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Vulcan-Hart Frycat™ Model CCFD-2 Gas Fryer Performance Report

Customer Systems
Report 008.1-91.6

Project Manager: Bettie Ferlin

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

Final Report, September 1991

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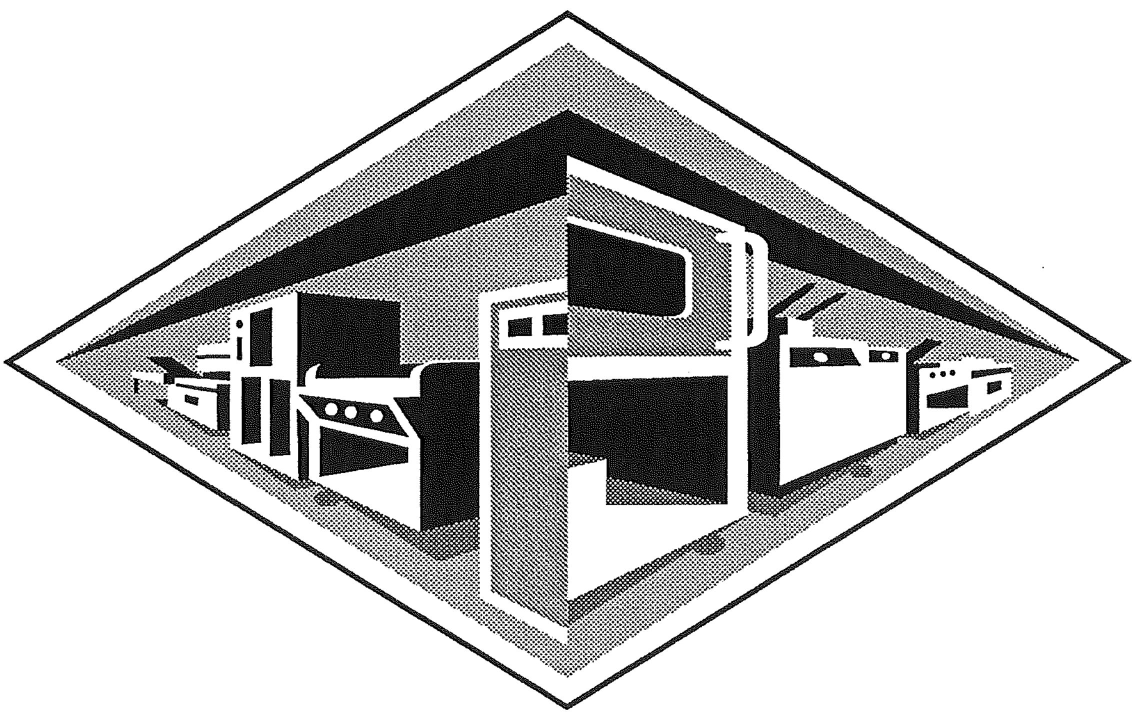
LEGAL NOTICE

PREFACE

Food service establishments are the most intensive energy users in the commercial building sector. For example, in PG&E's service territory, there are an estimated 28,000 food service facilities with an annual energy bill approaching $300 million. The goal of PG&E's Food Service Technology Center is to provide these customers with information to help them evaluate the performance of cooking appliances and to make informed equipment purchases based on data for advanced technologies and energy source. The establishment of the Food Service Technology Center symbolizes PG&E's commitment to the hospitality industry.

The PG&E Food Service Technology Center has two distinct components. The first is the real-world Production-Test Kitchen, established in 1987 as PG&E's corporate Learning Center dining facility in San Ramon, California. The second is a 2,600-square-foot appliance research laboratory, also located in San Ramon, that was opened in 1990 to complement the Production-Test Kitchen and support the accelerated development of Uniform Testing Procedures for commercial cooking appliances. The laboratory also provides PG&E with the resources to identify and investigate environmental issues related to food service facilities.

This R&D technical report, paralleling other appliance reports, focuses on the energy performance evaluation within the real-world component of the Food Service Technology Center—the Production-Test Kitchen.



ACKNOWLEDGMENTS

The Food Service Technology Center is the result of many people and departments working together within PG&E. However, it would not have been possible without the overwhelming support of the commercial equipment manufacturers who loan the cooking appliances for testing. Specific appreciation is extended to the Vulcan-Hart Corporation for supplying PG&E with a Frycat gas fryer for controlled 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 include the American Gas Association Laboratories (AGAL), the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), Underwriters Laboratories (UL), the National Restaurant Association, The Pennsylvania State University, the Energy Resource Group, McDonald's Corporation, Marriott International, and General Mills Restaurants, Inc.

EXECUTIVE SUMMARY

This research report presents the results of monitoring the Vulcan-Hart Frycat model CCFD-2 (split vat) gas fryer as it was used for routine menu production in the PG&E Production-Test Kitchen and during tests under controlled conditions. It was one of six open deep-fat fryers selected for production-energy monitoring and performance evaluation in the second phase of appliance testing in the kitchen. Investigated performance indices included the measured energy input rate, preheat energy requirement and time, production-energy consumption rate, idle-energy consumption rate, and average production-energy factor. The Frycat fryer was monitored in the Production-Test Kitchen from May 1 to June 9, 1989 and from July 13 to August 17, 1990.

Energy-use data for this 2-month test period were reduced to include only days that reflected typical fryer usage in the Production-Test Kitchen (i.e., only days where the fryer was used for two meal periods—lunch and diner were included). This resulted in a 15-day energy-use data set where the fryer was operated an average of 7 hours per day, approximately 3 hours at lunch and 4 hours over dinner. This split vat fryer was used much like a single vat fryer by the fry cooks. Both thermostats were consistently set at 350°F (a standard temperature setting in commercial food service operations) and turned on and off at the same time. Throughout the cooking periods, one vat was used to fry french fries and the other fried onion rings. Both vats were routinely turned off between the two meal periods. On average, the fryer consumed 125 kBtu per day over the two meal periods. The average rate of production-energy use (based on the aggregate preheat, idle, and cooking energy for the entire day of appliance operation) was 17 kBtu/h, resulting in a production-energy factor of 20%. This ratio of the average rate of energy consumption to the peak energy input rate was conservative in comparison to production-energy factors for the other appliance categories monitored in the Production-Test Kitchen (e.g., gas griddles @ 30%, gas broilers @ 95%).

Based on a five-day-per-week food service operation, it was estimated that this fryer would consume 33,000 kBtu per year, or 330 therms. This corresponded to an annual energy cost of $178 based on PG&E's applicable rate schedule for natural gas ($0.54/therm). This represented an average monthly energy cost of approximately $15.

To supplement monitoring information acquired during actual production when test conditions were uncontrolled, controlled energy tests were also conducted. The measured peak energy input rate for the Frycat fryer was 84 kBtu/h, confirming its 85 kBtu/h name-plate input. This fryer consumed 14.3 kBtu of energy over a 10-minute preheat period that was required to bring the frying medium to 350°F. The rate of idle energy use at 350°F averaged 9.2 kBtu/h, representing 11% of the fryer's peak energy input rate, or an idle-energy factor of 11%.

Fryer usage by the production staff was typical of many food service operations in that they deep-fried standard food items such as french fries, onion rings, tempura vegetables, eggrolls, breaded seafood, and chicken. Recording the quantity and type of food cooked showed that, on average, this fryer cooked 30 pounds of food at lunch, while consuming an average of 69 kBtu of energy. The recorded amount of food cooked over the lunch period ranged from 13 to 42 pounds, depending on the menu and customer count. It also showed that, for approximately 70% of the time, it was used to cook only french fries and onion rings. The number of customers served over the test period averaged 380 per day. Although the quantity of food cooked over the lunch period would be considered "light" in comparison to high volume fast food restaurants, it was considered to be representative of many corporate/commercial cafeteria operations offering a diverse menu mix to a varied customer base.

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Section 1

INTRODUCTION

BACKGROUND

Historically, food service equipment manufacturers, utilities, and research organizations have tested commercial cooking appliances under controlled laboratory conditions. However, key decision makers in the food service industry have been wanting to evaluate appliance performance under real-life conditions. Pacific Gas and Electric Company (PG&E) is providing this opportunity at its Production-Test Kitchen in San Ramon, California.

