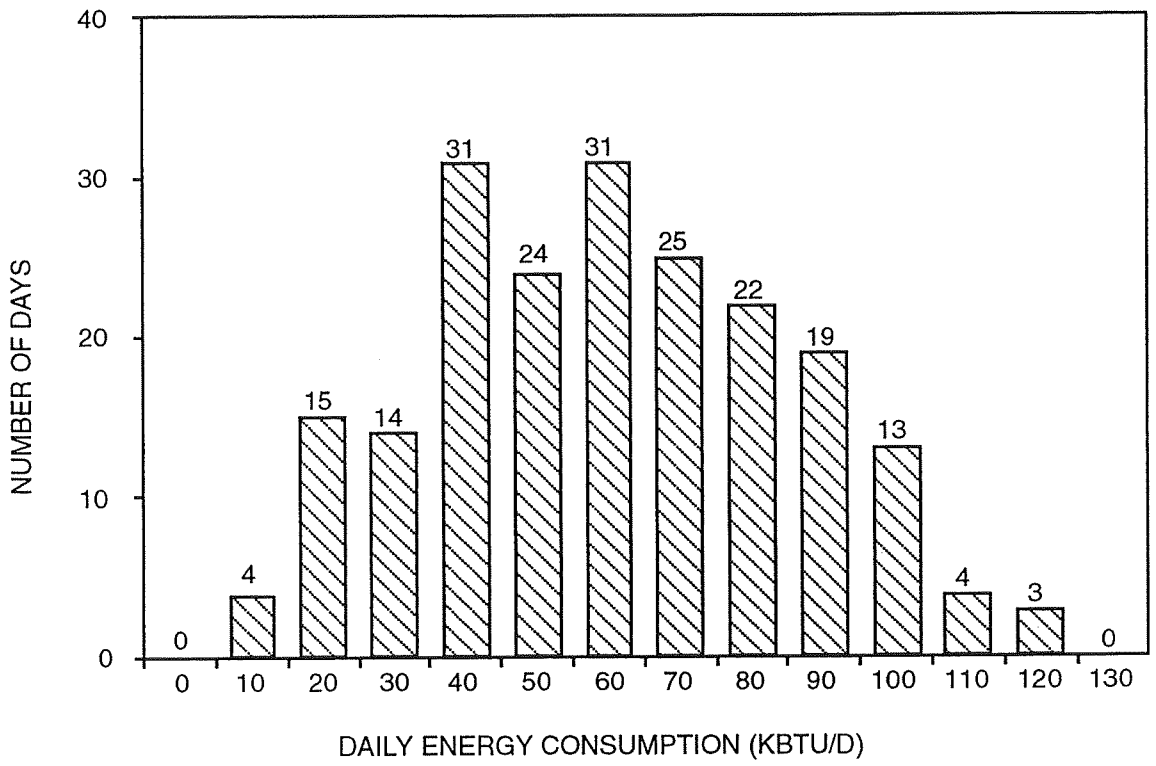


Figure 3-2. Frequency of daily energy consumption.

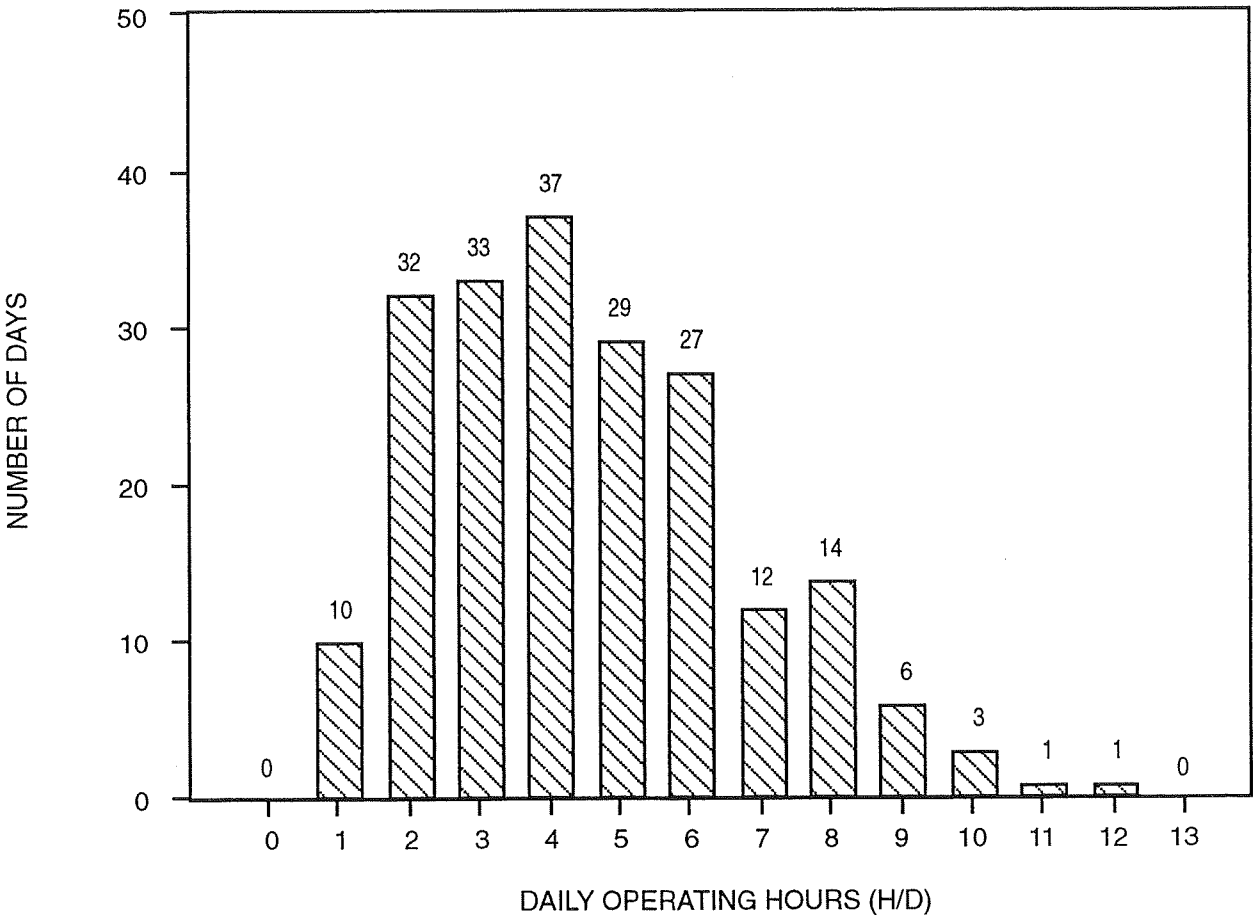


Figure 3-3. Frequency of daily operating hours.

