Report Issued:
June 30, 1993

Research and Development

Wolf Commander Range-Match SUPER Char-Broiler: Appliance Performance in Production

Customer Systems
Report 008.1-91.28

Project Manager: Bettie Ferlin

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

Final Report, February 1993

Prepared by:

Tim Geiger

Contributors:

Mary Conner
John Holliday

Prepared for:

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

LEGAL NOTICE

Pacific Gas and Electric Company (PG&E) makes no warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe upon privately owned rights. Nor does PG&E assume any liability with respect to use of, or damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

POLICY ON THE USE OF FOOD SERVICE TECHNOLOGY CENTER TEST RESULTS AND OTHER RELATED INFORMATION

- The FSTC is *strongly* committed to testing food service equipment using the best available scientific techniques and instrumentation.

- The FSTC is neutral as to fuel and energy source. It does not, in any way, encourage or promote the use of any fuel or energy source nor does it endorse any of the equipment tested at the FSTC.

- FSTC test results are made available to the general public through both PG&E technical research reports and publications provided by the *Kitchen Monitor* subscription service. All of these documents are protected under U.S. and international copyright laws.

- In the event that FSTC data is to be reported, quoted, or referred to in any way in publications, papers, brochures, advertising, or any other publicly available documents, the rules of copyright must be strictly followed, including written permission from PG&E *in advance* and proper attribution to PG&E and the Food Service Technology Center. In any such publication, sufficient text must be excerpted or quoted so as to give full and fair representation of findings as reported in the original documentation from FSTC.

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 Wolf for supplying PG&E with a broiler 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

This study documents the performance and energy use of the gas-operated (87,000 Btu/hour) Wolf Commander Range-Match SUPER Char-Broiler (Model FS-SCB-36) as it was used for routine menu production in the PG&E Production-Test Kitchen and during tests under controlled conditions. The char-broiler was monitored for seven months (January-July 1991).

The broiler was typically started at mid-morning and operated until the end of the lunch period. It would be turned on again around mid-afternoon and operated until the end of the dinner period. The broiler was operated an average of 7.7 hours/day. The estimated average quantity of food cooked per day was 95 pounds. The number of customers served over the test period averaged 430/day.

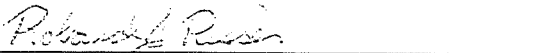
The broiler consumed an average of 619 kBtu/day. The initial energy rate was 97 kBtu/hour, the average rate of production was 80.4 kBtu/hour, and the stabilized input rate was 88.3 kBtu/hour, resulting in a production energy factor of 91%.

Based on a five-day food service operation, it is estimated that the broiler's annual energy consumption would be 160,896 kBtu, with an estimated annual energy cost of $826. These costs were calculated using PG&E's small commercial rate schedule for natural gas if the Production-Test Kitchen was billed separately.

The operators were satisfied with the ease of use, performance, and reliability of the broiler. Some operators were concerned because the control knobs became excessively hot when the burners were on.

Project Manager 

Bettie Ferlin

Research Director 

Roland J. Risser

CONTENTS

FIGURES

TABLES

Section 1

INTRODUCTION

The gas-operated Wolf Commander Range-Match SUPER Char-Broiler (Model FS-SCB-36) was selected for production energy monitoring and performance because it represents the state of the art in under-fired radiant heat broilers. PG&E has previously monitored a gas under-fired ceramic coal char-broiler and an electric under-fired char-broiler in the Production-Test Kitchen.[1,2] Terms used in this report are defined in Appendix A.

OBJECTIVES

The objectives were to (1) determine the energy consumption patterns of the Wolf gas-operated char-broiler as it was used for daily food production and during tests under controlled conditions, and (2) obtain typical use information while the broiler was operated in the cafeteria.

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 SPECIFICATIONS

The 87,000-Btu/hour Wolf char-broiler is manufactured with broiling grates and a finned heat radiant that shields the cooking surface from direct contact with the gas flames. The cooking is accomplished by radiant heat. The grate blades have built-in angled grease troughs for fat runoff. Heat deflector baffles are installed below the stainless steel burner to deflect heat away from an exterior mounted grease can. A large-capacity drip pan is mounted below the burners to catch fat drippings. Table 1-1 lists the manufacturer's appliance specifications (see also Appendix B).