The Production-Test Kitchen, integrated with PG&E's corporate training facility, is a unique combination of a food service operation and a testing facility. As a testing facility, 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 room is open Monday through Thursday for cafeteria-style breakfast and lunch and sit-down dinner for PG&E Learning Center participants and staff. On Friday, only breakfast and lunch are served. The operation is closed on Saturday. On Sunday, dinner service is available for participants arriving for Monday classes.

The Vulcan-Hart Frycat was one of six open deep-fat fryers selected for production-energy monitoring and performance evaluation during the second phase of the PG&E Production-Test Kitchen research program (phase one comprised the performance evaluation of the first appliance "line" that was installed in the Production-Test Kitchen[1]). Each fryer was used for routine menu production within this PG&E food service operation over at least a 2-month period between May 1, 1989 and August 17, 1990. Appliance performance reports[2,3,4,5,6] (paralleling this report) were prepared for the following fryers:

Elec 1: Frymaster, Model H-17, 17 kW, single vat, 50 lb capacity
2 low-watt density heating elements
Tested: November 4 - November 22, 1989
March 26 - July 12, 1990

Elec 2: Pitco Frialator, Model E14, 16.5 kW, single vat, 50 lb capacity
Tubular, immersion type heating elements
Tested: November 23, 1989 - January 12, 1990

Elec 3: Frymaster, Model H-14, 14 kW, single vat, 50 lb capacity
2 low-watt density heating elements
Tested: January 13 - March 23, 1990

Gas IR: Frymaster, Model MJH50, 80,000 Btu/h, single vat, 50 lb capacity
2 infrared burners
Tested: June 10 - July 7, 1989
September 2 - September 22, 1989

Gas ATM: Dean, Model Decathlon-35, 85,000 Btu/h, single vat, 35 lb capacity
2 atmospheric burners
Tested: July 8 - September 1, 1989
September 23 - November 3, 1989

Gas CAT: Vulcan-Hart Frycat, Model CCFD-2, 85,000 Btu/h, split vat, 50 lb capacity
2 infrared, catalytic burners
Tested: May 1 - June 9, 1989
July 13 -August 17, 1990

These three gas and three electric floor model fryers also were evaluated under controlled conditions in PG&E's Food Service Technology Center within the scope of developing a Uniform Testing Procedure (UTP) for Fryers.[7]

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). Eight cooking appliances were centrally located on two sides of a utility distribution system (UDS), as illustrated in Figure 1-2. The UDS functioned as a central "spine," containing all plumbing, wiring, and natural gas distribution lines. The equipment island was ventilated by a 16-foot, double-sided canopy exhaust hood at a design air flow of 9,600 cfm. Makeup air was directed into the kitchen through grilles along the front face of the hood. Appliance Slot 10 was used by the research team during kitchen off-hours to conduct "dedicated," or controlled, laboratory-style testing on selected appliances.

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 were installed as an integral component of the UDS. This energy metering interfaced with a remote data acquisition and processing system. Appliance monitoring and performance evaluation was conducted apart from the food service operation. The operation and usage of the appliances were not influenced by the presence of the researchers, as the intent of the program was to evaluate the cooking equipment in a real-world environment.

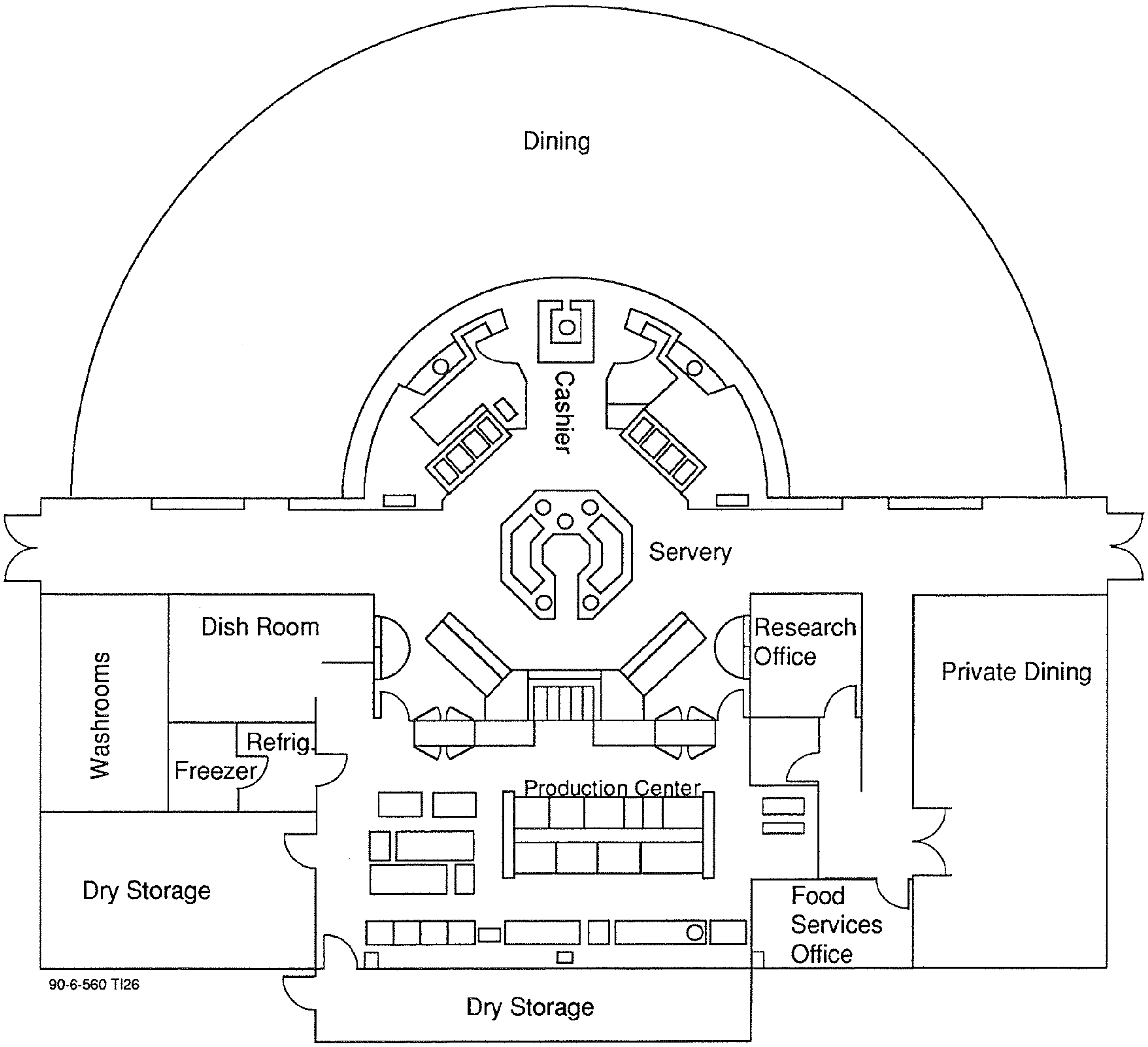
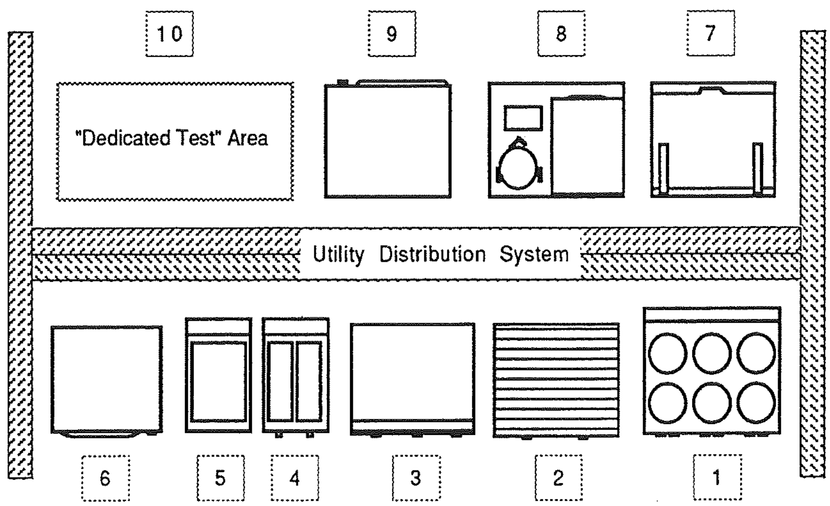


Figure 1-1. Dining facility, PG&E Learning Center.



