Vulcan-Hart Model VR-4 Heavy-Duty Electric Range: Application of ASTM Standard Test Method F 1521-94

Report 5011.94.7

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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's 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 6,700-square-foot appliance research laboratory 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.

The Food Service Technology Center actively provides food service information to PG&E's customers through classes, demos and through PG&E's marketing representatives. Food Service Technology Center technical publications are available to PG&E customers as well as the general public.

ACKNOWLEDGMENTS

The 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 Vulcan-Hart Corporation for supplying PG&E with an electric range for testing at the Food Service Technology Center.

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, McDonald's Corporation, Darden Restaurants, Inc. (formerly General Mills Restaurants), Marriott International, and International Facility Management Association (IFMA).

EXECUTIVE SUMMARY

This study documents the performance of the Vulcan-Hart model VR-4 electric range top as determined by applying the American Society for Testing and Materials' (ASTM) *Standard Test Method for the Performance of Range Tops* (Designation F 1521).

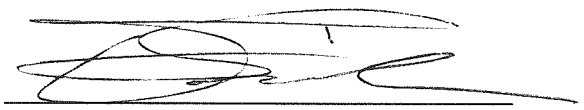
Range top performance is characterized by temperature response and uniformity, energy consumption, cooking energy efficiency, and production capacity. A summary of the cooking energy efficiency and production capacity test results is presented in Table ES-1.

Table ES-1

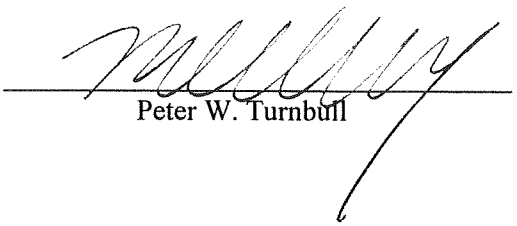
Cooking Energy Efficiency and Production Capacity Test Results

Type of Cooking Unit:	French Plate	Speed Coil
Energy Input Rate Per Cooking Unit:	2.0 kW	2.0 kW
Average Temperature at Minimum Input:	210°F	289°F
Average Temperature at Maximum Input:	788°F	787°F
Cooking Energy Efficiency (without pot):	76.1%	68.3%
Cooking Energy Efficiency (with pot):	80.4%	72.2%
Production Capacity Per Cooking Unit:	38.9 lb/h	34.7 lb/h

The Vulcan-Hart VR-4 is an excellent example of a standard, heavy-duty range top. There are six elements on the range top; four solid "french plate" elements and two open coil or "speed coil" elements. These test results are useful not only in quantifying the performance of this range top but also as a benchmark against which other range top designs can be compared.

FSTC Manager 

Donald R. Fisher

Technical Support Supervisor 

Peter W. Turnbull

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Section 1

INTRODUCTION

BACKGROUND

PG&E's Food Service Technology Center (FSTC) is developing uniform testing procedures (UTPs) to provide standard methods of testing commercial cooking appliances. We are submitting these procedures to the American Society for Testing and Materials (ASTM) for approval as national standard test methods. The data gathered in the application of these tests allow PG&E to educate end users about energy-efficient commercial cooking equipment. Terms used in this report are defined in the glossary (Appendix A). Support for the development and application of these test procedures comes from the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), and the National Restaurant Association.

OBJECTIVES

The *ASTM Standard Test Method for the Performance of Range* Tops[1] was applied to the Vulcan-Hart model VR-4 electric range top to evaluate its performance under tightly specified, repeatable conditions. The scope of this testing is as follows:

- Verify that the appliance is operating at the manufacturer's rated energy input.
- Characterize the minimum and maximum temperature rise and temperature uniformity.
- Document the cooking energy efficiency at half- and full-input rates.
- Determine the production capacity.

APPLIANCE DESCRIPTION AND OPERATION

The 12.0 kW electric range cooktop includes four solid "french plate" elements and two open coil or "speed coil" elements, each rated at 2.0 kW. Appliance specifications are given in Table 1-1. The manufacturer's specification sheet is in Appendix B and the data sheets generated during testing are in Appendix C.

Cooking utensils are supported directly on top of the elements and each element is manually controlled by a front-mounted control knob. The french plates have a high temperature switch built into the element which reduces the energy input rate to 1.0 kW when no load is on the element.

Table 1-1

Appliance Specifications

Generic Appliance Type:	36" all-purpose heavy-duty range cooktop
Manufacturer:	Vulcan-Hart Corporation
Model:	VR-4
Rated Input:	12.0 kW (range cooktop only)
Cooking units:	4 - french plate and 2 - speed coil elements, 2.0 kW each
Dimensions:	36" wide by 38-1/4" deep by 37" high (to work surface)
Construction Material:	Steel with a stainless-steel front

TEST SETUP/INSTRUMENTATION

The range was installed on a tiled floor under a 4-foot-deep canopy hood that was 6 feet 6 inches above the floor. The hood operated at a nominal exhaust rate of 300 cfm per linear foot of hood. There was at least 6 inches of clearance between the vertical plane of the range top and the edge of the hood. All test apparatus were installed in accordance with Section 8 of the ASTM standard.[1] Because there are two types of cooking units on the range top, all tests were performed on both a french plate and a speed coil element.