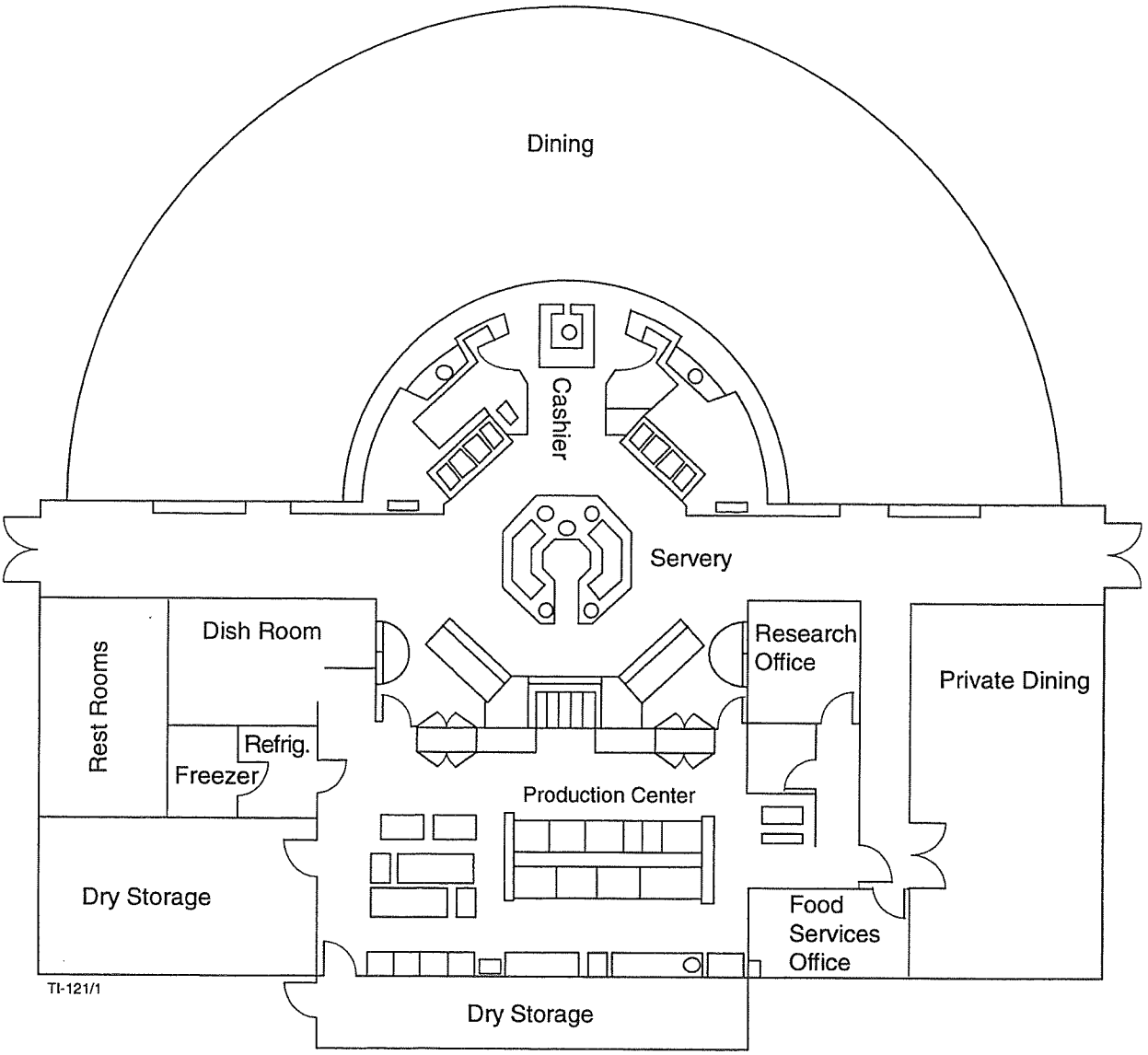


Figure 1-1. Dining facility, PG&E Learning Center.

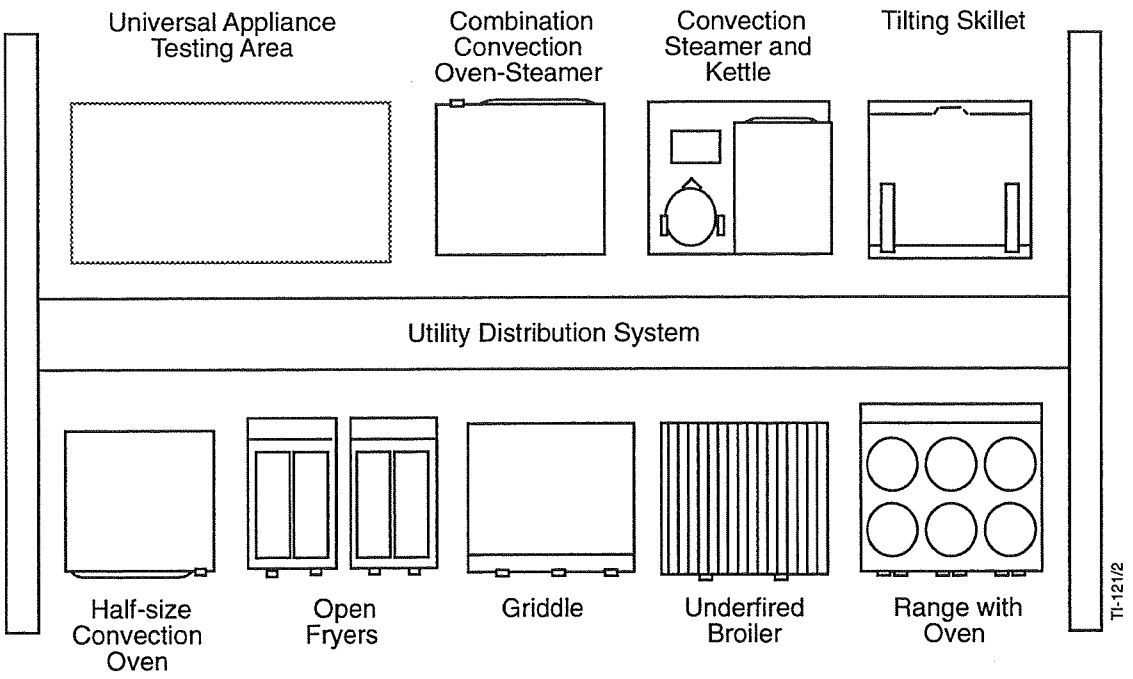


Figure 1-2. The production center.

Table 1-1

Appliance Specifications

Generic Appliance Type:	Under-fired broiler
Manufacturer:	Wolf Range Company
Model:	FS-SCB-36 Wolf Commander Range-Match SUPER Char-Broiler
Rated Input:	87 kBtu/h
Broiling Area:	32" x 20-1/2"
No. of Burners:	6
Dimensions:	Width - 36" Depth - 38 1/4" Height - 66"
Construction Material:	Stainless steel and baked-on enamel finish
Options Available:	Swing-out doors that enclose a storage area

Section 2

CONTROLLED ENERGY TEST

The controlled energy test verified the following operating characteristics of the char-broiler under controlled conditions:

1. Initial energy input rate
2. Preheat period
3. Energy consumed during preheat period
4. Energy input rate after preheat period

Thermocouples were welded at the left rear, right rear, right front, and center of the grate (both the upper and lower extremes of a grate blade). A pulse initiator was attached to the gas meter. The burner control knobs were turned on full, and data were recorded. Test results are summarized in Table 2-1. The energy consumption (in 15-minute average intervals) and the temperature at the center of the broiler's grate are presented in Figure 2-1. See Appendix C for energy monitoring system information. The initial input rate was derived from the middle of the period, when the energy usage was at its highest level (see Figure 2-1). The preheat period for the broiler was determined to be the elapsed time for the grill surface to reach 600°F from ambient temperature. This event took 21 minutes. The highest temperatures were reached in the middle of the grill surface, followed by the right rear, left rear, and right front. Once the temperatures had passed 600°F and stabilized, the energy input rate decreased from 97 kBtu/hour to 88 kBtu/hour, confirming the manufacturer's rated energy input (i.e. 87 kBtu/hour).

Table 2-1

Controlled Energy Test Results

Rated Energy Input (kBtu/h):	87.0
Measured Initial Energy Input (kBtu/h):	96.7
Preheat:	
Time to 600°F (min):	21
Energy Consumption (kBtu):	32.8
Energy Input Rate After Preheat (kBtu/h):	88.3
Broiler Surface Temperatures after Preheat (°F):	
Left rear	421
Right rear	525
Right front	411
Center (bottom of blade)	620
Center (top of blade)	603