Slot 1 - Range with Convection Oven
Slot 2 - Underfired Broiler
Slot 3 - Griddle
Slot 4 - Open Fryer
Slot 5 - Fryer "dump" station
Slot 6 - Half-Size Convection Oven
Slot 7 - Tilting Skillet
Slot 8 - Convection Steamer and Kettle
Slot 9 - Combination Convection Oven-Steamer
Slot 10 - Dedicated Test Area

Figure 1-2. The production center.

APPLIANCE DESCRIPTION AND INSTALLATION

Vulcan-Hart's gas deep-fat fryer, the Frycat, was installed in accordance with the manufacturer's installation manual in appliance Slot 4 (Figure 1-2). The manufacturer's specifications are summarized in Table 1-1 and detailed in Appendix A.

Table 1-1
Appliance Specifications

Manufacturer:	Vulcan-Hart Corporation (PMI Company)
Model:	Frycat CCFD-2, Gas
Rated Energy Input:	85,000 Btu/h
Heat Transfer:	Two catalytic heat exchanger tubes
Controls:	Independent temperature control of each vat with melt cycle and electronic ignition
Configuration:	Split vat with integral "cold zone"
Frying-Medium Capacity:	Minimum 50 lb, 25 lb per vat
Dimensions:	Width: 15-1/2 inches
Accessories:	2 fry baskets

Section 2

CONTROLLED ENERGY TEST

PURPOSE

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

1. Verify that the appliance was operating within the manufacturer's rated energy input.
2. Characterize preheat and idle energy use under selected operating conditions.

The controlled energy tests were conducted using a partially hydrogenated soybean based frying medium. The tests were carried out with both thermostats on and set at 350°F.

RESULTS

The results of the controlled energy tests are summarized in Table 2-1. The time and energy required to preheat the fryer are also illustrated in Figure 2-1. The Frycat consumed 14.3 kBtu over a 10-minute preheat period at an average energy input rate of 84 kBtu/h. The rate of idle energy consumption at 350°F averaged 9.2 kBtu/h, representing 11% of its measured energy input rate (i.e., 11% idle-energy factor).

Table 2-1

Summary of Controlled Energy Consumption

Rated Energy Input (kBtu/h):	85.0
Measured Energy Input Rate (kBtu/h]:	84.0
Preheat:	
Time @ 350°F (min):	10.1
Energy to 350°F (kBtu):	14.3
Idle Energy Input Rate @ 350°F (kBtu/h):	9.2
Idle-Energy Factor (%):	11.0
Control Circuit @ 120 Volts :	
Both thermostats on (kBtu/h):	0.434 (127 W)
Both thermostats off (kBtu/h):	0.334 (98 W)

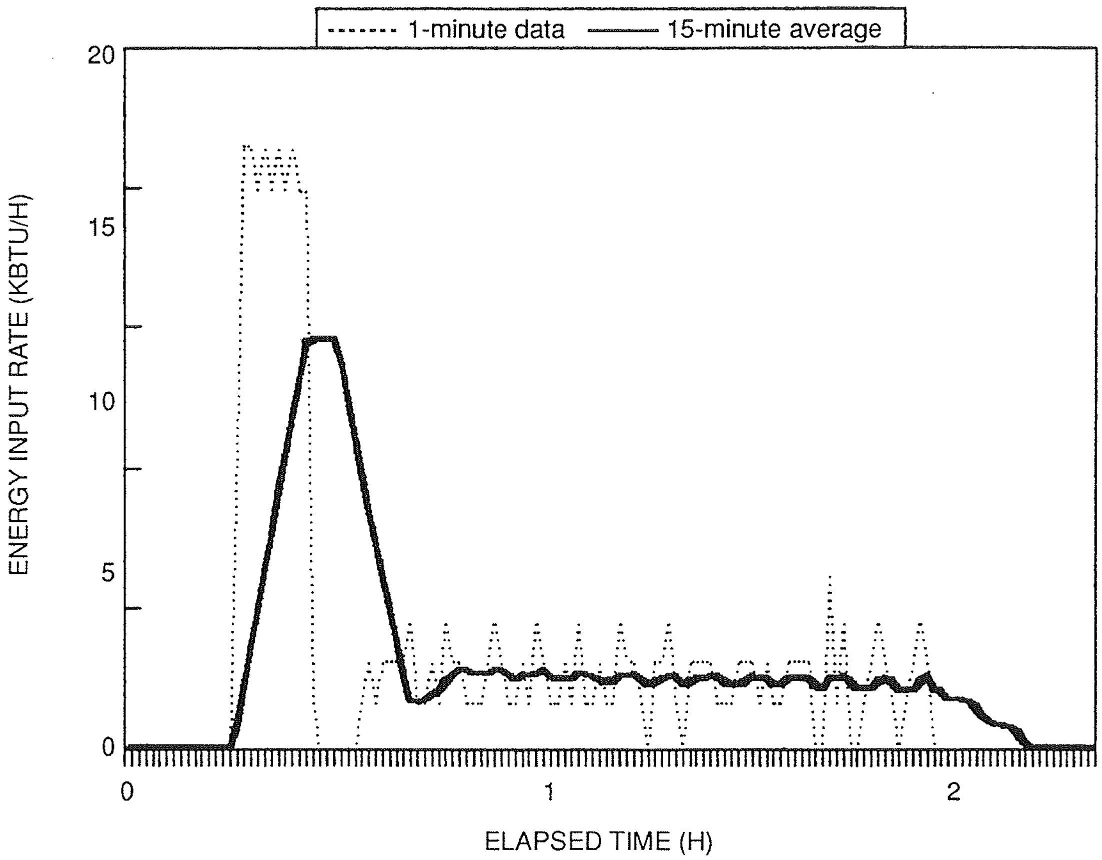


Figure 2-1. Fryer controlled energy test.

Note: The energy consumption profile for the controlled energy test is plotted on a 1-minute basis and on a 15-minute average. The 1-minute plot reflects the instantaneous input of energy into the appliance during preheat, while the 15-minute plot better characterizes the average rate of energy use.

Section 3

PRODUCTION MONITORING

ENERGY CONSUMPTION

Daily

In establishing the typical-day (see Section 6, Glossary) production-energy use for the fryer, the day-to-day energy data for the 2-month test period were reduced to include only those days where the fryer was used for two meal periods—lunch and dinner. Zero or minimal energy-use days and days when the fryer was used for breakfast were excluded as this was not considered typical of fryer usage over the monitoring period. The typical day energy performance of the Vulcan-Hart Frycat gas fryer summarized in Table 3-1 was based on the 15 days of energy use data presented in Appendix B. Note that the average production-energy use rate was based on the aggregate preheat, idle, and cooking energy for the entire day of appliance operation.

Table 3-1

Summary of Production-Energy Consumption

Rated Energy Input Rate (kBtu/h):	85.0
Measured Energy Input Rate (kBtu/h):	84.0
Average Production-Energy Use (kBtu/d):	125
Average Operating Time (h/d):	7.3
Average Production-Energy Use Rate (kBtu/h):[1]	17.1
Production-Energy Factor (%):	20.4

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

The average production-energy use rate (kBtu/h) was derived by dividing the energy consumption for the day by the corresponding hours of fryer operation. The production-energy factor was calculated by dividing the average production-energy use rate by the appliance's measured energy input rate.

The energy consumption profile plotted in Figure 3-1 characterizes the typical day production-energy use for the fryer. The energy consumption data are presented on a 1-minute basis (dotted-line plot) and on a 15-minute "sliding window" average (solid-line plot).

The 1-minute-interval plot reports the energy consumption of the fryer as it was logged by the data recorder (i.e., pulses output from the gas meter were accumulated over each minute of appliance operation). Thus, during the preheating of the fryer, the peak rate of energy input is displayed by the dotted-line plot. This peak energy input rate is not reflected during the idle and cooking periods because the burners were often not "on" for an entire minute, even though they consumed energy at the peak rate for the portion of each minute that the thermostat was calling for heat. The 15-minute-average plot better illustrates the average rate of energy consumption (i.e., it smooths the sharp peaks and valleys of the 1-minute plot).