Electric energy consumption was measured with a calibrated watthour meter with a 10-watthour resolution. Cooking unit temperature rise and uniformity were measured with K-type thermocouples strain-gage-welded to a 12-inch diameter, 1/4-inch-thick steel plate. Water temperature was measured with T-type immersible thermocouple probes. The cooking container used for testing was an aluminum Wear Ever Model 4332, 12-in diameter, 14-qt, sauce pot weighing 4.53 lb, with an aluminum lid weighing 1.14 lb. Each test load consisted of 20 lb of water. All data were logged using a Fluke Helios data logger and recorded on a PC. The testing software was developed by the FSTC using Microsoft® Visual Basic™ Professional Version. Voltage is maintained at 208V with a voltage regulator.

Section 2

RESULTS

INPUT RATE TESTS

Input rate tests were performed on the six cooking units in accordance with the ASTM test method. The energy input rates for the four french plates varied an average of 0.25% from the manufacturer's 2.0 kW rating while the two speed coils varied an average of 2.75%. The input rate for all six elements operating at once was 1.1% lower than the 12.0 kW nameplate of the range top.

TEMPERATURE RESPONSE AND UNIFORMITY TESTS

FSTC researchers attached 17 thermocouples to a 1/4-inch-thick, 12-inch-diameter carbon steel plate, as detailed in section 10.4 of the ASTM test method. The cooking unit was turned on to the minimum control setting and time, temperature, and energy were recorded over the next hour. Input rate at the minimum setting was 0.17 kW for the french plate and 0.28 kW for the speed coil. Based on the 17 temperature measurement points, the average plate temperature at the end of the hour for the french plate test was 210°F, with a standard deviation of 8°F. For the speed coil test, the average temperature was 289°F with a standard deviation of 23°F. The test was repeated with the cooking unit controls at the maximum setting (an input rate of 1.92 kW for the french plate and 1.94 kW for the speed coil) and the average plate temperature at the end of the hour was 788°F, with a standard deviation of 124°F for the french plate while the speed coil temperature was 787°F with a standard deviation of 136°F. The average temperature rise for each test is plotted in Figures 2-1 and 2-2.

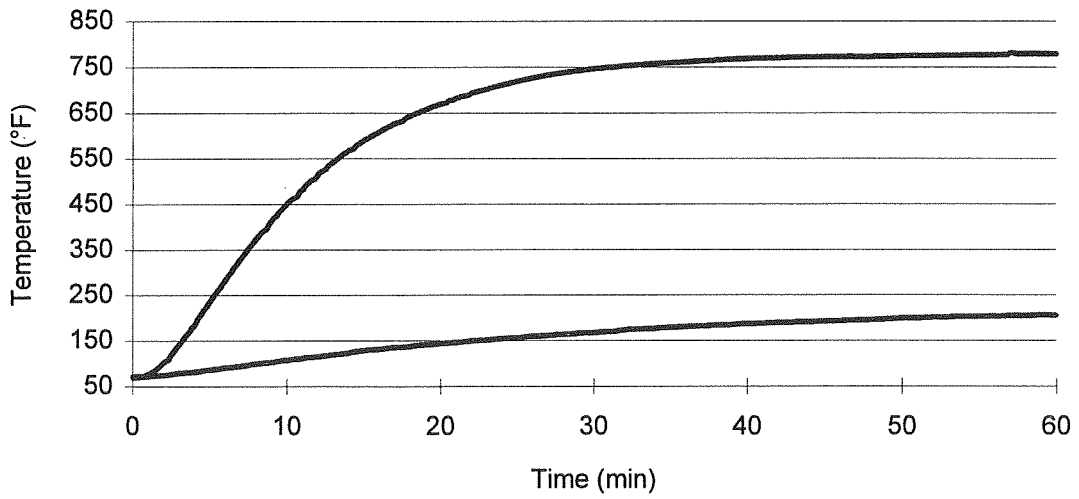


Figure 2-1. Temperature rise on french plate element at maximum and minimum settings.

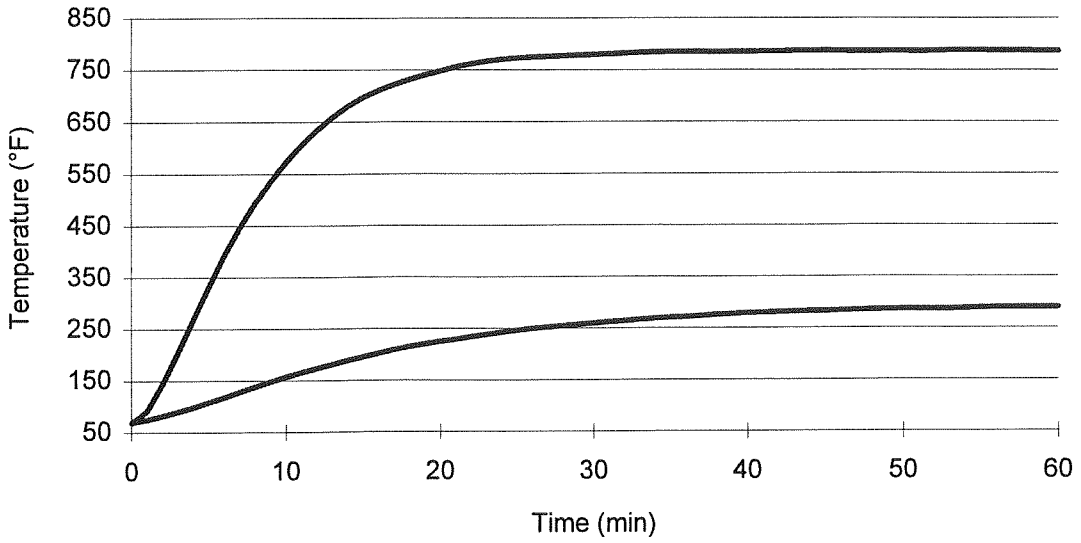


Figure 2-2. Temperature rise on speed coil element at maximum and minimum settings.