These figures show that, for approximately 70% of the days, the oven's daily energy consumption varied from 30-80 kBtu/d, while daily operating hours varied from 1.7 to 6.3 h/d.

Average Production Energy Consumption Rate

Figure 3-4 shows the frequency distribution of the average production energy consumption rate for the oven. This variable ranged from 11-19 kBtu/d for 70% of all the days in the data set.

The daily energy consumption correlated with the daily operating hours, quantity of food cooked daily, and the daily customer count for the dining facility. However, only operating hours contributed significantly to daily energy consumption. See Appendix D.

Energy Consumption and Cost

Based on a five-day per week food service operation, it is estimated that the oven would consume 13,800 kBtu, or 138 therms per year. The associated annual energy cost of $79 per year, shown in Table 3-2, was projected using a seasonal average of PG&E's gas rate for small commercial customers (Appendix F).

Table 3-2

Estimated Annual Energy Consumption and Cost

Energy Consumption:		
55.2 kBtu/d x 5 d/wk x 50 wk/yr	=	13,800 kBtu/yr
13,800 kBtu/yr x 1 therm/100 kBtu	=	138 therms/yr
Estimated Annual Energy Cost:		
138 therms/yr x $0.57/therm	=	$79/yr

Note: Estimated annual energy consumption is based on PG&E's G-NR1 rate schedule, effective January 1, 1992.

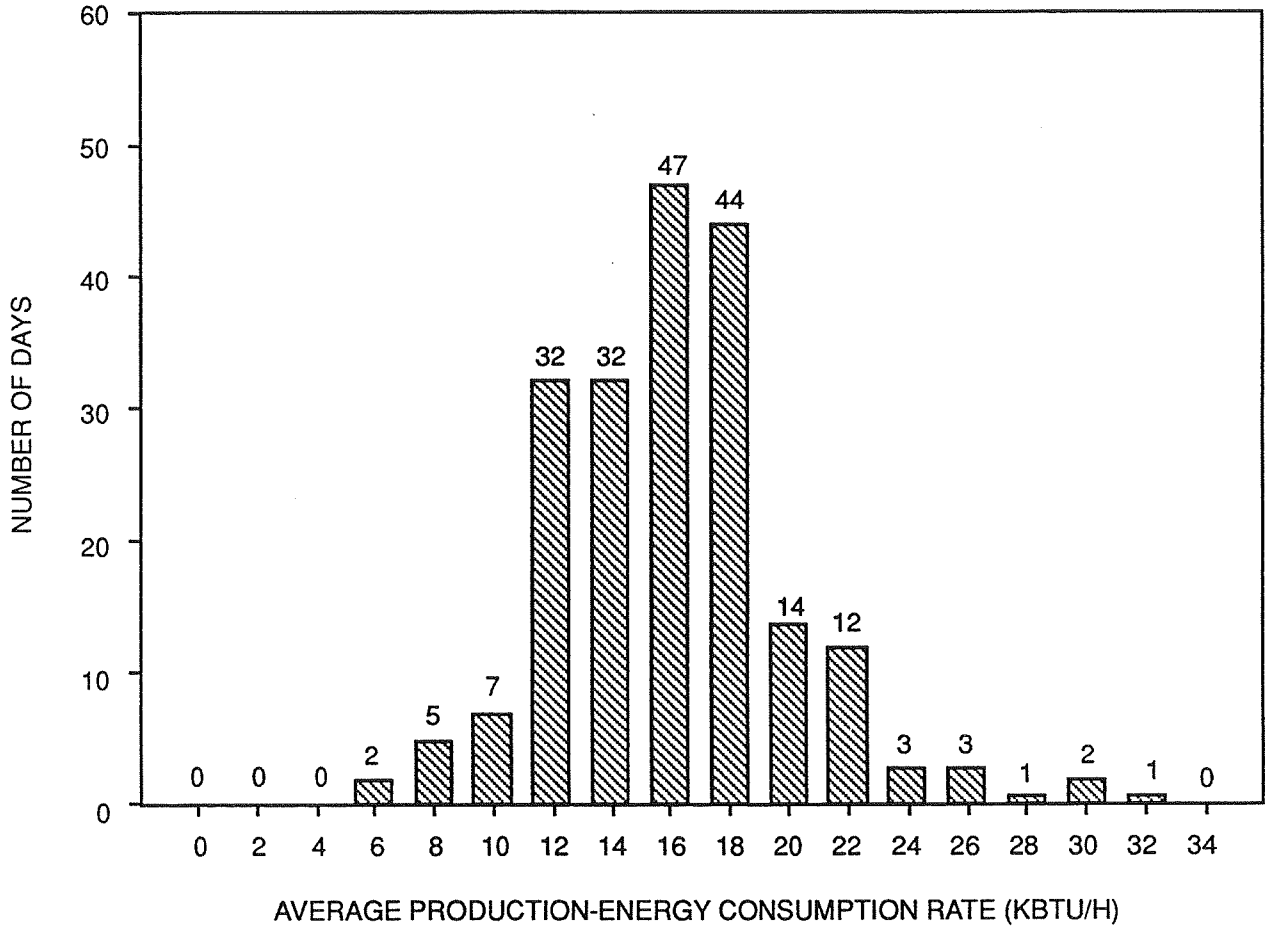


Figure 3-4. Frequency of average production-energy consumption rate.

FOOD

Items Cooked

For breakfast, the oven was used mostly to cook sausage and biscuits. The cooks occasionally used it to cook bacon and to prepare coffee cake. A variety of food was prepared for lunch; potatoes (baked, oven-browned), chicken, and rice (fried and Spanish) were the foods prepared most frequently. Other foods prepared included quiche, corn pudding, lasagna, turkey dressing, and canned yams. For dinner, the oven was used to precook ribs and to finish pork chops, fish, half chickens, and eggplant parmesan. It was also used to bake scalloped potatoes and lasagna and to warm plates.

Quantity Cooked

The following summarizes information regarding the quantity of food cooked in the oven for 128 days:

Quantity of food cooked daily (lb/d): Average: 21; Range: 1 to 108

Daily energy consumption (kBtu/d): Average: 54.8; Range: 7 to 109

Bacon or sausage prepared for breakfast was the only food cooked in the oven on low production days (i.e., 10 lb/d or less). In contrast, on high production days (i.e., 100 lb/d or more) baked potatoes, biscuits, cookies, yams, and eggplant parmesan were cooked in addition to bacon or sausage.

