



**Toastmaster® Model RA36C1 Heavy-Duty
Hot Top Electric Range: Application
of ASTM Standard Test Method F 1521-94**

Report 5011.94.8

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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 Toastmaster® 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 the International Facility Management Association (IFMA).

EXECUTIVE SUMMARY

This study documents the performance of the Toastmaster® model RA36C1 hot top 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).

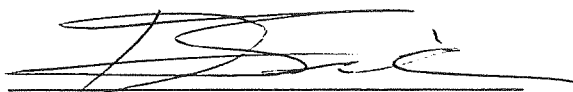
Range top performance is characterized by temperature response and uniformity, cooking energy efficiency, and production capacity. A summary of the cooking energy efficiency and production capacity test results is presented in Table ES-1.

Table ES-1
Cooking Energy Efficiency and Production Capacity Test Results

Energy Input Rate Per Cooking Unit:	5.3 kW
Average Temperature at Minimum Input:	275°F
Average Temperature at Maximum Input:	695°F
Cooking Energy Efficiency (without pot):	63.6%
Cooking Energy Efficiency (with pot):	67.2%
Production Capacity Per Cooking Unit:	81.4 lb/h

The Toastmaster® RA36C1 is an excellent example of a heavy-duty, all purpose, hot top range top. 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 Toastmaster[®] model RA36C1 electric hot top 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 15.9 kW all purpose cooktop includes three 12-inch hot tops, each rated at 5.3 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 hot tops, each of which is manually controlled by a front-mounted control knob.

Table 1-1
Appliance Specifications

Generic Appliance Type:	36" all-purpose hot top range cooktop
Manufacturer:	Toastmaster®
Model:	RA36C1
Rated Input:	15.9 kW (range cooktop only)
Cooking unit:	5.3 kW hot top
Dimensions:	36" wide by 37-1/4" deep by 36" high (to work surface)
Construction Material:	Steel with stainless-steel front and sides

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

Electric energy consumption was measured with a calibrated watt-hour meter with a 10-watt-hour 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 three cooking units in accordance with the ASTM test method. The energy input rates for the three individual cooking units varied an average of 2.5% from the manufacturer's 5.3 kW rating. The input rate for all three hot tops operating at once was 2.5% lower than the 15.9 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. Each temperature test was run twice, once with the plate in the front of the hot top and once with the plate in the rear, with the results averaged together so that each square foot of hot top surface would be tested. 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 1.38 kW. Based on the 17 temperature measurement points, the average plate temperature at the end of the hour was 275°F, with a standard deviation of 13°F. The test was repeated with the cooking unit controls at the maximum setting (an input rate of 4.84 kW) and the average plate temperature at the end of the hour was 695°F, with a standard deviation of 54°F. The average temperature rise for each test is plotted in Figure 2-1.

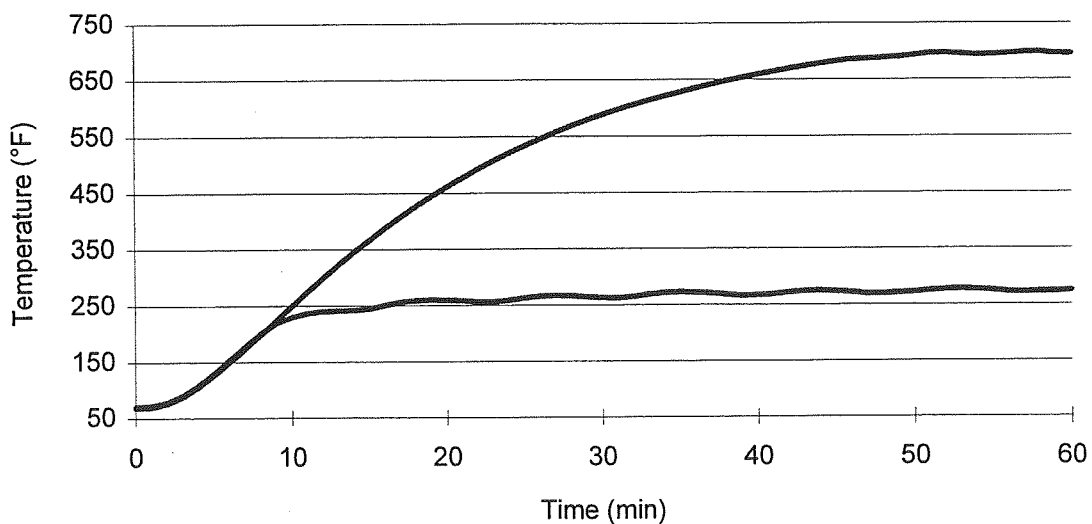


Figure 2-1. Temperature rise at maximum and minimum settings.

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

Cooking Energy Efficiency	without pot	with pot	uncertainty
Half-Energy Input Rate:	54.1%	57.1%	6.0%
Full-Energy Input Rate:	63.6%	67.2%	4.0%
Production Capacity Per Cooking Unit			
Half-Energy Input Rate:	38.7 lb/h		
Full-Energy Input Rate:	81.4 lb/h		

In Figure 2-2, production rate is plotted against input rate. Knowing the energy input rate required to achieve a desired production rate is helpful in estimating the cost of operation.