COOKING PERFORMANCE TESTS

Table 2-1 presents the results of the cooking energy efficiency and production capacity tests for the range top. Three test runs were performed at half-input rate and three were performed at full-input rate in accordance with section 10.5 of the ASTM test method. The FSTC is planning to submit to ASTM a revised *Standard Test Methods for the Performance of Range Tops* which will include the weight of the cooking container in the energy efficiency equation. In anticipation of this revision, the cooking energy efficiency data in Table 2-1 reports the efficiency with and without the weight of the cooking container. The production capacity per cooking unit remains the same with or without the cooking container because only the weight of the water is considered in production.

Table 2-1

Cooking Energy Efficiency and Production Capacity Test Results

Type of Cooking Unit:	French Plate			Speed Coil		
Cooking Energy Efficiency	without pot	with pot	uncertainty	without pot	with pot	uncertainty
Half-Energy Input Rate:	69.8%	73.8%	3.4%	66.1%	69.8%	1.4%
Full-Energy Input Rate:	76.1%	80.4%	6.2%	68.3%	72.2%	1.6%
Production Capacity Per Cooking Unit						
Half-Energy Input Rate:	17.7 lb/h			16.3 lb/h		
Full-Energy Input Rate:	38.9 lb/h			34.7 lb/h		

In Figure 2-3 and 2-4, production rate is plotted against input rate for the french plate and speed coil elements. Knowing the energy input rate required to achieve a desired production rate is helpful in estimating the cost of operation.

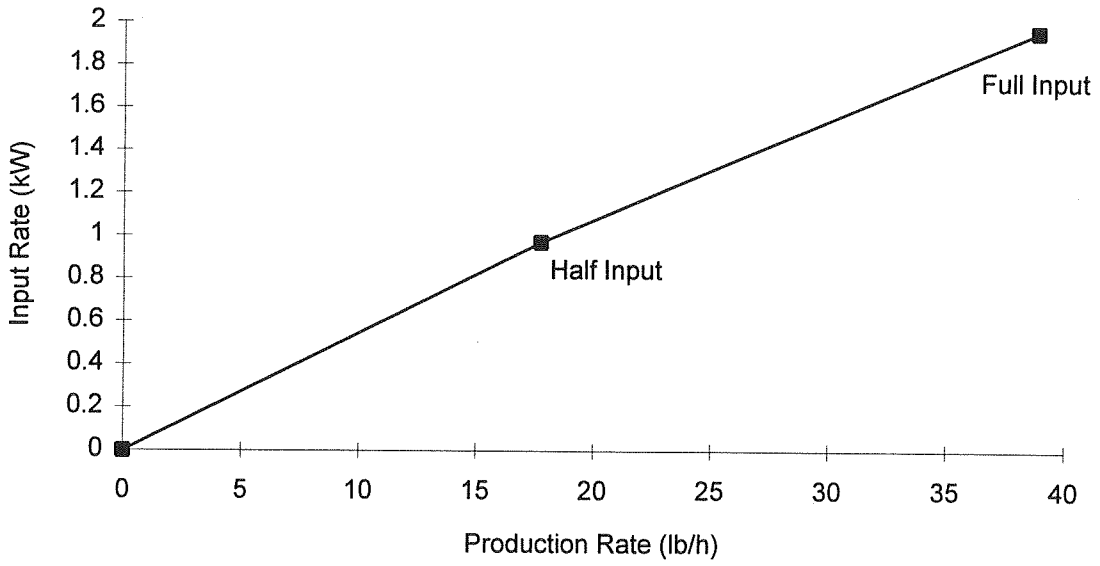


Figure 2-3. Energy input rate vs. production rate for french plate element.