Although the quantity of food cooked daily correlated with the daily energy consumption, its effect on consumption was small when compared to that of daily operating hours. The oven's daily energy consumption, which consists of energy for preheating, idling, and cooking, varied greatly with quantities of food cooked daily and daily customer count. (Appendix E: Figures E-2 and E-3). This, coupled with the fact that the oven's operating hours were significantly longer on many days than the time required to cook the food, leads to the conclusion that a significant portion of each day's consumption consisted of energy used for preheating and idling the oven. The quantity of food cooked, however, can only be related to the cooking energy consumed each day. So, the oven's daily energy consumption was only partially affected by the quantity of food cooked.

Customer Count

The following summarizes information regarding the quantity of food cooked in the oven for all of the days included in the data set:

Daily customer count (Customers/day): Average: 392; Range: 9 to 962

Daily energy consumption (kBtu/d): Average: 55.2; Range: 6 to 112

As with the quantity of food cooked, the daily customer count correlated with the daily energy consumption; yet its effect on consumption was smaller than that of quantity of food cooked daily. As discussed above, daily energy consumption was significantly affected by oven preheating and idling. As with the quantity of food cooked daily, there is no relationship between the daily customer count and the number of oven preheats or the number of hours the oven idled. Also, like the quantity of food cooked daily, the customer count could only be related to the amount of energy used daily for cooking. Therefore, the oven's daily energy consumption was also only partially affected by the daily customer count.

Observation Day

The operation of the half-size convection oven was observed throughout the production day on Thursday, June 7,1990, to document how it was used by the kitchen staff and how this use affected the oven's energy consumption. A detailed chronological summary of this observation day is presented in Appendix G.

On the observation day, the number of customers served was 546: 117 at breakfast, 321 at lunch, and 108 at dinner. The oven was used to cook sausage and biscuits for breakfast, to cook rice and meat loaf for lunch, and to cook barbecued ribs as well as to heat plates for dinner. Sausage and biscuits were cooked at 375°F, the rice and meat loaf at 350°F, and the barbecued ribs at 310°F. The oven temperature was kept at 380°F for plate warming and for finishing steaks.

The oven consumed 106 kBtu during the day. Approximately 22% was used for cooking breakfast, about 28% for lunch, and 50% for dinner. Energy consumption for the observation day was significantly higher than the average of 55.2 kBtu/d during the monitoring period. The oven was operated empty for approximately 20 minutes during the day, consuming approximately 2.5 kBtu of energy unnecessarily. The remainder of the energy consumption was used for cooking, causing the oven to be operated more hours (8 hours vs. 4 hours on the average day). The increased oven operating hours caused the oven energy consumption to be almost twice that of the average day. This increased operating time was due partly to more food being cooked (30 lb vs. 21 lb on an average day) and partly because the oven was kept at 380°F, ready to finish steaks at dinner.

A higher daily energy cost would be attributed to this increased consumption. If this oven were operated at this daily consumption rate in a five-day food service operation, the energy consumed would cost $3 per week, or $156 per year.

Section 4

CONCLUSIONS

CONTROLLED ENERGY TEST

The Blodgett half-size gas oven performed well in the Production-Test Kitchen. Typically, the oven was used in the morning to cook sausages and biscuits; at lunch to prepare a variety of baked foods such as potatoes, chicken, lasagna, and quiche; and in the evening to finish steaks cooked on the broiler and to warm plates. The application of the oven was considered light duty in this cafeteria-style food service operation.

Measured Energy Input Rate

The controlled energy test showed that the measured energy input rate was equal to the rated input.

Preheat Energy and Time

During the controlled energy test, the oven preheated in 10.9 minutes and consumed 5.9 kBtu. The test was performed at a 350°F oven temperature setting.

PRODUCTION ENERGY MONITORING

Energy consumption, operating hours, and rate of energy consumption varied considerably throughout the monitoring period. For approximately 70% of the days considered in the analysis, the oven was operated between 1.7 and 6.3 hours and consumed between 30 and 80 kBtu of gas per day at a rate that ranged from 11 to 19 kBtu per hour. On average for all days considered, the daily operating hours and energy consumption was 55.2 kBtu and 4.0 hours, respectively. For all days, the average rate of energy consumption was 13.8 kBtu/h.

Energy Use Correlation

The daily energy consumption correlated with the operating hours, quantity of food cooked daily, and the daily customer count for the dining facility. However, changes in daily energy consumption were most significantly affected by changes in the oven's daily operating hours. Changes in either the quantity of food cooked daily or the daily customer count caused a much smaller change in daily consumption since daily consumption was significantly affected by energy consumed each day for preheating and idling the oven as well as for cooking. It was only partially affected by the quantity of food cooked and customer count because these factors do not affect the preheat and idle energy consumption.

Energy Factors

The controlled energy test showed that the idle energy factor was 23.6%. The production energy factor was 42.7%.

Annual Energy Consumption and Cost

It was estimated that the oven would consume 138 therms of gas in a 5-day food service operation. This corresponds to an annual cost of $79 at applicable PG&E gas rates in effect on January 1, 1992.

FOOD PRODUCTION MONITORING

Observation Day

Energy consumption on the observation day (106 kBtu) was significantly higher than the average for the monitoring period (55.2 kBtu/d). This was due to increased oven operating hours (8 hours vs. 4 hours on the average day), which can be attributed to cooking more food in the oven on this day. Although the oven was left on while empty for about 20 minutes, only about 2.5 kBtu were consumed. If the oven were to consume energy at this daily rate in a five-day food service operation, the energy cost would be $3 per week, or $156 per year.

The oven temperature setting range from 310°F to 375°F for cooking. Dinner plates were warmed at 380°F. The customer count for the day was 546.

Section 5

REFERENCES

1. Pacific Gas and Electric Company. 1990. *PG&E Production-Test Kitchen: Cooking Appliance Performance Report.* Final Report No. 008.1-90.8. Prepared for the Department of Research and Development. San Ramon, California: Pacific Gas and Electric Company.

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

General Specifications for

BLODGETT Ovens
Since 1848

DUAL-FLOW GAS*

MODELS DFG-50 AND DFG-52
COUNTER SIZE CONVECTION OVENS
GAS FIRED

STANDARD EXTERIOR FINISH: Shall consist of #430 STAINLESS STEEL front, #3 finish and a dull heat resistant black enamel finish on the top, sides and back of oven.

CONTROL PANEL: Shall be of a modular type with individual control markings on durable black LEXAN. Panel to be hinged for easy access.