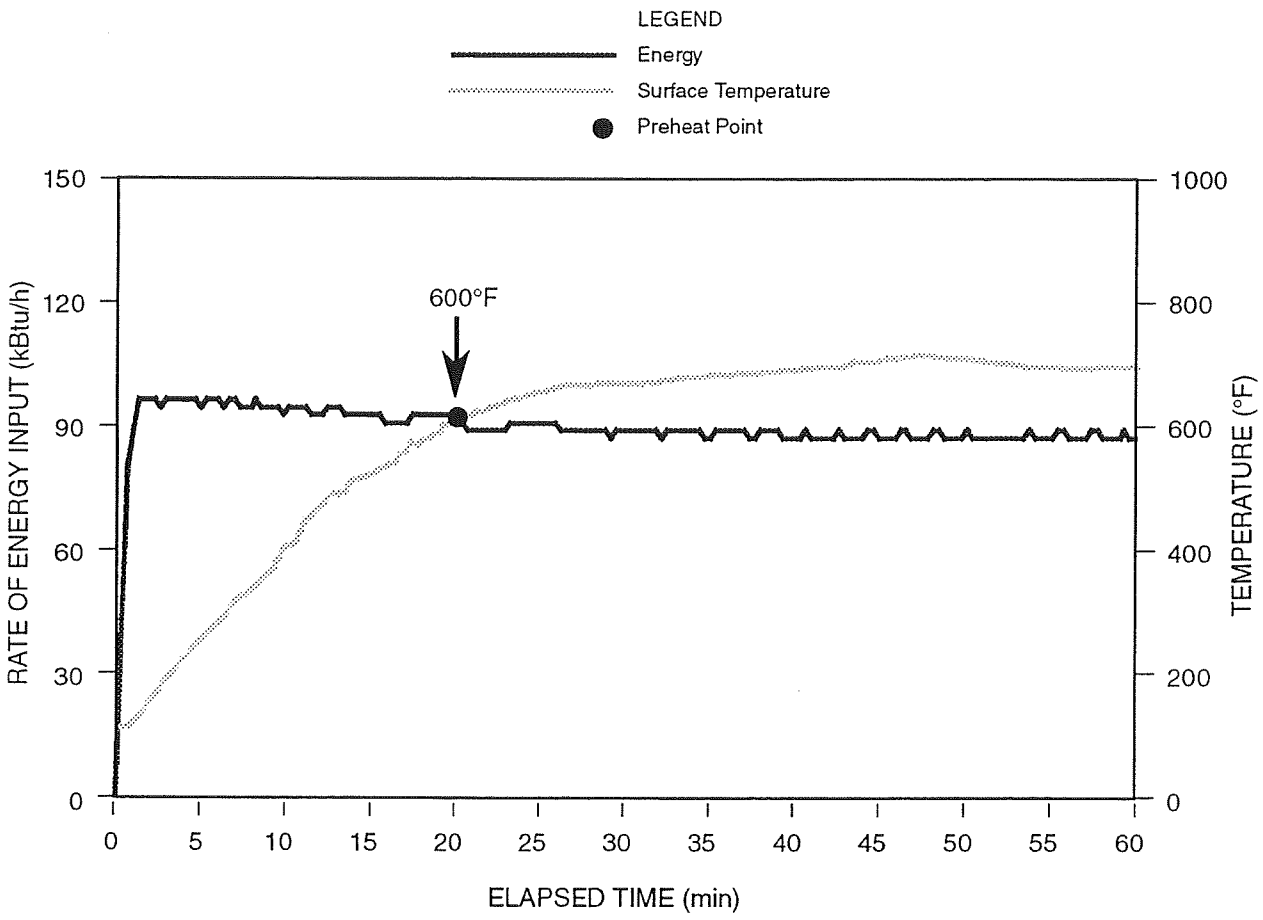


Figure 2-1. Wolf gas broiler controlled energy test.

Section 3

PRODUCTION MONITORING

ENERGY CONSUMPTION

Daily

The dataset from which typical day characteristics were quantified covers the time period of January 22 to June 27, 1991. All Fridays, Saturdays, Sundays, and holidays were eliminated because they were not three-meal food service days. Days with abnormal equipment usage patterns were also eliminated. The total number of days in the reduced data set is 82. A statistical description of the dataset is given in Appendix D.

Daily averages are summarized in Table 3-1. Included is the average "on" time, which is simply defined as the period when the burners are on.

Table 3-1

Production Energy Consumption

Daily Production Energy Use (kBtu/day):	619
Daily Cooking Energy Use (kBtu/day):	576
Daily "On" Time (h):	7.7
Daily Number of Cooking Operations:	2
Average Rate of Production Energy Consumption (kBtu/h):	80.4
Average Energy Input Rate After Preheat (kBtu/h):	88.3
Estimated Average Quantity of Food Cooked/Day (lb):	95
Duty Cycle (%):	91
Average Daily Customer Count:	590

Figure 3-1 shows the energy consumption profile of a typical day. The broiler was normally turned on from 9:00 A.M. to 1:00 P.M. and 4:00 P.M. to 7:30 P.M. Some foods were precooked on the broiler and finished in an oven, while other food items were cooked entirely on the broiler. The broiler was sometimes sporadically used due to the varying demand for short-order items such as hamburgers and hot dogs.