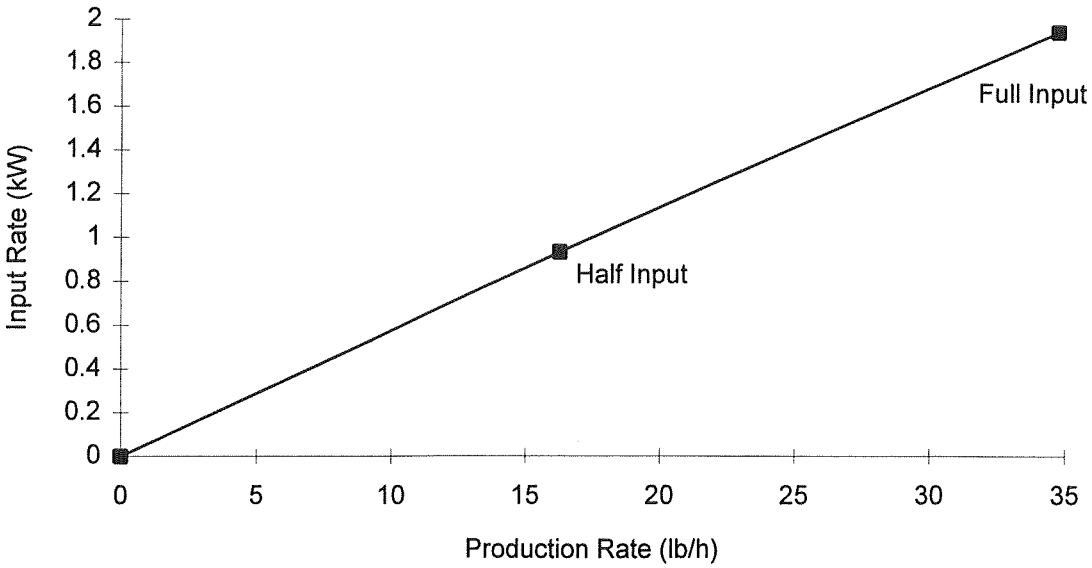


Figure 2-4. Energy input rate vs. production rate for speed coil element.

Section 3

CONCLUSIONS

Range top energy use and performance were accurately tested and quantified during application of the uniform test procedure for range tops. Temperature response and uniformity test results help to characterize the heat transfer of both the french plate and speed coil elements. At full input, the french plate delivered enough heat to the test plate to raise the average temperature to over 600°F within 15 minutes, reaching a final average temperature of 788°F, while the speed coil raised the temperature to over 700°F with a final temperature of 787°F. At minimum input, the french plate average temperature was 210°F and the speed coil average temperature was 289°F. Heat produced by both types of elements at both the minimum and maximum input rates was evenly distributed over the surface of the elements. At the maximum input rate, the temperatures measured at the edges of the test plate (where there is no direct contact with the surface of the element) dropped off by more than 100°F for both types of elements.

The cooking energy efficiencies for the french plate and speed coil, respectively, at the half-input rate were 69.8% and 73.8%, rising to 76.1% and 80.4% at the full-input rate. The revised cooking energy efficiency, which includes the weight of the cooking container, for the french plate and speed coil, respectively, at half-input rate are 66.1% and 68.3%, and 69.8% and 72.2% at full-input rate. Based on a temperature rise from 70° to 200°F, the production rate for the french plate was 17.7 lb/hr at the half-input rate and 38.9 lb/hr at the full-input rate while the speed coil production rates were 16.3 lb/h at half-input and 34.7 lb/h at full-input.

Section 4

REFERENCES

1. American Society for Testing and Materials. ASTM F 1521-94. *Standard Test Methods for the Performance of Range Tops*. In *Annual Book of ASTM Standards*. Philadelphia: American Society for Testing and Materials. This test method can be purchased from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

Appendix A

GLOSSARY

GLOSSARY

Cooking Energy

Energy consumed by the range top as it is used to cook at half- and full-energy input rates.

Cooking Energy Efficiency

The quantity of energy input to the food, expressed as a percentage of the quantity of energy input to the range top during the half- and full-energy input rate cooking energy efficiency tests.

***Energy Input Rate* (kW or kBtu/h)**
Energy Consumption Rate
Energy Rate

The rate (Btu/h or kW) at which an appliance will consume energy.

Range Top

A device for cooking food by direct or indirect heat transfer from one or more cooking units to one or more cooking containers.

Heating Value
Heating Content

The quantity of heat (energy) generated by the combustion of the fuel. For natural gas, this quantity varies depending on the constituents of the gas.

***Pilot Energy Consumption* (kBtu)**
Pilot Energy Use
Standing or Constant Pilot Energy Consumption
Standing or Constant Pilot Energy Use

The rate of energy consumption by the standing or constant pilot(s) while the appliance is not being operated (i.e., when the thermostats or control knobs have been turned off).

Production Capacity

The production rate (lb/h) of the range top as it is used to cook at half- and full-energy input rates.

Test Method

A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

Temperature Response

The temperature rise measured on the surface of a steel plate during the test period in accordance with the heat-up temperature-response test.

Temperature Uniformity

The comparison of individual temperatures measured on the surface of a steel plate at the end of the test period in accordance with the heat-up temperature-response test.