STANDARD BAKING COMPARTMENT INTERIOR: Including baffle to be of PORCELAIN-ENAMELED STEEL. Dimensions 15¼" (387mm) wide, 20" (508mm) high and 21" (533mm) deep. Combustion chamber to be of aluminized steel with stainless steel deflector. The combining of superheated air and oven temperature air shall be accomplished by means of a DOUBLE INLET BLOWER WHEEL located behind the oven compartment baffle, prior to entering the baking chamber.

INSULATION: Top, back and sides to be insulated with 1" (25mm) bottom ½" (13mm) high temperature mineral fiber sheet.

DOOR AND HANDLE: A single handle mounted on the right hand side of the door shall open to a horizontal plane up to 180°. Doors shall have a dual pane thermal window of tempered glass.

RACKS AND RACK SUPPORTS: Standard racks and rack supports shall be of a bright chrome plated steel wire, capable of holding 9 racks with a minimum of 1⅞" (41mm) spacing. Standard sections shall have 5 wire racks, 14⅜" × 20⅞" (365mm × 530mm).

VENTING: This oven is heated both directly and indirectly, due to the recirculating of heated air. Products of combustion are finally vented through a flue vent located at the right rear of each section.

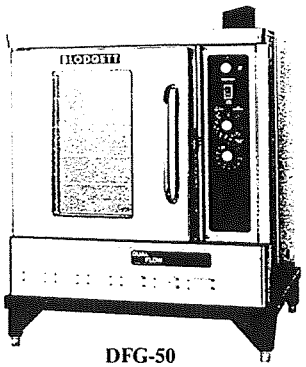
THERMOSTAT: Shall be an infinite setting solid state thermostat with temperature control. Range shall be 200°F (93°C) to 500°F (260°C).

IGNITION SYSTEM: Main burner ignition shall be achieved by a pilot burner operating through an electronic proven pilot spark ignition control system.

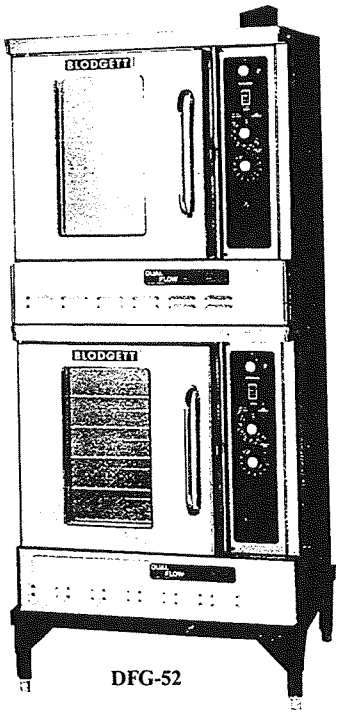
BURNER AND AIR MIXER: Each section shall have one easily removable duplex tube burner with a rated total input of 27,500 BTU per hour. Increased input (Optional) of 34,500 BTU per hour is available. Air mixer shall have an adjustable air shutter. Oven furnished with pressure regulator and manual gas service shut-off valve located in front control area, for easy serviceability.

TIMER: Each section to be supplied with a 60-minute electric COOK TIMER with buzzer.

ELECTRICAL COMPONENTS: Each section shall be equipped with a ¼ HP blower motor with automatic thermal overload protection and a control area cooling fan. Each section shall have a MODE/POWER SWITCH; COOL DOWN SWITCH to operate blower with oven door open; INTERLOCK SWITCH to automatically shut off blower upon door opening. Standard section wired 115 VAC single phase with cord set.



DFG-50



DFG-52

LISTINGS: Oven designs are certified by A.G.A. and C.G.A., and NSF listed.

OPTIONAL EXTRAS AT ADDITIONAL COST:

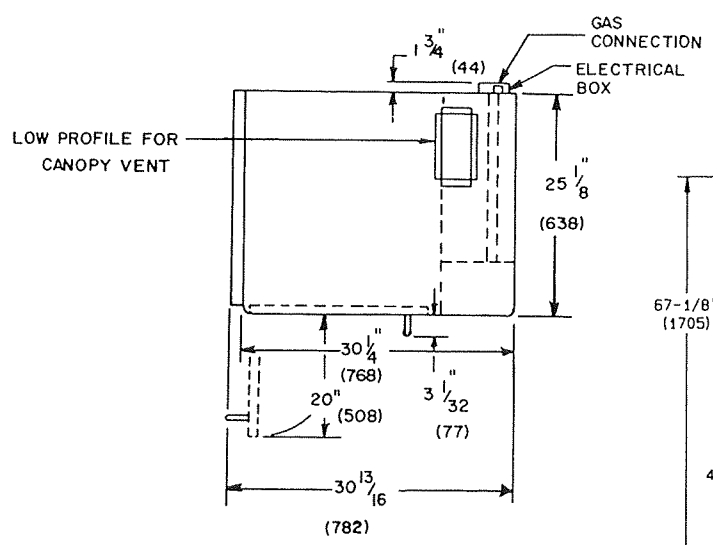
____ Stainless steel top, sides and back (430, #3 finish).
____ Decorator Color on top, sides and back. Available Decorator Colors: Mandarin Red, Coppertone and Platinum Gray.
____ Stainless steel right or left side ONLY.
____ Stainless steel top ONLY.
____ Extra racks.
____ 5¾" (146mm) stand, stainless steel.
____ 7" (178mm) stand, stainless steel.
____ 33" (839mm) stand, painted.
____ 33" (839mm) stand, stainless steel.
____ Swivel casters (2 locking) 6" high for mounting with stands.
____ Fan delay w/Pulse Plus.
____ 8 set point solid state thermostat.

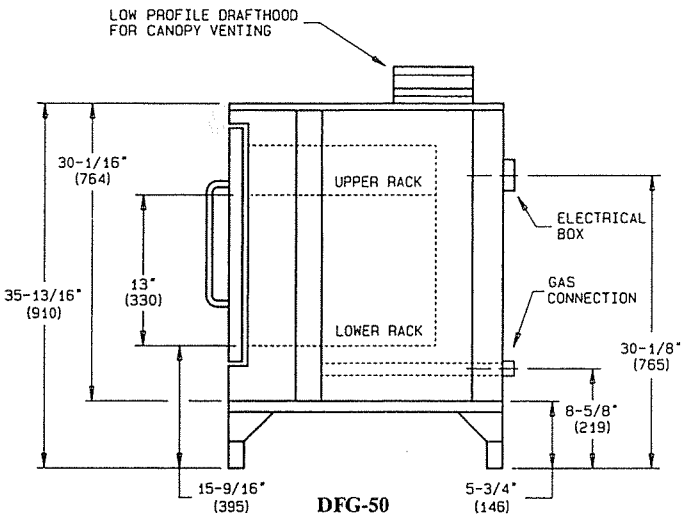
OPTIONAL EXTRAS AT NO ADDITIONAL COST:

____ Solid doors (recommended for oven used for roasting).
____ Increased input 34,500 BTU per hour.

*U.S. Patent No. 4,516,012

MODELS DFG-50 AND DFG-52 GAS FIRED CONVECTION OVEN





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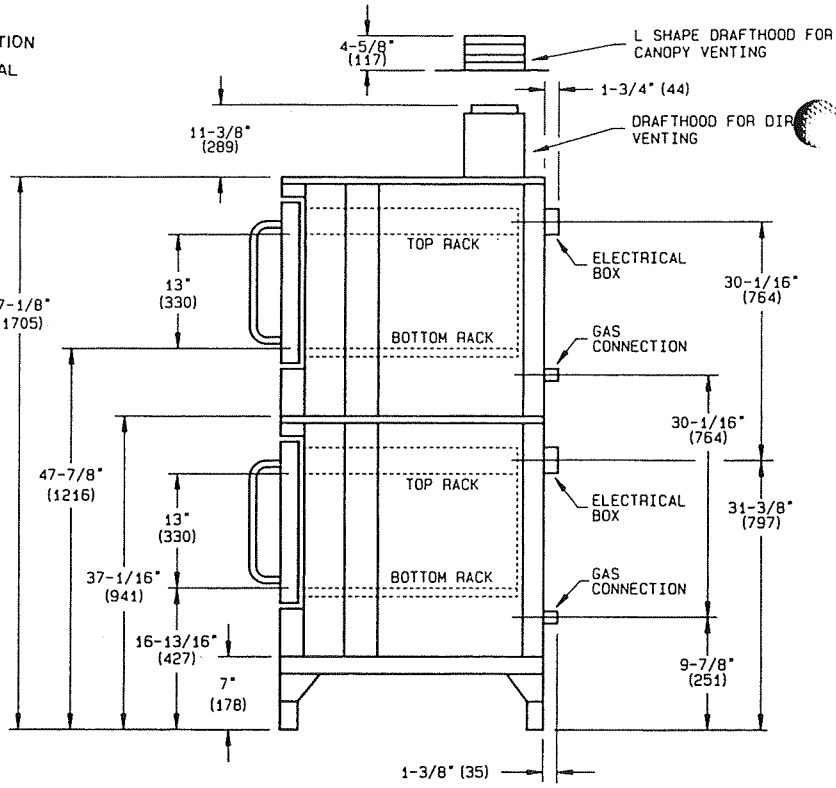


DFG-52

Note: Minimum spacing between racks in 1⅜" (41mm)

ALL DIMENSIONS ARE BOTH INCHES AND MILLIMETERS

½" IPS gas connection at rear of oven.
6 ft. (1.8m) electric cord set furnished on 115 VAC ovens only.
Oven installation requires minimum clearance of 6 inches from combustible and non-combustible construction.

PLEASE SPECIFY WHETHER OVEN IS TO BE DIRECT FLUED OR VENTED UNDER A CANOPY WITH MECHANICAL EXHAUST SYSTEM.

Floor space	30 13/16" (782mm) wide × 25⅛" (638mm) deep
B.T.U. per hour	27,500 or 34,500
Motor single speed	¼ H.P. 1725 RPM
Minimum entry clearance	28" (711mm) (uncrated)
	32½" (826) (crated)
Approx. Shipping weight (crated)	312 lbs. (142kg)
Crate Size	32½ × 36 × 34½ (826mm × 914mm × 645 mm)

ELECTRICAL RATINGS

115 VAC, 60Hz. 1 phase, 5 AMPS, 1725 RPM
(For other electrical requirements contact factory)
Note: Motor available for most 50Hz. current.

BLODGETT OVEN COMPANY 50 Lakeside Avenue, Box 586, Burlington, Vermont 05402 USA
Telephone (802) 658-6600 Cable: BLODOVEN Telex: 954645 FAX: (802) 864-0183
A Division of G. S. Blodgett Corporation

GL 192N 2/90

Appendix C

DETAILS OF APPLIANCE OPERATION

DETAILS OF APPLIANCE OPERATION

BASIC COOKING MECHANISM

Heat is transferred to the oven cavity air in two ways. It is first transferred through the oven walls from the combustion products. Then, part of the combustion products are drawn into the cavity where they are mixed with the cavity air, releasing an additional amount of heat before being exhausted through the vent.

Heat is transferred to the food product by forcing heated air over it and by radiation from the hot oven cavity walls.

COOKING PRODUCTION CAPABILITY

The oven can be used for roasting meats and poultry, baking fish, seafood, potatoes, bread, rolls, cookies, cakes and pies. It can also be used to defrost and rethermalize previously prepared foods.

CONTROL SYSTEM DESCRIPTION

Power to the oven control panel is controlled by a "MODE/POWER" switch. The fan can be manually controlled for rapidly cooling the oven or automatically started or stopped by closing and opening the door. The fan is single speed. The oven air temperature is maintained between 200°F and 500°F by a solid state thermostat. An oven ready light glows until the air temperature reaches the temperature selected by the operator. A 60-minute manual timer can be used to remind the operator to remove food from the oven when it buzzes. The oven has an electronic ignition.

Appendix D

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.