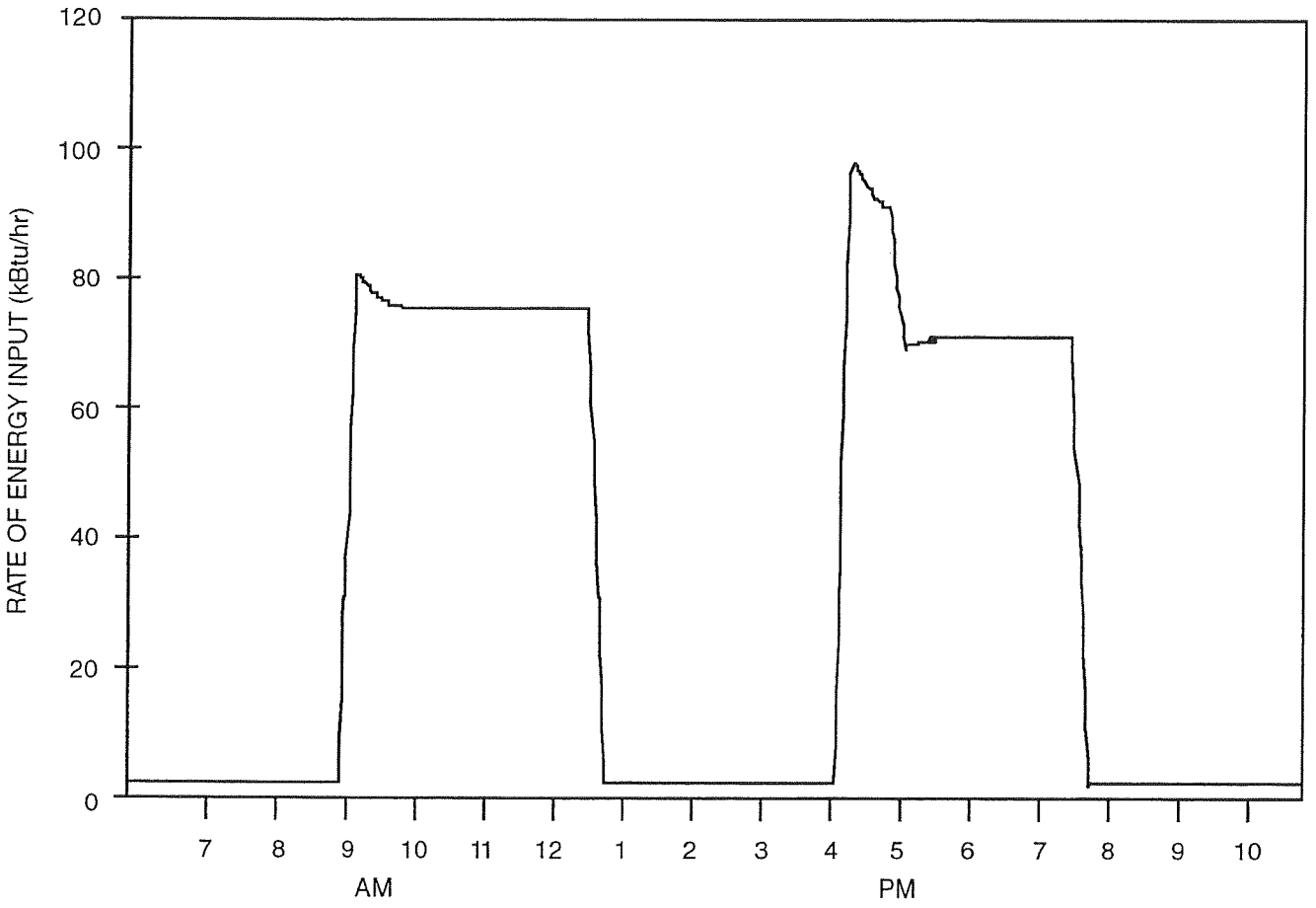


Figure 3-1. Typical day energy consumption profile.

Estimated Annual Energy Consumption and Cost

Based on a five-day, 52-week-per-year food service operation, it was estimated that the broiler would consume 160,896 kBtu, or 1,609 therms per year. The annual energy costs based on these amounts are $420 (summer) and $406 (winter), for a total of $826. These costs were calculated using PG&E's Core Commercial gas rates (G-NR1, see Appendix E) that would be applicable if the Production-Test Kitchen was separately billed. It includes two billing rates—one for summer (April 1 to October 31) and one for winter (November 1 to March 31).

Appendix E contains details about the energy cost calculation and a summary of the projected annual energy cost using PG&E's applicable small commercial gas rates. All calculations are based on rates in effect on January 1, 1993.

FOOD PRODUCTION

We interviewed the cooks numerous times as they were using the broiler and afterwards as well. Actual use of the broiler was monitored on an ongoing basis, and three full days (mornings, afternoons, and evenings) in October were dedicated to broiler usage observations (see Appendix F). The average "on" time (7.7 hours) indicates that the broiler was left on during the entire lunch and dinner meal periods, including some time before meal periods for browning and partially cooking some foods.

Items and Quantity Cooked

Data from the three observation days show that the majority of food cook on the broiler, by weight, was chicken (148 pounds), pork (81 pounds), and steak (81 pounds). Other items cooked on the broiler were burgers (34.5 pounds) and fish (15.5 pounds). The overall average amount of food cooked on the broiler was 95 pounds/day.

Section 4

CONCLUSIONS

The controlled energy test provided the necessary information to verify the manufacturer's energy input rating of 87 kBtu/hour. From the surface temperatures and energy input rate obtained during the test, we determined that the broiler needed a preheat period of at least 21 minutes. This was verified with information taken during observation days, when the broiler was turned on 45 to 60 minutes before being used.

If the broiler were preheated for only 30 minutes before a meal, the annual cost savings would be $90 to $120 based on the rated energy input and a two-meal usage pattern per day.* Using a short preheat period may be one of the easiest ways to save energy because the broiler is not thermostatically controlled, and its burner control knobs are on full when in use.

At 619 kBtu, the daily production energy use of the Wolf broiler was high, and is second only to the energy usage of the Magikitch'n broiler in the Production-Test Kitchen (i.e., 685 kBtu).[1] All other gas appliances tested used less than 365 kBtu of production energy per day.

Although the Wolf broiler used nearly as much production energy as the Magikitch'n broiler (90%), its energy input rate is less than that of the Magikitch'n (i.e., 87 kBtu/hour compared to 120 kBtu/hour). Only the Cleveland Steamer has a higher energy input rate than the gas broilers (i.e., 200 kBtu/hour).[3]

The production kitchen staff cooks were interviewed numerous times. The cooks expressed their satisfaction with the broiler's ease of use, performance, reliability, and cooking temperatures; however, they were not comfortable with the position of the burner control knobs. They felt that the temperature of the control knobs made them "too hot to the touch." The kitchen supervisor also felt that the broiler surface was too hot when the burners were on full.

*Estimate is based on PG&E's G-NR1 rate schedule, effective January 1, 1993.

Section 5

REFERENCES

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

2. Pacific Gas and Electric Company. Publication Pending. *Hobart Model CB-51 Electric Char-Broiler Performance.* R&D Report 008.1-92.4. Prepared for the Department of Research and Development. San Ramon, California: Pacific Gas and Electric Company.

3. Pacific Gas and Electric Company. 1992. *Cleveland Electric Pressureless Steamer Performance.* Report 008.1-90.30. 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.

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.

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

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)
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 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.