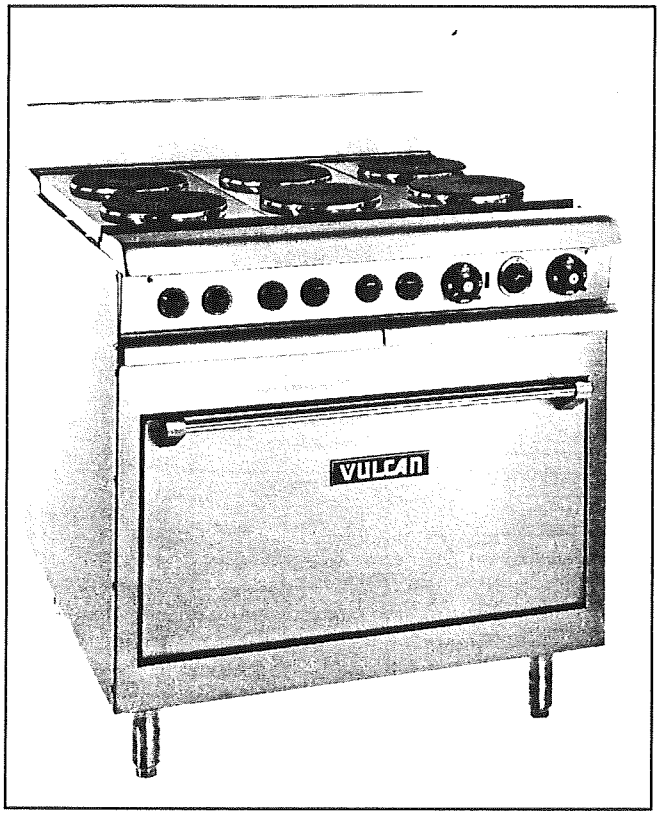
Appendix B

MANUFACTURER'S PRODUCT SPECIFICATIONS

VULCAN

Item # _____

VR4 SERIES
Heavy Duty Electric Hot Plate Range



Listed by Underwriters Laboratories, Inc.
Listed by the National Sanitation Foundation

SPECIFICATIONS:
Heavy duty floor model hot plate range, with oven below. To be Model No. (VR4) (VR4C), manufactured by Vulcan-Hart. Range front and legs to be stainless steel, painted heat resistant sides. Stainless steel 5" high backsplash behind cook top. Cooking tops to be supported by stainless steel front and back top ledges, each with grease trough and drain chute. Top section to consist of three 12" wide x 24" deep sections having two 9½" diameter hot plates in each section. Each 2 KW, 9½" diameter hot plate to be controlled by an individual infinite temperature control. Each section to be rated at 4 KW each, 12 KW total range top. Dimensions: 36"w x 38¼"d x 37"h to cooking surface. U L and NSF listed.

(Continued on back)

MODELS:
- VR4 Standard Conventional Oven
- VR4C Convection Oven

STANDARD FEATURES
- Stainless steel front, painted sides.
- Range tops supported by polished stainless steel front and back top ledges.
- Six 9½" diameter, 2 KW input cast iron hot plates mounted in three 12" wide x 24" deep top sections.
- Each 9½" hot plate to have an individual infinite heat control.
- 5" high stainless steel vented backsplash.
- Adjustable 6" stainless steel legs.
- Two porcelain on steel drawers under range top, one a baffled grease drawer, second is a warming drawer.
- 2½" fiberglass insulation sides, top, back and bottom, 2" in door.
- Standard voltages include 208 or 240 volt, 60 Hz, 1 or 3 phase with magnetic circuit breakers.
- One year limited parts and labor warranty.

STANDARD OVEN FEATURES:
- Single pan bake and roast oven.
- Top and bottom solid sheath heating elements.
- Four position oven switches for top and bottom elements.
- Thermostat adjustable from 155° to 550°F with cycling light.
- Provided with two rack positions and one oven rack as standard.
- Oven rating 6.7 KW input.
- Oven dimensions: 23½"w x 13"h x 31½"d.

CONVECTION OVEN FEATURES: (Models with suffix "C")
- Three pan, forced air convection oven.
- Six side mounted solid sheath heating elements, 7 KW input total.
- ¼ H.P., single speed fan motor.
- Oven main power switch turns on elements and fan motor.
- Thermostat with cycling light adjustable from 200° to 500°F.
- Interlock switch shuts off the fan and elements when the door is opened.
- Silicon rope type oven door gasket.
- Provided with five rack positions and three oven racks as standard.
- Oven dimensions: 19¼"w x 14½"h x 27"d.

OPTIONS AT EXTRA COST
- Stainless steel side (specify side _____).
- Stainless steel both sides.
- Stainless steel finishing back.
- 4" toe base in place of legs - 35" (897 mm) work surface.
- Without legs for masonry base - 31" (787 mm) work surface.
- Marine features provided upon request.
- Export voltages.
- 480/60/3 (Overload protection not included).
- Second year extended limited parts and labor warranty.

VULCAN MODEL VR4 SERIES Heavy Duty Electric Hot Plate Range

VULCAN-HART COMPANY, P.O. BOX 696, LOUISVILLE, KY 40201, TEL.: (502) 778-2791
QUOTE FAX: 800-333-1808 ORDER FAX: 800-444-0602

F-32076 (7/93)

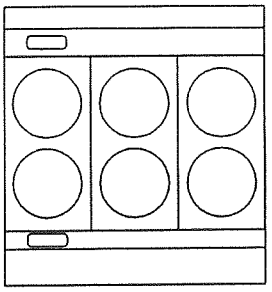
VULCAN

VR4 SERIES

Heavy Duty Electric Hot Plate Range

ACCESSORIES AT EXTRA COST

- ☐ Additional oven rack(s) Qty. _____.
- ☐ Casters (5" diameter, front two are locking).
- ☐ VDD double deck high shelves (see spec sheet).
- ☐ VB73 elevated broiler rated at 6 KW input (see spec sheet).