Appendix E

STATISTICAL DATA

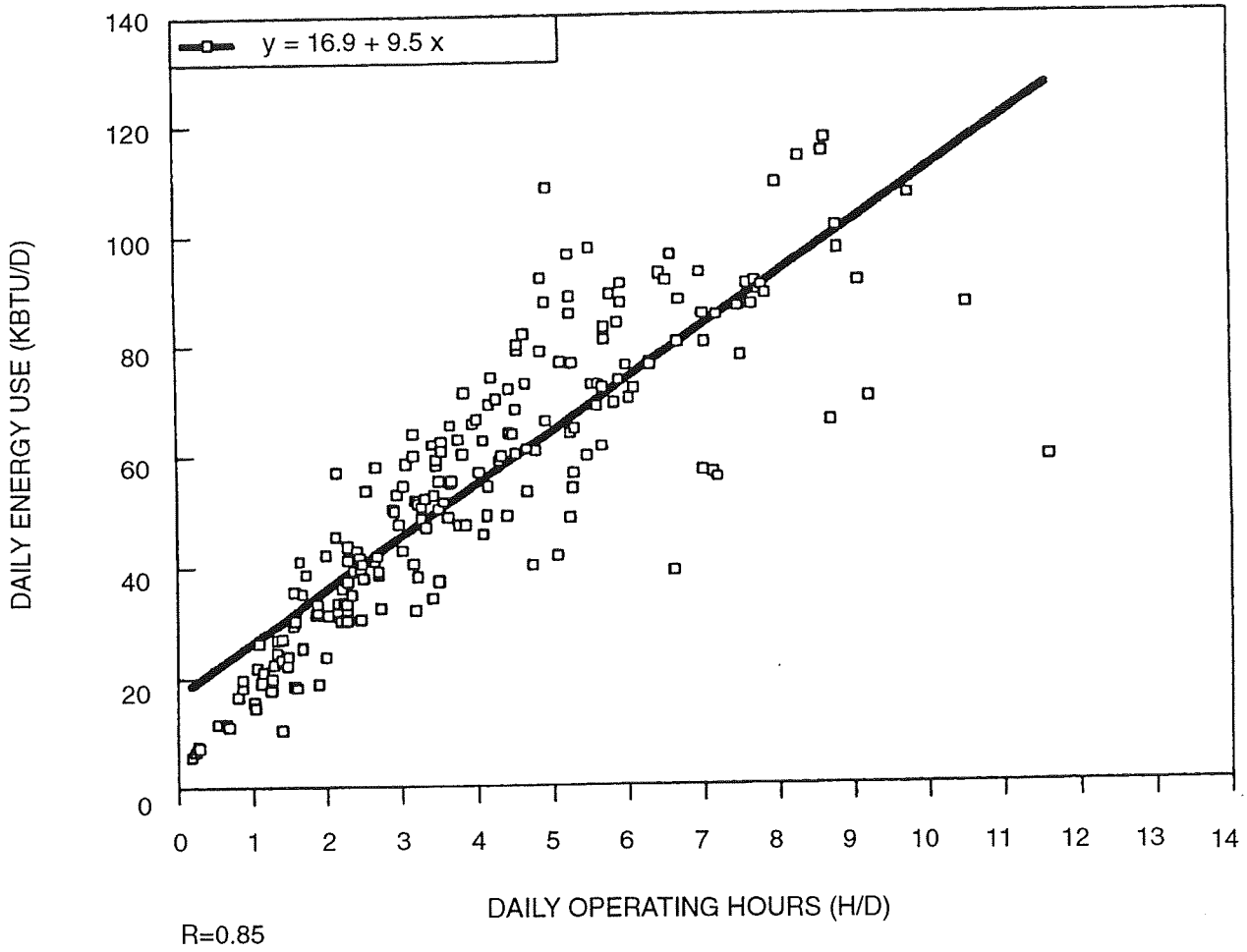
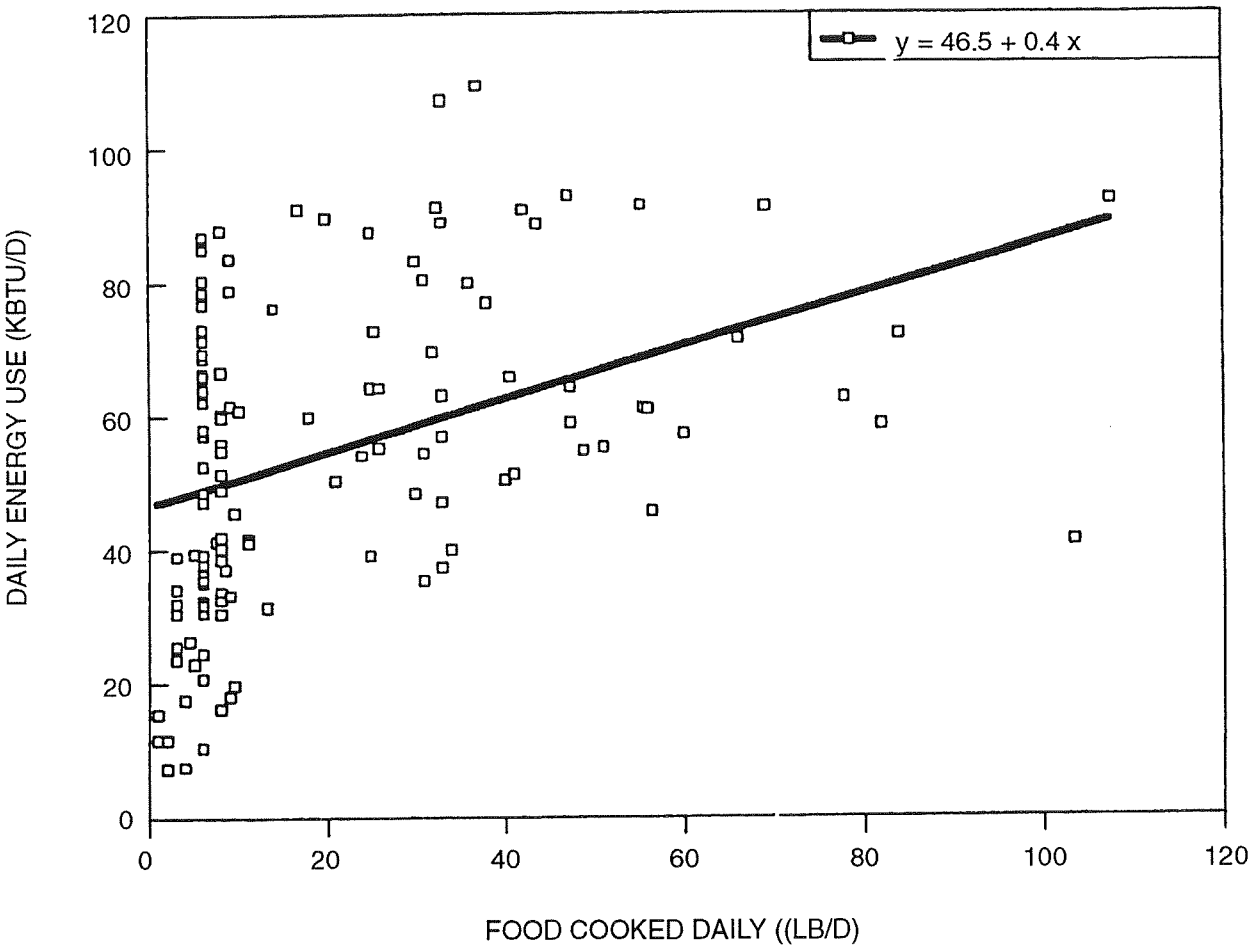


Figure E-1. Daily energy use vs. daily operating hours.