The energy consumption plots illustrate that the fryer was used for two distinct periods (lunch and dinner) for a total operating time of approximately 7 hours. The higher energy consumption peaks at the beginning of each operation document the energy required to preheat the fryer to a given operating temperature (the thermostat was generally set at 350°F by the kitchen staff). Following each preheat period, the intermittent spikes above the idle or base rate of energy consumption reflect the incremental energy required to cook the food product that was loaded into the fryer .

Statistical Description. The frequency distributions for daily production-energy use and hours of operation within the 15-day data set are presented in Appendix B.

ESTIMATED ANNUAL ENERGY CONSUMPTION AND COST

Based on a two-meal-period use for a five-day food service operation, it was estimated that the fryer would consume 33,000 kBtu or 330 therms per year. The associated annual energy cost as shown in Table 3-2 is $146. The cost was calculated using PG&E's average gas rate (Schedule G-NRI) for small nonresidential customers (see Appendix C). For calculation purposes, it was assumed that the Production-Test Kitchen operated 22 days per month.

FOOD

Items Cooked

The fryer was used to cook lunch and dinner menu items. At lunch, it was primarily used to batch cook french fries and onion rings. It also fried foods such as chicken, fish, shrimp, clam strips, and spring rolls, depending on the menu for the day. At dinner, in addition to frying french fries and onion rings, the fryer was used on a cook-to-order basis for items such as tempura vegetables, beer battered shrimp, breaded clam strips, and specials such as Mexican chimichangas or Chinese eggrolls.

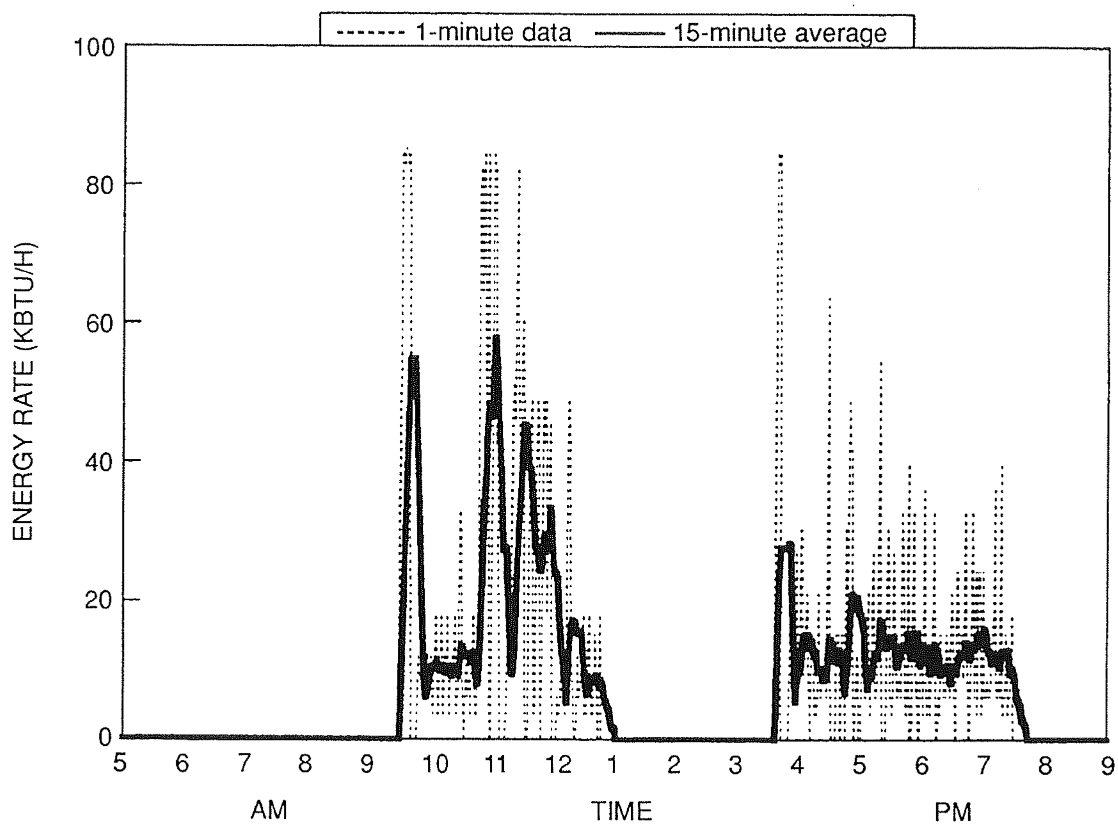


Figure 3-1. Energy consumption profile.

Table 3-2

Estimated Annual Energy Consumption and Cost ($)

Annual Energy Consumption:[1]	
125 kBtu x 22 days x 12 months	= 33,000 kBtu per year or 330 therms[2]
Estimated Annual Energy Cost:[3]	
330 therms x $0.54/therm	= $178 per year

[1]Energy use is based on a heating value of 1015 Btu/ft^3.
[2]1 therm = 100,000 Btu or 100 kBtu.
[3]Estimates are based on PG&E's G-NR1 rate schedule, effective July 1, 1990 (Appendix C).

Quantity Cooked

Levels of fryer production (i.e., quantities of food cooked) were recorded from standard food service production worksheets filled out on a daily basis by the cooks. From these worksheets, the menu mix for each meal period was identified. In some instances, the worksheet provided the weight (in pounds) of raw food product used in the production of a menu item. In other cases, the number of portions and portion size were recorded on the worksheet. These were subsequently used by the research team to estimate the quantity of food associated with these menu items. Where portion sizes were not given, standard product weights were determined from product specification sheets or product packaging information. Once the individual weight of each menu item was determined, the total weight of food cooked by the fryer was calculated for each day.

Previous investigation[1] of fryer energy consumption versus the quantity of food cooked had indicated that there was no correlation between these two variables. Although this was counter intuitive (i.e., the more food a fryer cooked, the more energy it should require), it was concluded that the small changes in energy requirements due to food product were being overshadowed by the changes in energy consumption due to variations in operating time and the associated increase or decrease in appliance idle time. Over this second phase of the fryer monitoring, it was decided to revisit the issue of energy consumption versus quantity of food cooked. An effort was made to develop a more consistent production-energy-use data set and to monitor the food production more accurately.

Given the random nature of frying on a cook-to-order basis during the dinner period, more precise data were available by monitoring the quantity of food cooked during the lunch period (10:00 A.M. to 1:00 P.M.). The recorded amount of food cooked over this 3.3-hour period for the 15-day data set ranged from 13 to 42 pounds, depending on the menu and customer count. On average, this fryer was used to cook 30 pounds of food at lunch, while consuming an average of 69 kBtu of energy.

A linear regression of "lunch" energy consumption against the quantity of food cooked (Figure 3-2) shows that the energy consumption was dependent on the amount of food according to the "best fit" equation:

$$Y = 48.5 + 0.71(X) \tag{3-1}$$

where

Y = lunch energy consumption (kBtu)

X = quantity of food cooked (lb)

It is important to recognize that the "best-fit" Y-axis intercept (i.e., 48.5 kBtu) represents the quantity of energy that would have been consumed by this fryer if it had been preheated and operated over the lunch period without being used to cook food. Thus, this value is independent of the quantity of food cooked. It also corresponds with an estimate of the Y intercept based on the controlled energy test data, where:

$$\text{Preheat Energy (14.3 kBtu)} + \text{Idle Energy (3.3 hours x 9.2 kBtu/h)} = 44.7 \text{ kBtu} \tag{3-2}$$

Observation Day

An in-kitchen observation day— the researchers observed and recorded actual production use of the fryer in the kitchen—supplemented the production worksheet method. The researcher's notes are included in Appendix C. The observation day, randomly selected by the researcher, was typical of the lunch usage pattern for the fryer in this kitchen. The fryer's thermostats were set at 350°F and both turned on at 10:00 A.M. in anticipation of starting to fry food at 10:40 A.M. The fryer was operated until 12:51 P.M. at which time it was shut off. Over this period, it cooked 32 pounds of food, of which 18 pounds were fries and 14 pounds were onion rings. Throughout the cooking period, one vat was used to fry french fries while the other fried onion rings. Both vats were turned on and off at the same time.

The fryer was again operated during the dinner period. It was turned on at 4:30 P.M. and used until 8:00 P.M. Each thermostat was set at 350°F. The fryer was primarily used to fry french fries (12 lb), onion rings (5 lb), beer battered shrimp (4 lb) and clam strips (1 lb). The shrimp and clams were cooked on a to-order-basis, while the fries and onion rings were cooked in small batches. Throughout this cooking period, the right vat was used to fry fries and onion rings, the left for shrimp and clams. As at lunch, both sides were operated for the same duration of time.