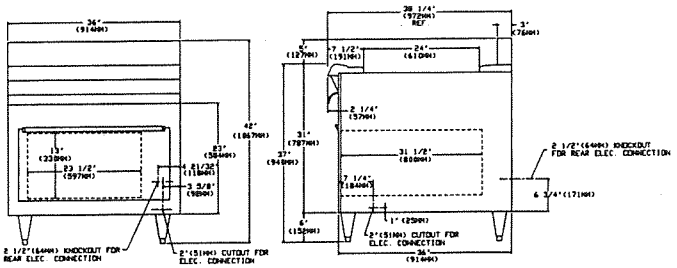
TOP VIEW

(Continued from front)

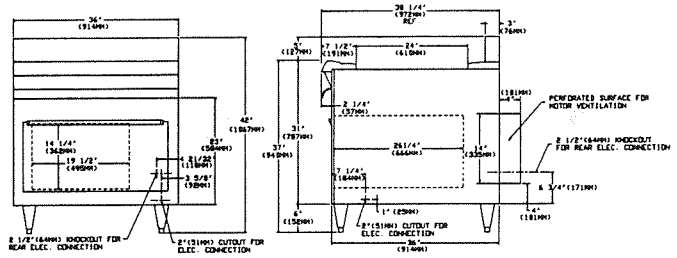
(Specify one of the following ovens.)

- ☐ To have a standard oven base with porcelain enameled cavity, two rack position guides and steel oven hearth. Provided with top and bottom heating elements with separate top and bottom four position switch controls and a thermostat adjustable from 155° to 550°F. To have a separate temperature cycling light. Oven fiberglass insulation to be blanket type, 2¾" around sides, back, top and bottom, 2" in door. Full width door spring counterbalanced by a lever mechanism to provide positive closure. Oven is rated at 6.7 KW input. One rack is provided as standard.

- ☐ To have a forced air convection oven base with porcelain enameled cavity. Provided with side mounted solid sheath heating elements. Single oven main power switch to turn on elements and convection fan. Adjustable thermostat from 200° to 500°F provided. To have a separate temperature cycling light. Oven fiberglass insulation to be blanket type, 2¾" around sides, back, top and bottom, 2" in door. Full width door spring counterbalanced by a lever mechanism to provide positive closure. Oven is rated at 7 KW input and has a ¼ H.P. single speed convection oven motor. Five rack positions with three racks are provided as standard.



VR4 - STANDARD OVEN



VR4C - CONVECTION OVEN

MODEL	TOTAL KW CONN.	3 PHASE LOAD KW PER PHASE			NOMINAL AMPS PER LINE WIRE											
					3 PHASE									1 PHASE		
		208V	204V	480V	208V			240V			480V			208V	240V	480V
		X-Y	Y-Z	X-Z	X	Y	Z	X	Y	Z	X	Y	Z	XYZ	XYZ	XYZ
VR4	18.7	6.7	4	8	61	45	50	53	39	43	19	27	22	90	78	39
VR4C	19	5.2	5.2	8.6	58	43	58	50	37	50	25	19	25	91	79	N/A

NOTE: In line with its policy to continually improve its products, Vulcan-Hart Company reserves the right to change materials and specifications without notice.

VULCAN-HART COMPANY, P.O. BOX 696, LOUISVILLE, KY 40201, TEL.: (502) 778-2791
QUOTE FAX: 800-333-1808 ORDER FAX: 800-444-0602

F-32076 (7/93)

Appendix C

TEST RESULTS-DATA SHEETS

Data Sheet for Range Top UTP

company: Vulcan - Hart
model: VR - 4
fuel: electric
notes: french plate element

pilot energy: na Btu/h

energy input rate: test sequence was rr,rf,cr,cf

	kW		nameplate	% diff
unit 1	2	unit 1	2	0.0
unit 2	2	unit 2	2	0.0
unit 3	1.98	unit 3	2	1.0
unit 4	2	unit 4	2	0.0
unit 5	coil	unit 5		
unit 6	coil	unit 6		
unit 7	na	unit 7	na	
unit 8	na	unit 8	na	
all units	11.87	all units	12	1.1

17 temperatures on plate at end of 1 hour of operation at minimum control setting:

	°F		°F		°F		
1	216	7	215	13	206		
2	219	8	215	14	207		
3	217	9	216	15	200		
4	217	10	202	16	199		
5	220	11	198	17	202		
6	219	12	201		*input rate:*	0.17	kW

average plate temperature (average of 17 temperatures): 210 °F

17 temperatures on plate at end of 1 hour of operation at maximum control setting:

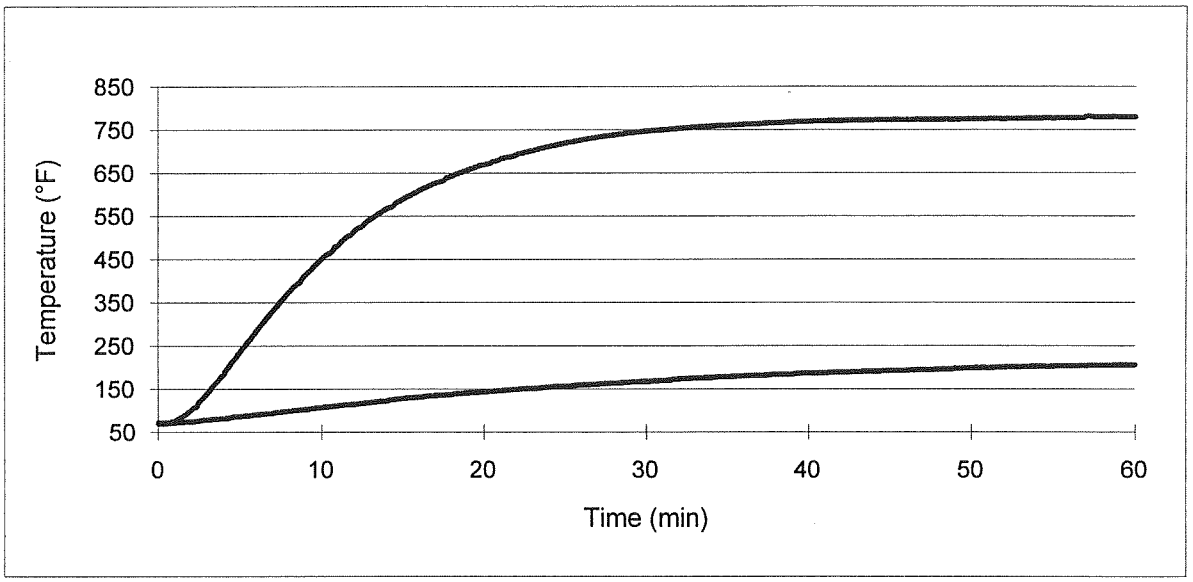
	°F		°F		°F		
1	857	7	887	13	663		
2	879	8	908	14	673		
3	889	9	888	15	680		
4	1035	10	653	16	676		
5	853	11	661	17	658		
6	860	12	674		*input rate:*	1.92	kW