R=0.37

Figure E-2. Daily energy use vs. daily food cooked.

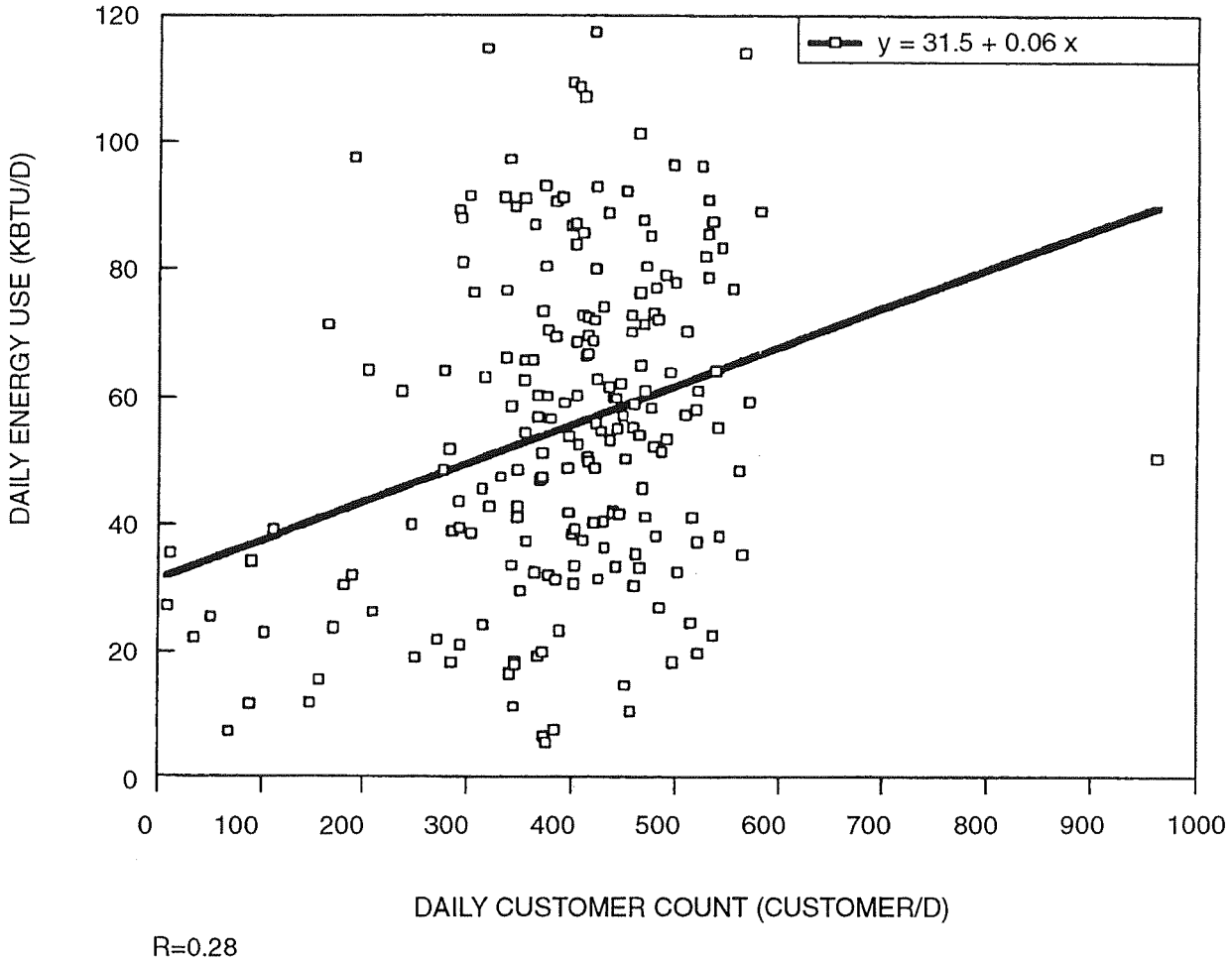


Figure E-3. Daily energy use vs. daily customer count.

Appendix F

PG&E ENERGY RATES

SCHEDULE G-NR1--GAS SALES TO SMALL NONRESIDENTIAL CORE CUSTOMERS

APPLICABILITY: Schedule G-NR1 is available to nonresidential Customers and applies to the combined sale and transportation of natural gas. To take service at Schedule G-NR1 rates, the uses of gas must be among those classified in PG&E's priority sequence as P1, P2A or P3A, and the Customer's average monthly use must not have exceeded 20,800 therms in those months during the last 12 months in which gas use exceeded 200 therms. (See Rule 14* for an exact description of these priorities.) Each March, service to all Customers under this schedule will be reviewed to determine continued applicability. Such determination will be based on natural gas use in the 12 billing months ending in the most recent calendar year.

TERRITORY: Schedule G-NR1 applies everywhere PG&E provides natural gas service.

RATES: The Customer will pay the following charges under this schedule:

	Per Month
Customer Charge	$13.14(I)
Delivered Commodity Charge:	Per Therm
Summer Service	$0.50070(I)
Winter Service	$0.67596(I)

SEASONS: Winter Season begins November 1 and ends on March 31.
Summer Season begins April 1 and ends on October 31.

CURTAILMENT OF SERVICE: Service under this schedule may be curtailed. Details are provided in Rule 14.

TRANSPORTATION: If a Customer is taking service under this schedule in conjunction with any noncore service at the same premises, the Customer can qualify for gas transportation service. The transportation rate per therm will be the delivered commodity charge shown above less the core procurement rate. Customers who elect such transportation service will be required to sign a Natural Gas Service Agreement (Form No. 79-756). If there is a difference between actual deliveries and actual usage, such difference may be subject to the terms and conditions of Schedule G-BAL. Transportation volumes will be subject to a shrinkage allowance in accordance with Rule 21.

Or, transportation-only service is available in conjunction with Schedule G-CT -- Experimental Core Gas Transportation Service.

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* The Rules referred to in this schedule are part of PG&E's gas tariff schedules. Copies are available at local offices.

Appendix G

OBSERVATION DAY REPORT

OBSERVATION DAY REPORT

The following is a summary of observations of the gas convection oven operation in PG&E's Production-Test Kitchen on Thursday, June 7,1990. The energy consumption profile for this day is shown in Figure G-1.

The operation of the convection oven was observed in detail during breakfast, lunch, and dinner. The purpose was to see how it was used by the kitchen staff (i.e., what foods were cooked, temperature settings used, how long it took to prepare the food, if food quality was affected, etc.).