Appendix B

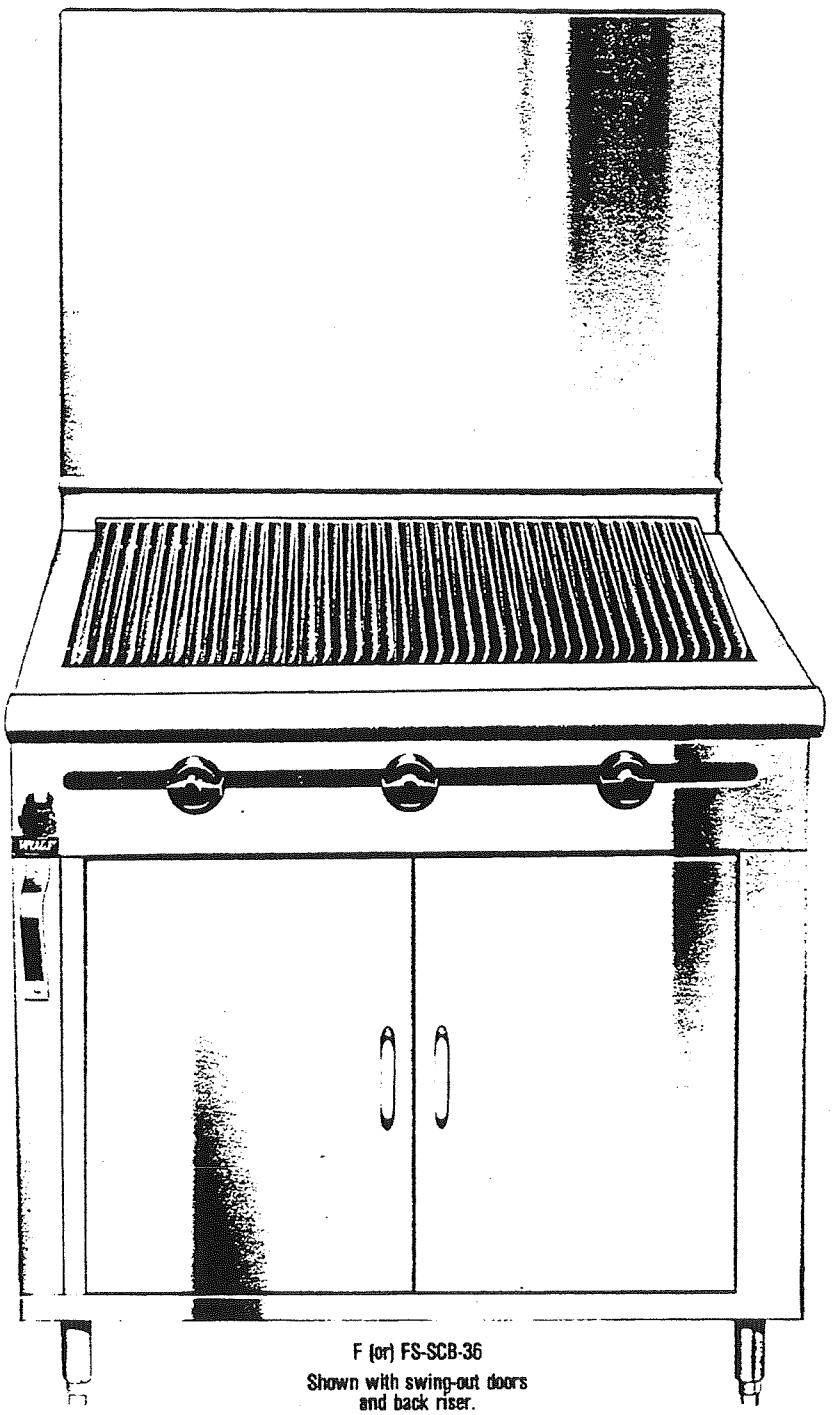
MANUFACTURER'S PRODUCT SPECIFICATIONS

WOLF COMMANDER

SECTIONAL RANGE LINE

EXTRA HEAVY-DUTY SUPER CHAR BROILER

GAS OPERATED

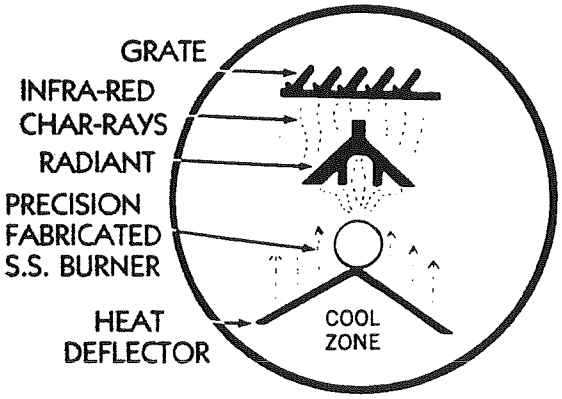


F (or) FS-SCB-36

Shown with swing-out doors and back riser.

Only Wolf could design the finest in heavy duty broiling equipment...the incomparable WOLF Commander SUPER Char-Broiler with revolutionary "Flame Arrestor" broiling grates and improved radiants and burners. Specially designed grate blades have cast-in pitched grease troughs for instant fat runoff. Finned heat radiants control cross drafts, maintain constant cooking temperatures for increased broiling efficiency and greater production, with infrared cooking rays that seal in the juices. Heat deflector baffles beneath the precision fabricated stainless steel burners direct heat upward and create a "cool zone" where the large-capacity, non-spilling exterior-mounted grease can is located. Also in this "cool zone" there is a full-with, large-capacity drip pan mounted beneath the burners to catch fat drippings. Smart-appearing swing-out doors that enclose a large storage area are available. The Commander Range-Match SUPER Char-Broiler is designed for battery installations.

WOLF CHAR-RADIANT PRINCIPLE



PATENT NO. 341-8921

"FLAME ARRESTOR" GRATE with cast-in pitched grease trough.

"FINNED" CAST ALLOY RADIANTS for uniform heat.

DEFLECTOR BAFFLE creates "Cool Zone" in grease drawer.

When ordering, specify type of gas, B.T.U. and altitude if over 2000 feet.

NSF

WOLF®

WOLF RANGE/company

19600 S. ALAMEDA ST. • P.O. BOX 7050 • COMPTON, CA. 90224

(213) 637-3737 • From L.A. (213) 774-7565

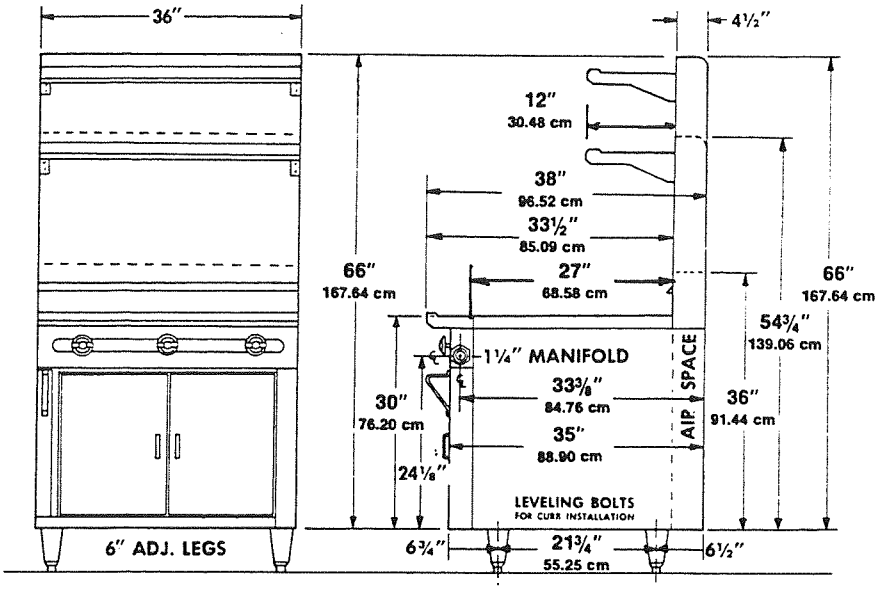
SPECIFICATIONS ON OTHER SIDE

SPECIFICATIONS

WOLF COMMANDER "RANGE MATCH" SUPER CHAR-BROILER

MODEL NO.	F (or) FS-SCB-25	F (or) FS-SCB-36	F (or) FS-SCB-47
OVERALL WIDTH	25½"	36"	46¾"
OVERALL DEPTH	38¼"	38¼"	38¼"
BROILING AREA	21½" x 20½"	32" x 20½"	43" x 20½"
NO. OF BURNERS	4	6	8
TOTAL B.T.U.	58,000	87,000	116,000
APPROX. SHIP. WT.	350 lbs.	525 lbs.	625 lbs.