average plate temperature (average of 17 temperatures): 788 °F

company: Vulcan - Hart
fuel: electric

model: VR - 4
notes: french plate element

Temperature Plots:



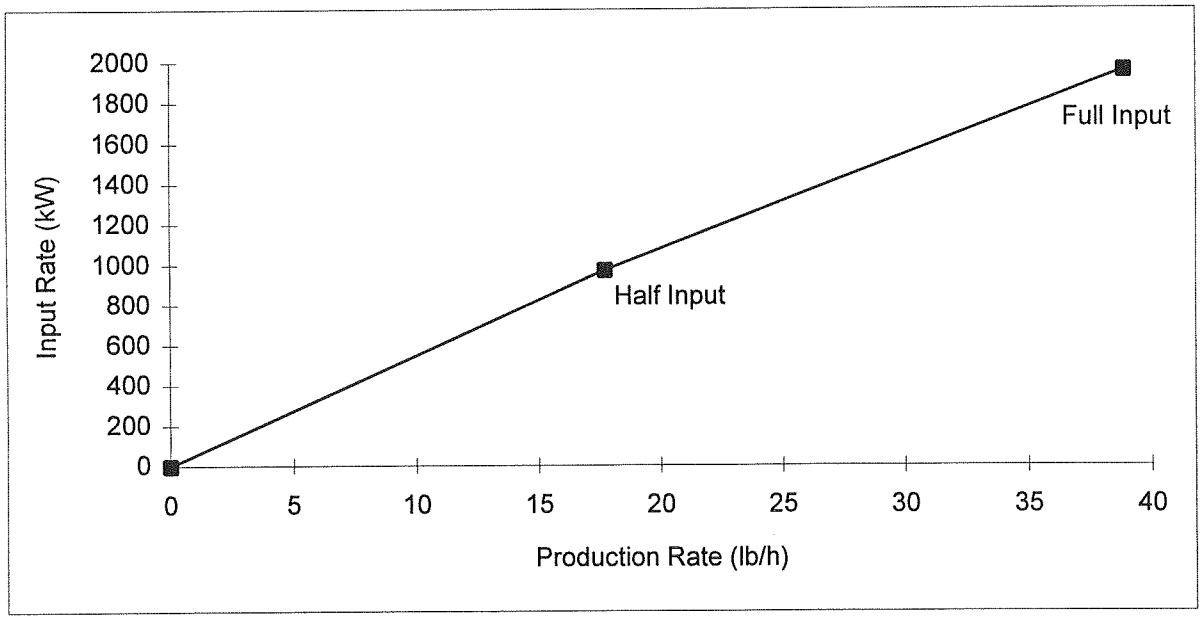
company: Vulcan - Hart
fuel: electric
model: VR - 4
notes: french plate element

half input

run	1	2	3	4	average
pot wt	5.67	5.67	5.67	5.67	
H2O wt	20	20	20	20	
delta t	130.3	132.6	130.0	130.0	
time	67.7	70.5	64.5	68.5	
lb/h	17.7	17.0	18.6	17.5	17.7
wh	1090	1130	1060	1110	
avg kw	966.5	961.7	986.0	972.3	971.6
Btu	3720.2	3856.7	3617.8	3788.4	
sens pot	147.8	150.4	147.4	147.4	
sens H2O	2606.0	2652.0	2600.0	2600.0	
eff w/pot	74.0	72.7	75.9	72.5	73.8
eff w/o pot	70.1	68.8	71.9	68.6	69.8
% uncertainty					3.4

full input

run	1	2	3	4	average
pot wt	5.67	5.67	5.67	5.67	
H2O wt	20	20	20	20	
delta t	130.4	130.4	130.9	130.9	
time	31.0	32.3	29.3	31.0	
lb/h	38.7	37.1	40.9	38.7	38.9
wh	1010	1050	960	1010	
avg kw	1954.8	1948.5	1963.6	1954.8	1955.4
Btu	3447.1	3583.7	3276.5	3447.1	
sens pot	147.9	147.8	148.5	148.4	
sens H2O	2608.7	2607.2	2619.0	2618.0	
eff w/pot	80.0	76.9	84.5	80.3	80.4
eff w/o pot	75.7	72.8	79.9	75.9	76.1
% uncertainty					6.2