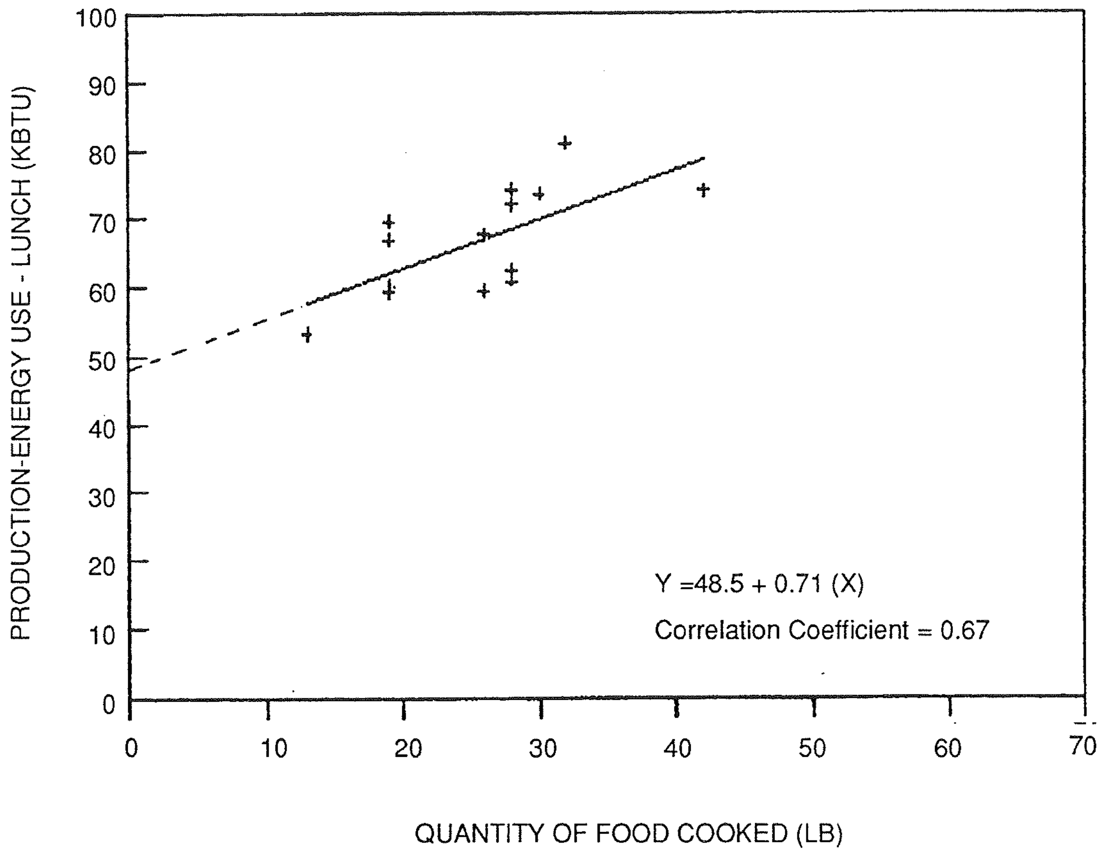


Figure 3-2. Energy use versus quantity of food cooked.

Section 4

CONCLUSIONS

GENERAL

The energy performance of the Vulcan-Hart Frycat as it was operated in the Production-Test Kitchen was successfully monitored and documented. Fryer usage by the production staff was typical of many food service operations in that they deep-fried standard food items such as french fries, onion rings, tempura vegetables, breaded seafood, chicken and, on occasion, Mexican or Chinese fare. Although the quantity of food cooked over the lunch period (an average of 10 lb per hour) was considered "light" in comparison to high volume fast food restaurants, it was considered to be representative of many corporate/commercial cafeteria operations offering a diverse menu mix to a varied customer base. This split vat fryer was used much like the single vat fryers that were operated and tested in the kitchen; that is, both vats were operated throughout the two meal periods. The fryer was operated an average of 7 hours per day—approximately 3 hours at lunch and 4 hours at dinner. It was routinely turned off between these two meal periods. The fryer thermostats were consistently set at 350°F, a standard temperature setting in commercial food service operations.

CONTROLLED ENERGY TESTING

The measured peak energy input rate for this fryer was 84 kBtu/h, confirming its 85-kBtu/h nameplate input. The fryer used 14.3 kBtu of energy over the 10-minute preheat that was required to bring the frying medium to 350°F. To maintain the frying medium at this temperature, 9.2 kBtu/h of idle energy input was required. Conducting controlled preheat and idle tests helped to characterize the fryer's performance under the real-life production conditions. For example, based on the controlled energy test data, it is possible to quantify the base-load component of the daily energy consumption (i.e., the energy that would have been consumed by the fryer if food had not been cooked).

PRODUCTION-ENERGY MONITORING

Daily production-energy consumption was relatively stable over the 2-month test period, ranging from 105 to 145 kBtu and averaging 125 kBtu per day. Based on the average operating time of 7.3 hours over two meal periods, this represented an average production-energy consumption rate of 17 kBtu/h. This rate is slightly higher than the rate reported by an earlier investigation[1] of this fryer, when it was used over 3-meal periods for a total on-time of 8.1 hours and a total energy usage of 126 kBtu/day. This represented an average production-energy use rate of 16 kBtu/h. The slight increase in the average rate of production-energy consumption is explained by a change in the way that the fryer was used by the food service staff during this second phase of fryer testing. During the second monitoring period, the two vats were almost always operated as a single vat fryer (i.e., both vats were operated over the duration of the cooking periods), whereas during the initial monitoring period[1], each vat was operated more independently (i.e., one of the thermostats was sometimes turned off during low production periods).

Production-Energy Factor

Based on the average rate of production-energy use of 17 kBtu/h and the measured energy input rate of 84 kBtu/h, an associated production-energy factor (i.e., average rate divided by peak input rate) of 20% was calculated for this fryer. This factor was one of the lowest that had been determined, when compared to the other appliance categories monitored in the Production-Test Kitchen (e.g., gas griddles @ 30%, gas broilers @ 95%).

FOOD PRODUCTION MONITORING

The standardized production worksheets that were routinely filled out by the fry-cooks proved to be an acceptable method for tracking daily levels of fryer production. Recording the quantity and type of food cooked over the lunch period showed that, for approximately 70% of the days in the 15-day data set, the fryer was used to cook only french fries and onion rings. The in-kitchen observation day was beneficial to understanding how the appliance typically was being used by the food service staff.

A linear regresson of lunch energy consumption against the quantity of food cooked demonstrated that, as larger quantities of food product were loaded into the fryer, the amount of energy consumed by the fryer increased, while the energy measured per pound of product cooked decreased.

ANNUAL ENERGY CONSUMPTION AND COST

It was estimated that the fryer would consume 33,000 kBtu (330 therms) of energy per year for this five-day-per-week food service operation. This corresponded to an annual energy cost of $178 based on PG&E's applicable commercial rate for natural gas (Schedule G-NRI), or an average monthly energy cost of approximately $14.

Section 5

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Section 6

GLOSSARY

1. **Rated Energy Input Rate** (kW, W or kBtu/h, Btu/h)
   Nameplate Energy Input Rate
   Rated Input
   Input Rating (ANSI definition)

   The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

2. **Measured Energy Input Rate** (kW, W or kBtu/h, Btu/h)
   Measured Peak Energy Input Rate
   Peak Rate of Energy Input
   Measured Input

   The maximum or peak rate at which an appliance consumes energy, measured during appliance preheat (i.e., the period of operation when all burners or elements are "on").

3. **Preheat Time** (minute, hour)
   Preheat Period

   The time required for an appliance to "preheat" from the ambient room temperature to a specified (and calibrated) operating temperature or thermostat set point.

4. **Preheat Energy Consumption** (kWh or kBtu)
   Preheat Energy

   The total amount of energy consumed by an appliance during the preheat period.

5. **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).

6. **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.

7. **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.

8. **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.

9. **Base-Load Energy Consumption Rate** (kW or kBtu/h)
Base-Load Energy Rate
Base-Load Rate
Base 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.

10. **Base-Load Energy Consumption** (kWh or kBtu)
Base-Load 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.