All Wolf ranges are completely assembled—ready for installation.

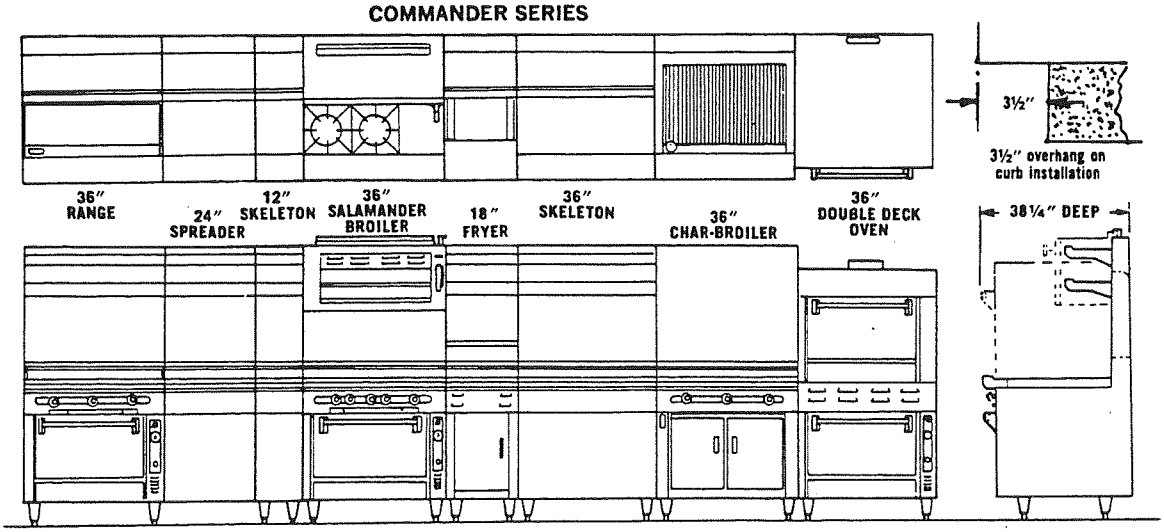


1. Char-Broiler equipped with heavy-duty cast iron top grates in individual 5½" wide sections. Cast-in pitched grease trough in each grate blade provides fat runoff.
2. Precision fabricated S.S. burners with baffles attached beneath reflect heat upward and create a "cool zone" below. Burners are rated at 14,500 B.T.U. each.
3. Broiler radiants are finned to control cross drafts and maintain uniform temperatures.
4. Each burner has a direct action valve to provide sectional heat for maximum flexibility.
5. Unit equipped with a large-capacity, non-spilling grease can mounted outside in cool zone and a full-width concealed drip pan.
6. 1¼" diameter gas manifold.
7. Swing-out doors conceal storage area. Aluminum lift-off breakfast griddle available (16½" wide x 21" deep).
8. Equipped with stub back as standard equipment—or unit may be ordered with a full-width slip-on back riser with lift-off shelf (single or double-deck). An open "flo-thru" shelf, providing free venting of cooking vapors and that acts as a heating area for sizzling platters, is available. Easily removable for cleaning.
9. Equipped with leveling bolts for curb installation. Casters or conical steel legs are available.
10. All-welded heavy gauge steel frame construction.
11. Model F Series finished in black baked enamel with SilverWolf baked enamel finish available on request at no extra charge. Model FS indicates stainless steel front, stub back and doors. One or both ends available in stainless steel at slight extra cost.
12. A.G.A. certified; and National Sanitation Foundation approved.

NOTE: IN LINE WITH ITS POLICY TO CONTINUALLY IMPROVE ITS PRODUCT, WOLF RANGE COMPANY RESERVES THE RIGHT TO CHANGE MATERIALS AND SPECIFICATIONS WITHOUT NOTICE.

Here is a convenient schematic layout for use in the designing of your Commander battery. The scale is 1/4" = One Foot.

COMMANDER SERIES



A PRESSURE REGULATOR SUITABLE FOR BATTERY OR SINGLE UNIT APPLICATION MUST BE FURNISHED BY THE INSTALLER. Natural Gas – 5" W.C. Propane Gas – 10" W.C.

Appendix C

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.

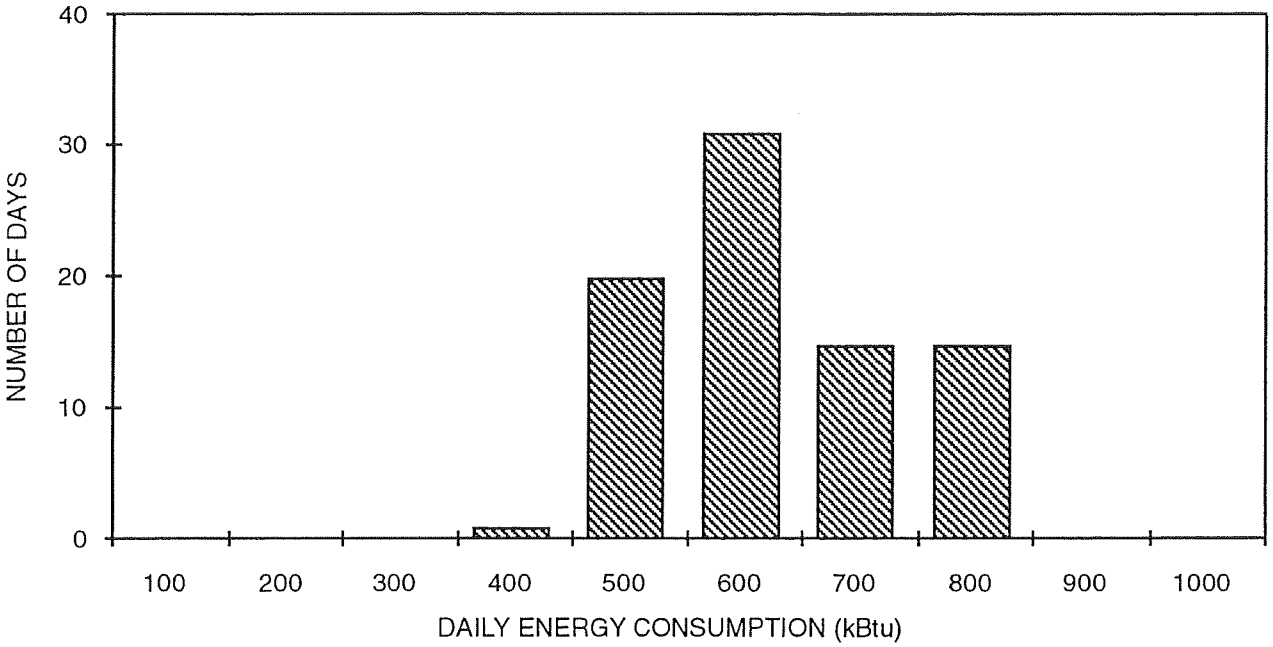
Long periods of constant input rate are usually reflected as a sawtooth pattern. Electronic pulses are generated by the meter, which measures the flow of electricity or gas to the appliance. Each pulse corresponds to a specific quantity of electric or gas energy consumed. The system stores the number 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 D