Data Sheet for Range Top UTP

company: Vulcan - Hart
fuel: electric
model: VR - 4
notes: speed coil element

pilot energy: na **Btu/h**

energy input rate: **test sequence was lr,lf**

	kW	nameplate	% diff
unit 1	french plate	unit 1	
unit 2	french plate	unit 2	
unit 3	french plate	unit 3	
unit 4	french plate	unit 4	
unit 5	1.94	unit 5 2	3.0
unit 6	1.95	unit 6 2	2.5
unit 7	na	unit 7 na	
unit 8	na	unit 8 na	
all units	11.87	all units 12	1.1

17 temperatures on plate at end of 1 hour of operation at minimum control setting:

Speed Coil test

	°F		°F		°F
1	322	7	312	13	274
2	302	8	306	14	269
3	307	9	302	15	268
4	312	10	263	16	267
5	315	11	259	17	260
6	311	12	270	***input rate:***	0.28 kW

average plate temperature (average of 17 temperatures): 289 °F

17 temperatures on plate at end of 1 hour of operation at maximum control setting:

Speed Coil test

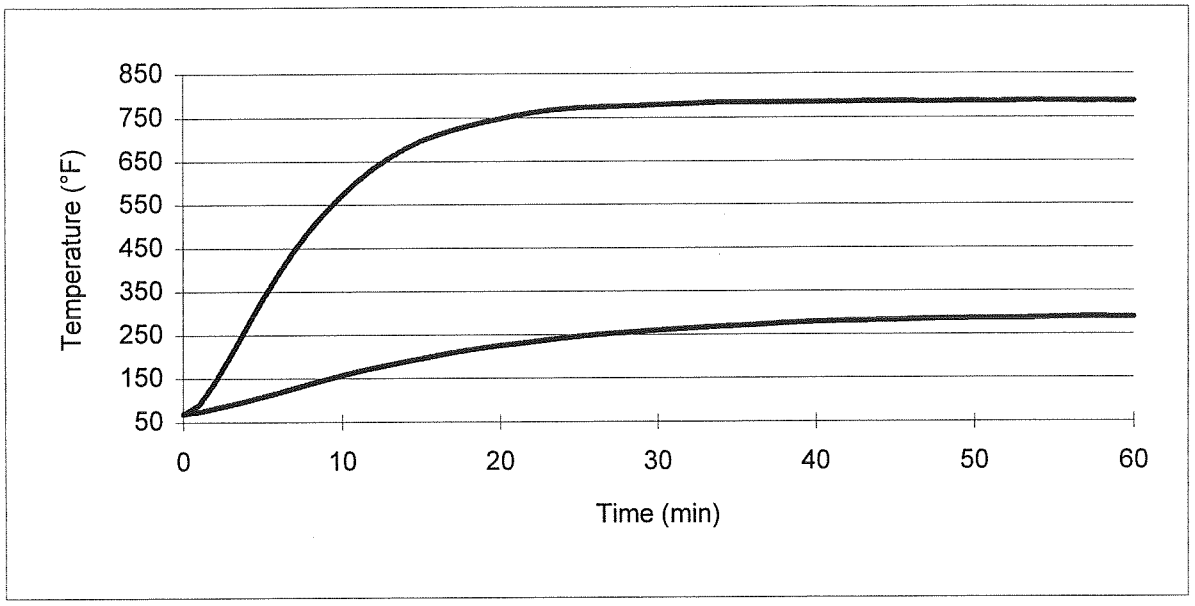
	°F		°F		°F
1	944	7	913	13	665
2	874	8	893	14	648
3	908	9	870	15	651
4	929	10	639	16	644
5	942	11	647	17	631
6	914	12	668	***input rate:***	1.94 kW

average plate temperature (average of 17 temperatures): 787 °F

company: Vulcan - Hart
fuel: electric

model: VR - 4
notes: speed coil element

Temperature Plots:



company: Vulcan - Hart
fuel: electric
model: VR - 4
notes: speed coil element

	half input			
run	1	2	3	average
pot wt	5.67	5.67	5.67	
H2O wt	20	20	20	
delta t	130.3	130.4	129.4	
time	73.5	74.0	73.5	
lb/h	16.3	16.2	16.3	16.3
wh	1160	1160	1140	
avg kw	946.9	940.5	930.6	939.4
Btu	3959.1	3959.1	3890.8	
sens pot	147.8	147.9	146.7	
sens H2O	2606.0	2608.2	2587.8	
eff w/pot	69.6	69.6	70.3	69.8
eff w/o pot	65.8	65.9	66.5	66.1
% uncertainty				1.4

	full input				
run	1	2	3	4	average
pot wt	5.67	5.67	5.67	5.67	
H2O wt	20	20	20	20	
delta t	130.2	130.2	131.9	130.1	
time	34.3	34.8	34.5	34.8	
lb/h	35.0	34.4	34.8	34.4	34.7
wh	1110	1130	1120	1120	
avg kw	1939.8	1946.4	1947.8	1929.2	1940.8
Btu	3788.4	3856.7	3822.6	3822.6	
sens pot	147.6	147.7	149.6	147.5	
sens H2O	2603.8	2605.0	2638.8	2601.6	
eff w/pot	72.6	71.4	72.9	71.9	72.2
eff w/o pot	68.7	67.5	69.0	68.1	68.3
% uncertainty					1.6