11. **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.

12. **Daily Energy Consumption** (kWh or kBtu)
Daily Production-Energy Consumption
Daily Energy Use
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.

13. **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.

14. **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.

15. **Appliance On-Time** (minute, hour)
Operating Time
Hours of Operation
Operating Period

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 that it is turned "off." Appliance on-time excludes any "off" periods between the first and last appliance operation.

16. **Average Production-Energy Consumption Rate** (kW or kBtu/h)
Average Production-Energy Use Rate
Average Production-Energy 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.

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

17. **Production-Energy 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.

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

18. **Idle-Energy Factor** (%)

The Idle-Energy Consumption Rate expressed as a percentage of the Measured Energy Input Rate.

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

19. **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:

i. Typical day energy consumption should approximate average daily energy consumption for energy-use data set.

ii. A specified number of appliance operations and/or cooking periods (e.g., lunch and dinner only).

iii. A specified range in operating hours.

iv. A specified mode of operation (or combination of modes) may be associated with a typical day's operation.

20. **Energy-Use Data Set**

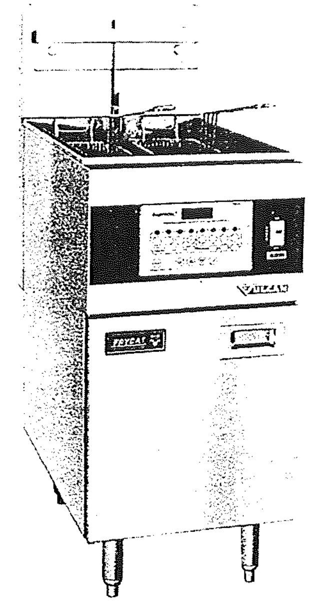
A set of daily energy consumption data compiled in accordance with typical day criteria.

Appendix A

MANUFACTURER'S PRODUCT SPECIFICATIONS

VULCAN

FRYCAT ™ CATALYTIC FRYERS
Models CCFD-1 & CCFD-2
Deluxe Models



CCFD-1
(Shown with optional computer control system)

STANDARD FEATURES:

Over 70% thermal efficiency
Production capacity, 85 lbs. of frozen french fries/hr.
Electronic ignition
Stainless steel front and both sides
Stainless steel fryer tank
Stainless steel removable basket hanger
Electronic temperature controller
Seven foot 120 volt power supply cord
Dual high limit protection
Melt cycle
Combustion air filter
50 lbs. frying compound capacity (Single vat)
25 lbs. frying compound capacity (Each side of split vat)
Design certified by A.G.A.
Listed by N.S.F.

OPTIONAL FEATURES & ACCESSORIES

- ☐ **Computer control system**
- ☐ **Stainless steel tank cover(s)**
- ☐ **Extra twin or single fryer basket(s)**
- ☐ **Automatic basket lifts**
- ☐ **Filter system in matching cabinet**
- ☐ **Frymate drain and hold unit in matching cabinet**
- ☐ **Built-In food warming light over drain unit**
- ☐ **Casters**
- ☐ **Quick disconnect flexible hoses**

GENERAL: The Vulcan 15½" Deluxe Frycat Catalytic Fryer has an energy efficiency of over 70%. It uses the proven efficency of infrared heat and the cold zone of a tube type fryer. The infrared heat is supplied by patented catalytic power burners. This 50 pound frying compound capacity fryer requires only two heat exchanger tubes rather than the standard four tubes.

SINGLE VAT: The CCFD-1 is 15½" (394 mm) wide and has an 85,000 B.T.U. per hour input for natural or propane gas. Production capacity is 85 pounds of ¼" frozen blanched fries per hour.

SPLIT VAT: The CCFD-2 is 15½" (394 mm) wide with two independently controlled separate vats. Each vat holds 25 pounds of frying compound and has a 42,500 B.T.U. per hour input for natural or propane gas. Vats may be operated at different temperatures for different products. Vats are drained independently.

NOTE: Due to a 25 lb. (11 kg) reservoir of heated fry compound rather than 50 lbs. (22 kg) in a single vat, production capacity for each split vat will be slightly less than 50% of full vat production.

ELECTRONIC IGNITION: With the power switch on and the temperature calling for heat, a direct spark ignition system ignites the automatic flow of gas and air into the catalytic burners. Once ignition is achieved, the ignitor shuts off. If ignition is not achieved within 4 seconds, the gas supply shuts down. A trouble light on the control panel will illuminiate indicating that ignition has failed. Gas cannot flow through the unit if ignition fails. The power button must be pushed "off" and back "on" for reignition.

ELECTRONIC THERMOSTAT AND DUAL LIMIT CONTROLS: For users requiring stringent temperature accuracy, the Deluxe Frycat Fryer uses an electronic thermostat. The electronic temperature control with thermistor probe maintains temperature accuracy with ± 3°C (±1.7°C) of set point. Dial(s) marked for a temperature range of 200° to 375°F (93° to 190°C). The fry compound is protected from overheating by a dual back-up temperature limit control system. The limit control will shut the unit down if the fryer temperature exceeds 410°F (210°C). If the first shut off device should not function, a second oven temperature gas shut off device responds if the frying compound temperature rises another 25°F (14°C).

MELT CYCLE: The solid state temperature control package includes a fat melt cycle. The melt cycle feature allows melt down of solid fry compound. Switch on the melt cycle to liquify the frying compound. After the compound has completely melted, return the switch to "fry" function and resume normal frying procedures. A 50 pound block of solid frying compound can be liquified in approximately 30 minutes. If liquid fry compound is used leave melt cycle off.

FRYER VATS: Vats are 16 gauge stainless steel with a satin glass peened finish. An oil level fill line is clearly embossed in each vat back. Full port drains are provided in each fryer.

NOTE: Two 1" full port drains are provided, one for each split vat unit.

BODIES: Bodies have a stainless steel front and both sides. Bottom and back are aluminized steel. Units are available in single 15½" (394 mm) wide, double 31" (787 mm) wide and triple 46½" (1181 mm) wide batteries. 9" (229 mm) adjustable legs are standard. A 15½" (394 mm) wide matching Frymate (drain and hold unit) is available. Model CCF-0 Frymate holds and drains fried foods. Top has a lift out screen. The center drain leads into a 3 qt. drain pan. Stores four standard No. 200 pans. (Pans not supplied). A filter system in a matching 15½" (394 mm) cabinet is available with either a flat stainless steel top work surface or with a cut out for factory supplied 12" x 20" (305 x 508 mm) perforated pan.

REAR QUICK DISCONNECT FLEXIBLE HOSES: Use when the operator wants to be able to roll the fryer away from the wall for sweeping or mopping behind the fryer. (Optional)

CASTERS: With quick connect flexible hose connections, casters make it easier to move the fryer away from the wall. (Optional)

FRYCAT CATALYTIC FRYERS
Models CCFD-1 & CCFD-2
Deluxe Models

GAS VALVE AND PRESSURE REGULATOR: Supplied with a combination gas pressure regulator and gas valve. Pressure setting 3.0" (76 mm) W.C. for natural gas, 9.0" (228 mm) W.C. for propane gas. (Specify which gas when ordering)

UTILITY CONNECTIONS: A single 1" (25 mm) pipe gas connection is provided for single, double or triple body units. Each unit is supplied with a 7 foot (2.1 meters) long electrical cord with a 3 prong grounding plug. The standard electric power source is 115 volts (1½ amps per body). Other voltages may be supplied upon request.

NOTE: When fryer is purchased in a battery with a filter system a 21 inch (533 mm) clearance from the filter door into the aisle of the work station must be maintained for filter drain tank removal.

Listed by the National Sanitation Foundation.