FREQUENCY DISTRIBUTION OF DATASET

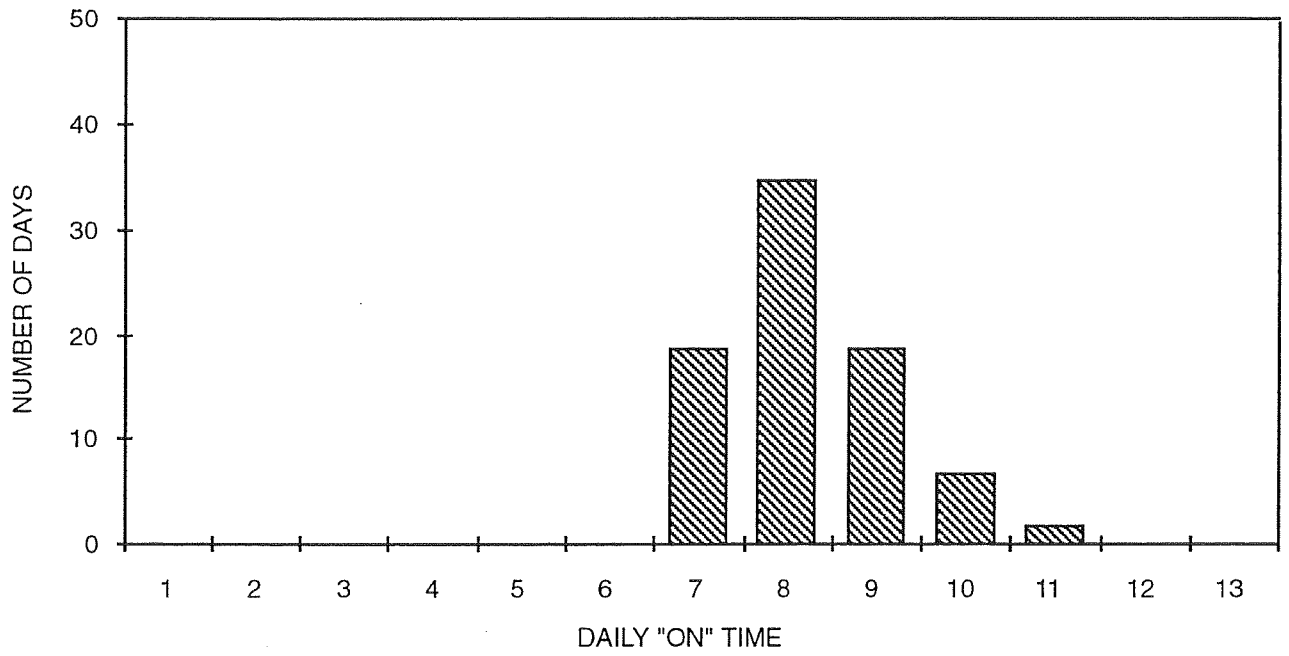
FREQUENCY DISTRIBUTION OF DATASET

The frequency distributions of daily production energy consumption and daily "on" time are shown in Figures D-1 and D-2. There are quite normal distributions about the means. Figures D-1 and D-2 also show the coefficient of variation, which is the standard deviation expressed as a percentage of the mean.



Standard Deviation = 100.2
Coefficient of Variation = 17.4

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



Standard Deviation = 1.0
Coefficient of Variation = 13.0

Figure D-2. Frequency of daily operating hours.

Appendix E

CALCULATION OF ENERGY COSTS

CALCULATION OF ENERGY COSTS

The Production-Test Kitchen would be considered a small, commercial, gas-consuming food service facility in PG&E's service territory. There are two rate schedules for gas usage (see PG&E's Core Commercial Rates)—the summer period (April 1 through October 31) and the winter period (November 1 through March 31).

The estimated annual costs of the char-broiler energy consumption were determined by multiplying the incremental cost per therm (1 therm = 100,000 Btu) by the energy consumed for both the summer and winter rate periods. This cost is in addition to the rest of the building base load and would not increase the cost of the "customer charge."

The estimated annual energy cost was calculated as follows, and the estimate was based on PG&E's G-NR1 rate schedule, effective January 1, 1993:

Summer: 93,856 kBtu • (1 therm/100 kBtu) • $0.448/therm = $420.59
Winter: 67,040 kBtu • (1 therm/100 kBtu) • $0.605/therm = $405.56
Total: $420.59 + 405.56 = $826.15

Residential Gas Rates

Residential: G-1, GM, GS, GT / Low-Income: GL-1, GSL, GTL

	G-1, GM, GS, GT	GL-1,GSL,GTL
Tier I Baseline Quantities	$.51187	$.43342
Tier II Excess	.69146	.58539

Summer Baseline Quantities

TERRITORY	INDIVIDUALLY METERED			MASTER METERED (GM only)		
GAS	Target	Monthly Equiv.	Daily	Target	Monthly Equiv.	Daily
P	18	18	0.6	15	15	0.5
Q	25	28	0.9	25	25	0.8
R	15	15	0.5	18	18	0.6
S	18	18	0.6	15	15	0.5
T	25	28	0.9	25	25	0.8
V	25	36	1.2	21	24	0.8
W	18	18	0.6	12	12	0.4
X	21	21	0.7	15	15	0.5
Y	21	28	0.9	21	21	0.7

Winter Baseline Quantities

TERRITORY	INDIVIDUALLY METERED			MASTER METERED (GM only)		
GAS	Target	Monthly Equiv.	Daily	Target	Monthly Equiv.	Daily
P	60	73	2.4	36	48	1.6
Q	69	69	2.3	33	43	1.4
R	60	66	2.2	57	57	1.9
S	63	66	2.2	33	43	1.4
T	60	60	2.0	48	48	1.6
V	57	66	2.2	45	45	1.5
W	60	60	2.0	39	39	1.3
X	69	69	2.3	33	43	1.4
Y	60	73	2.4	36	48	1.6

Core Commercial Gas Rates

Small Commercial: G-NR1

	$ Per Month	$ Per Therm Summer	$ Per Therm Winter
Customer Charge	13.42	-	-
Commodity Charge	-	.44812	.60496

Large Commercial: G-NR2

	$ Per Month	$ Per Therm Summer	$ Per Therm Winter
Customer Charge	150.70	-	-
Commodity Charge		.38635	.52158

Large Commercial Transport Only: G-NR3

	$ Per Month	$ Per Therm Summer	$ Per Therm Winter
Customer Charge	150.70	-	-
Volumetric Charge	-	.21858	.35381

Experimental Core Gas Transport Rate: G-CT

	$ Per Therm
Subtracter Rate*	.18999

Experimental Procurement Svc. for Agent-Identified Gas: G-AIG

Applicable concurrent with Schedule G-CT.