The oven consumed 106 kBtu of gas throughout the day. The approximate percentages of consumption for breakfast, lunch, and dinner were 22, 28, and 50, respectively. The oven was operated a total of 8 hours on this day. The customer count for the entire day was 546: 117 were served at breakfast, 321 at lunch, and 108 at dinner.

BREAKFAST

The oven was turned on at 5:06 A.M. with a temperature setting of 375°F. At 5:07 A.M., three pans of sausage were placed in the oven. The timer was not set. At 5:20 A.M., while the sausage was cooking, the cook reheated a pan of biscuits in the oven for 5 minutes. After 27 minutes, the top and middle pan of biscuits were removed from the oven. The bottom pan remained in the oven for an additional 5 minutes. At 5:42 A.M., the oven was empty, but remained on for another 15 minutes. At 7:05 A.M., the oven was again turned on at 375°F and a single pan of sausage was placed inside. The sausage was checked at 7:12 A.M. and the pan was removed at 7:17 A.M. The oven remained on, and empty, until 7:46 A.M. when two muffin pans of biscuits were placed in the oven. Both pans were placed on the same rack near the top of the oven, because the cook felt the biscuits would be more evenly cooked. The biscuits were checked after baking for 15 minutes and removed after 20 minutes. The oven was turned off at 8:36 A.M. An estimated 2 kBtu of energy were consumed during the periods when the oven was empty.

LUNCH

At 10:00 A.M. the oven was turned on at 350°F and the timer was set for 45 minutes. Rice in a 12" x 20" x 4" pan covered with foil and parchment paper was placed on the bottom rack of the oven. While the rice was cooking, the cook placed a pan of meat loaf on the top rack at 10:35 A.M. The temperature was unchanged. At 10:45 A.M., the rice was removed from the oven. The meat loaf remained in the oven until 11:40 A.M. The oven was left on an additional five minutes, with the door open, consuming 0.5 kBtu of energy.

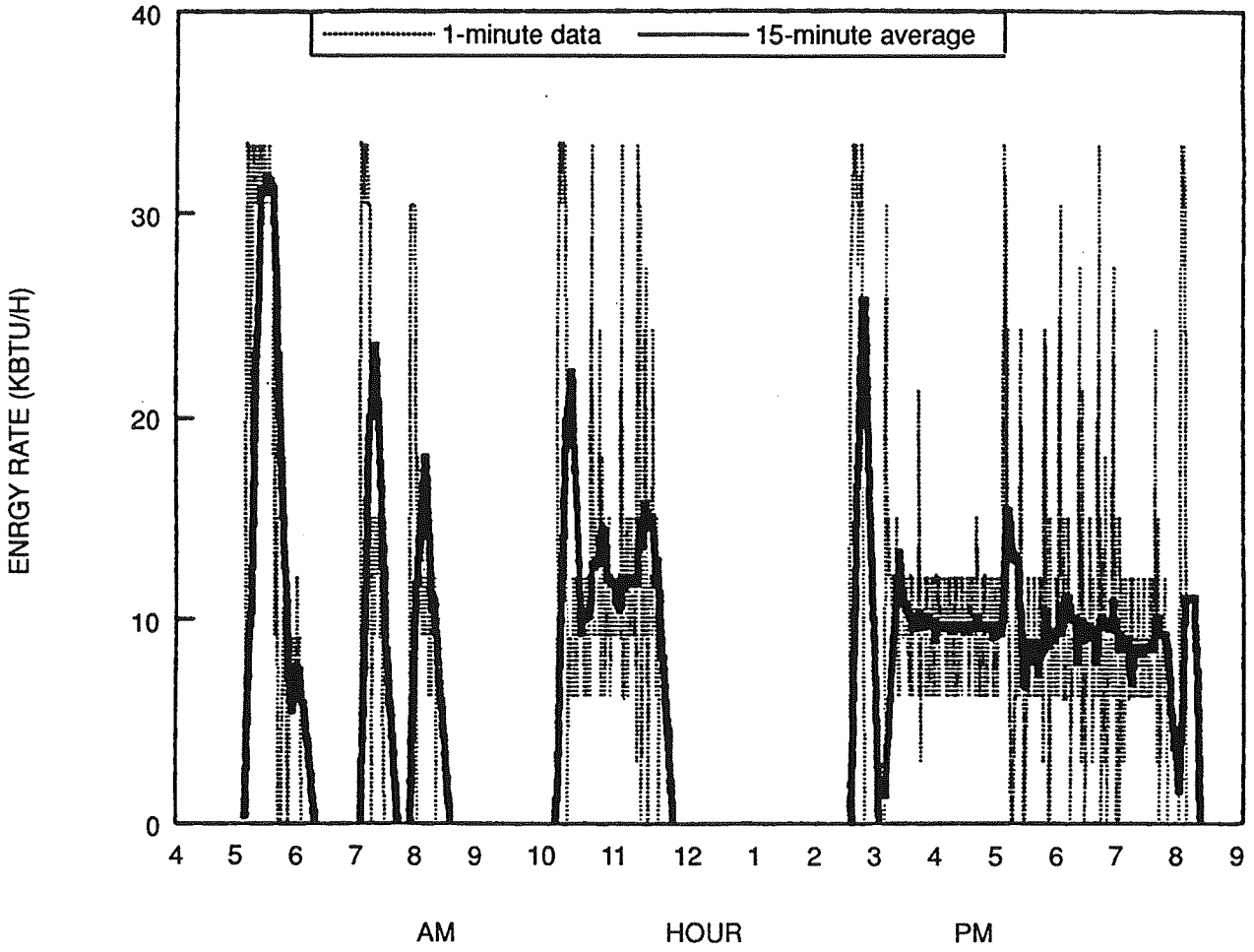

Figure G-1. Observation day energy profile.

DINNER

At 2:49 P.M., the oven was turned on at 380°F to heat a single piece of garlic bread for nine minutes. At 3:17 P.M., the timer was set for 60 minutes and the temperature was set to 310°F, and the two 12" x 20" x 4" pans of barbecued ribs covered with foil were placed in the oven. One was placed on the bottom rack and one on the middle rack. The ribs were removed from the oven at 5:10 P.M. (The timer was reset for 60 minutes at 4:18 P.M.). The temperature was then increased to 380°F and remained at that setting for the rest of the dinner period. During the dinner period, the oven was on continuously; it was used to "superheat" large rib dinner plates or to finish steaks to a "well done" condition (the steaks had been cooked previously to a medium condition on the broiler). During dinner, the cooks "superheated" five rib dinner plates and finished five 8-ounce rib eye steaks to a "well done" condition. It took 3 to 5 minutes to "superheat" each rib dinner plate or to finish each rib eye steak.