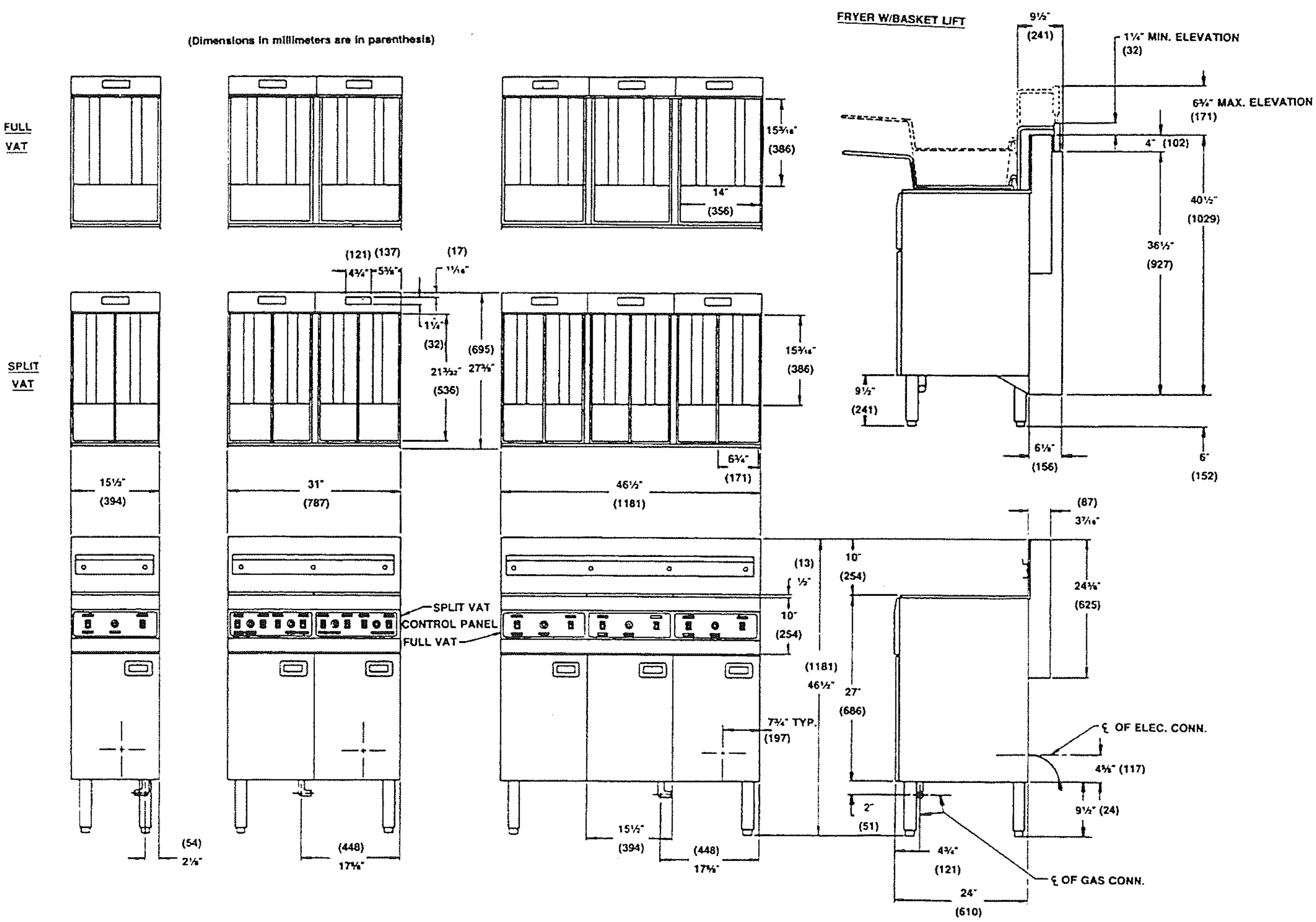
Design Certified by the American Gas Association.

Model Number Key:
Single Vat Fryer: CCFD-1
Split Vat Fryer: CCFD-2
Frymate: CCF-0
Filter: CCF-F
Example of Battery Model Number:

Single Vat, Split Vat, Single Vat:	CCFD - 1 2 1
Single Vat, Frymate, Split Vat:	CCFD - 1 0 2
Single Vat, Single Vat, Filter System, Split Vat:	CCFD - 1 1 F 2

IMPORTANT

1. A pressure regulator is provided for this unit. Natural Gas 3.0" (76 mm) W.C. Propane Gas 9" (228 mm)
2. An adequate ventilation systemis required for Commercial Cooking Equipment. Information may be obtained by writing to the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269. When writing refer to NFPA No. 96.
3. All models require a 6" clearance at both sides and rear adjacent to combustible construction.



GF-12 4/86

NOTE: In line with its policy to continuously improve its products Vulcan-Hart Corporation reserves the right to change materials and specifications without notice

Appendix B

ENERGY-USE DATA SET AND STATISTICAL DESCRIPTION

Production-Energy-Use Data for Vulcan-Hart FryCat Gas Fryer

Date	Energy Use (kBtu)	On-Time (Hour)	Average Rate of Production-Energy Use (kBtu/h)
07/16/90	126.5	7.2	17.7
07/18/90	147.8	7.1	20.9
07/19/90	137.8	8.6	16.1
07/23/90	116.8	6.5	18.0
07/24/90	118.1	8.2	14.5
07/2590	122.4	7.9	15.5
07/26/90	125.8	8.1	15.6
07/30/90	125.3	6.6	18.9
08/01/90	117.7	7.1	16.6
08/02/90	113.4	7.1	15.9
08/06/90	131.1	6.9	19.1
08/07/90	114.3	6.4	17.9
08/08/90	116.6	6.1	19.1
08/09/90	123.2	7.9	15.6
08/13/90	140.2	8.6	16.2
Average	**125.1**	**7.3**	**17.1**

Statistical Analysis of Production-Energy-Use Data Set

	Energy Use (kBtu)	On-Time (Hour)	Average Rate of Production-Energy Use (kBtu/h)
Maximum	147.8	8.6	20.9
Average	125.1	7.3	17.1
Minimum	113.4	6.1	14.5
Standard Deviation of 15 Days	9.8	0.8	1.7

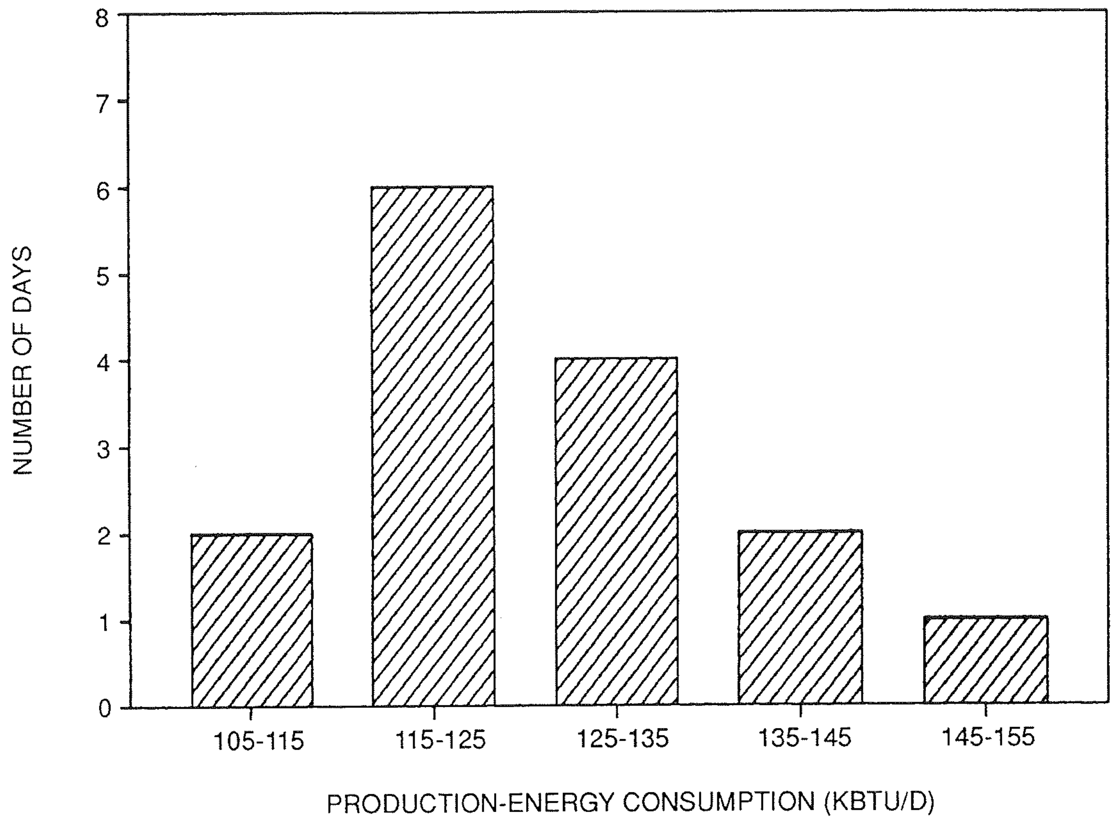


Figure B-1. Frequency of production-energy consumptions.