Residential Gas Seasons:

Summer:
May 1 through October 31

Winter:
November 1 through April 30

G-NR1, G-NR2, G-NR3 Seasons:

Summer:
April 1 through October 31

Winter:
November 1 through March 31

*Service under this schedule is provided at the customer's otherwise-applicable rate, less the Schedule G-CT subtracter.

Appendix F

OBSERVATION DAY

OBSERVATION DAY

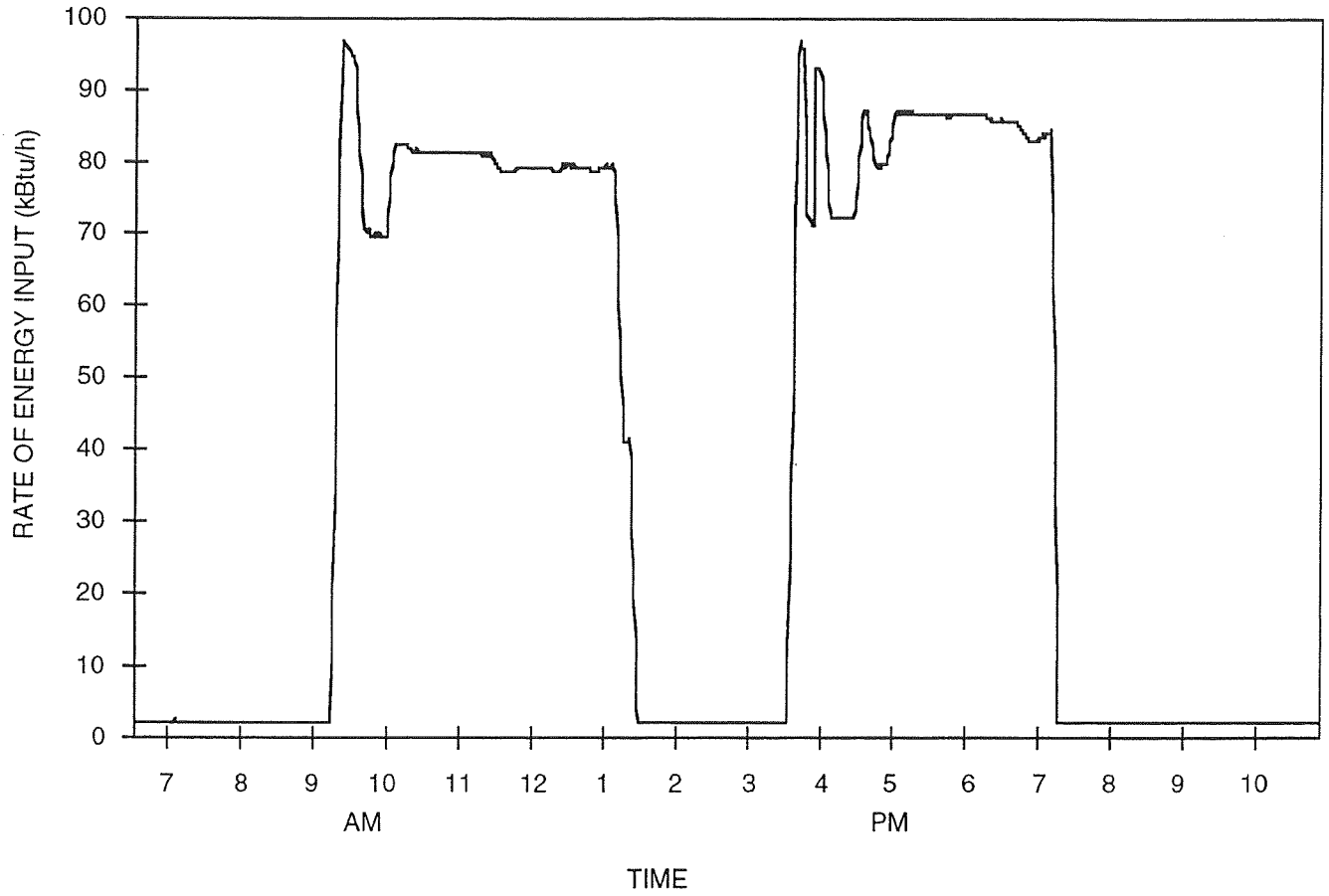
Over a three-day period, two members of the FSTC testing group observed and recorded all of the cooking events for various pieces of equipment in the Production-Test Kitchen, including the Wolf SUPER Char-Broiler. Table F-1 lists the cooking events observed during one of the three days, and Figure F-1 shows the energy consumption profile for the same day. The total energy consumed was 690 kBtu.

Table F-1

Observation Day Cooking Events

August 27, 1991

Time in	Duration (min)	Food	Position	Estimated Weight (oz)
0830	Turned on			
0915	12	10 flank steaks	center	100
0935	12	7 flank steaks	center	70
0948	12	8 flank steaks	center	80
1000	12	6 flank steaks	center	60
1045	15	3 burgers	left	24
1137	12	6 flank steaks	center	60
1145-1210	14	3 burgers	left	24
1212	12	5 flank steaks	right	50
1212	14	8 burgers	left/center	64
1240	10	2 burgers	left	16
1245	Right side off			
1300	Left side off			
1500	Turned on			
1545	15	5 burgers	right	40
1620	Burners on full			
1630	7	13 NY steaks	center	130
1637	Turned down	1 NY steak left on	right	10
1642	7	11 fish	right	88
1650	12	11 chicken	center	88
1705	7	12 swordfish	center	88
1715	6	9 steaks	center	60
1721	8	1 chicken	right	8
1729	7	14 steaks	center	140
1738	8	11 chicken	left	88
1745	5	9 fish	right	72
1752	7	14 steaks	center	140
1820	5	3 chicken	right	40
1820	7	16 steaks	center	160
1828	7	2 burgers	left	16
1836	8	12 steaks	center	120
1852	8	9 steaks	center	90
1925	Turned off			



Production Energy = 690 kBtu
On Time = 8.6 h
Date: August 27, 1991

Figure F-1. Energy consumption profile of observation day.