The distribution of daily energy consumption shows that 115 to 135 kBtu of energy was consumed approximately 67% of the time. The average production-energy consumption was 125 kBtu/d with a standard deviation of 9.8 kBtu/d.

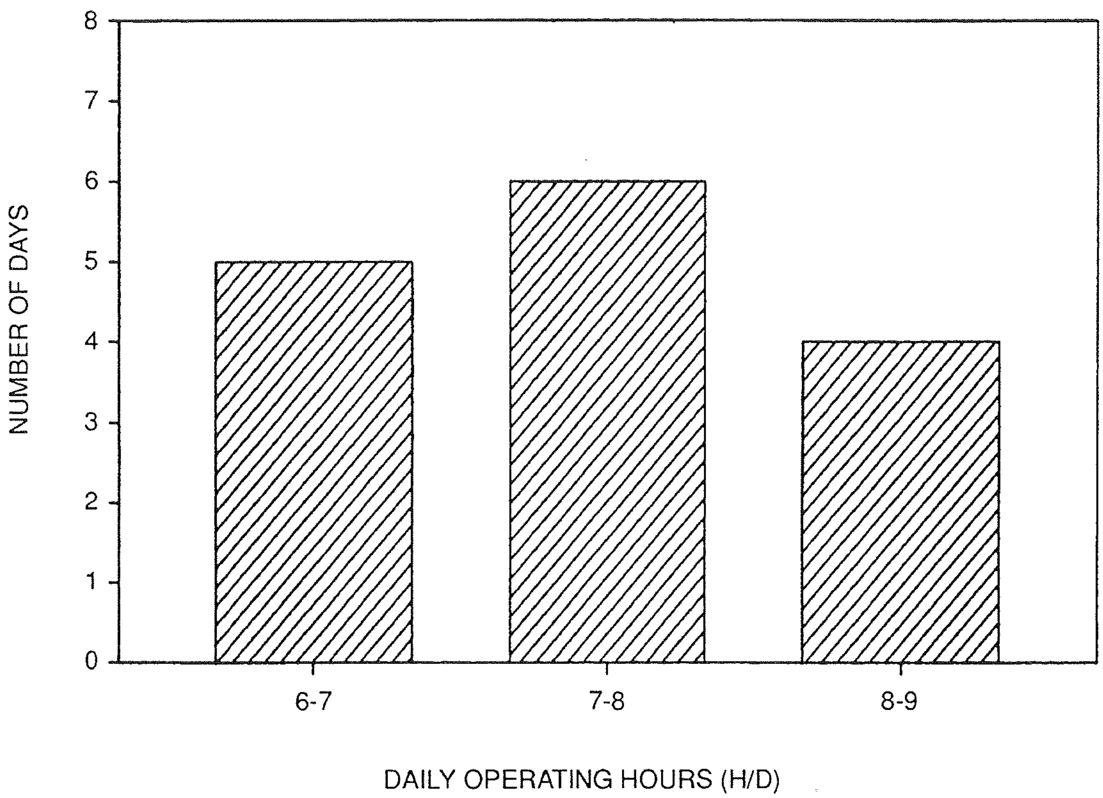


Figure B-2. Frequency of daily operating hours.

A normal distribution of operating hours is reflected, with 40% of the days showing between 7 and 8 hours of fryer use per day, 33% between 6 and 7 hours, and 27% between 8 and 9 hours. The average operating time was 7.3 hours with a standard deviation of 1.7 hours.

Appendix C

PG&E GAS RATES

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

APPLICABILITY: Schedule G-NR1 applies to the combined sale and transportation of natural gas. If you take service at Schedule G-NR1 rates, you must be a nonresidential customer, the uses to which you put the gas must be among those classified in PG&E's priority sequence as P1, P2A, P2B or P3A, and your average monthly use must not have exceeded 20,800 therms in those months during the last 12 months in which you used more than 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 twelve billing months ending in the most recent calendar year.

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

RATES: You will pay the following charges under this schedule:

	Per Month
Customer Charge	$11.37(R)
Delivered Commodity Charge:	Per Therm
Winter Service	$0.63934(I)
Summer Service	$0.47358(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 you are taking service under this schedule in conjunction with any noncore service at the same premises, you can qualify for gas transportation service. The transportation rate per therm will be the commodity rates shown above less the applicable Schedule G-PC rate. If you elect such transportation service, you will be required to sign a Natural Gas Transportation Service Agreement (Form No. 79-735) and a Natural Gas Supply Agreement (Form No. 79-736). In the event that your full requirement is not received by PG&E, any additional natural gas you require will be provided by PG&E under the terms and conditions of Schedule G-PN.

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

Appendix D

OBSERVATION DAY NOTES

OBSERVATION DAY - RECORD SHEET

APPLIANCE: Gas Split Vat Fryer

TEST DATE: 08-08-90

OBJECTIVE: To observe in-kitchen fryer use in the Production-Test Kitchen
OBSERVATIONS:

Both thermostats were set at 350°F and turned on at 10:00 A.M. in anticipation of starting frying at 10:40 A.M. Both vats were operated at 350°F throughout the cooking periods. This fryer was used like a single vat fryer.

Throughout the lunch period one vat was used to fry fries, while the other fried onion rings. At dinner, the right vat cooked fries and onion rings, and the left was used for shrimp and clam strips.

Frozen french fries and onion rings were removed from the walk-in freezer and stored in the reach-in close to the fry station. Several bags/boxes of each were kept next to the fryer on a cart.

French fries are generally cooked for 3 minutes, onion rings for 2 minutes.

French fries: Grade A Extra Long Fancy (Steak Fries) 30 lb/case
Onion rings: Breaded 20 lb/case

Time	Event	Estimated Food Quantity [lb]
A.M.		
10:00	Fryer start-up	
10:45	Load 2.5 lb fries into right basket	2.50
	Load 2.3 lb onion rings into left basket	2.30
11:00	Load 2.3 lb onion rings into right basket	2.30
11:03	Load 2.5 lb fries into left basket	2.50
11:04	Remove onion rings	
11:05	Remove fries	
11:07	Load 2 lb onion rings into left basket	2.00
11:08	Load 2.3 lb fries into right basket	2.30
11:10	Remove onion rings	
11:13	Remove fries	
11:18	Load left basket with 2.3 lb onion rings	2.30
11:20	Load 2.3 lb fries into right basket	2.30
11:22	Unload onion rings	
11:24	Unload fries	
11:28	Load 2.3 lb fries into right basket	2.30
11:31	Remove fries	

11:38	Load 2.3 lb onion rings into left basket	2.30
	Load 2.5 lb fries into right basket	2.50
11:41	Remove onion rings	
11:42	Remove fries	
P.M.		
12:05	Load 1.3 lb fries into left basket	1.30
12:09	Remove fries	
12:10	Load 2.5 lb fries in right basket	2.50
12:13	Remove fries	
12:24	Cook 2.5 lb fries in right basket	2.50
12:28	Unload fries	
12:35	Cook 1.3 lb onion rings in left basket	1.30
12:37	Remove onion rings	
12:51	Shut down fryer—both thermostats are turned off	
	Lunch Total	32.00
04:30	Turn fryer on, thermostat set at 350°F	
05:00	Load fries into both baskets	5.00
05:05	Remove right basket	
05:06	Remove left basket	
05:12	Load 1.5 lb fries into right basket	1.50
	Cook 6 portions shrimp (7.5 oz/portion) in left basket	3.00
05:25	Load 1 lb onion rings into basket	1.00
	Load 2 lb fries into other basket	2.00
05:27	Remove onion rings and fries	
05:45	Load 2 lb fries into right basket	2.00
	Cook 2 orders shrimp in left basket	1.00
05:48	Remove shrimp	
06:20	Load 2 lb fries into right basket	2.00
06:25	Ran out of french fry inventory	
06:27	Load 1lb onion rings into baskets	2.00
06:30	Fry 2 orders (6-8 oz) clam strips	1.00
06:35	Load onion rings into baskets	1.00
07:20	Load onion rings into baskets	1.00
08:00	Shut down fryer	
	Dinner Total	22.00
	Total	54.00