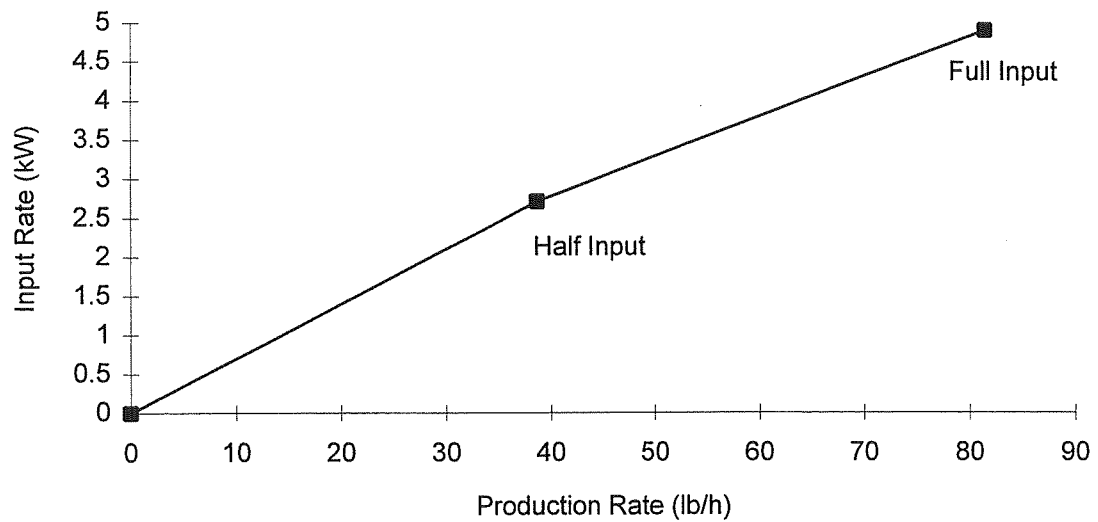


Figure 2-2. Energy input rate vs. production rate.

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 the 5.3 kW hot top. At full input, the burner delivered enough heat to the test plate to raise the average temperature to over 375°F within 15 minutes, reaching a final average temperature of 695°F. At minimum input, the average temperature was 275°F. Heat produced by the hot top at both the minimum and maximum input rates was evenly distributed over the surface of the test plate. The cooking energy efficiency at the half-input rate was 54.1%, rising to 63.6% at the full-input rate. The revised cooking energy efficiency, which includes the weight of the cooking container, is 57.1% at half-input rate and 67.2% at full-input rate. Based on a temperature rise from 70° to 200°F, the production rate for the cooking unit tested was 38.7 lb/hr at the half-input rate and 81.4 lb/hr at the full-input rate.

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

Ranges Convection Oven Base - RA36C Series



are controlled by a thermostat with a temperature range of 250° to 850°F. The griddle section on the RA36C3, RA36C6 and RA36C7 are controlled by a thermostat with a temperature range of 150° to 450°F. Range is provided with a 2-hour timer adjustable from 6 to 120 minutes (timer has bell signal). The oven temperature is controlled by a thermostat adjustable from 150° to 450°F. Each thermostat is provided with an "OFF" position. The four position, 3 heat switch has a "HIGH, MEDIUM, LOW and OFF" setting. Each 9" diameter hot plate provided with an integral temperature limit control. Oven provided with an "ON/OFF" power switch. An indicator light is associated with each thermostat and power "ON/OFF" switch. Oven section includes a cool down switch to activate blower motor while oven is turned "OFF".

Capacity

The convection oven section has a capacity for six 20.38" x 28.25" racks with positive stops. Three racks are furnished. Each rack will accommodate (1) 18" x 26" roll pan, (1) 18" x 24" meat pan, (2) #200 12" x 20" pans or (5) 10" pie tins. Oven has a clear height of 13 1/4".

Agency Listings

The RA36C Series Ranges are listed by Underwriters' Laboratories, Inc., and NSF.

Warranty

Warranted for one year covering parts and labor.

Ordering Information

Basic Models - 208VAC, 240VAC or 480VAC (3 or 1 phase) voltage must be specified. (Factory wired for 3 phase, may be field converted for 1 phase.)

Options At Extra Cost

- ACLGO6E - Legs, set of (4) 6", NSF listed, satin nickel.
- ACCS06J - Set of four, 6 1/4" high casters.
- ACBK36D - Stainless steel back.
- ACRK36CP - Additional oven rack.
- ACBS36D - Backshelf

Application

Saute, braise, pan fry, griddle, boil, stew, simmer, bake, brown, roast and reconstitute with the versatile Toastmaster heavy duty range.

General Information

Heavy duty electric range, with convection oven base. Range is 36" wide x 36" high (including 6" legs) x 39" deep. (Optional casters add 1/4" to height). Oven Cavity is 21 1/4" wide x 30 1/8" deep x 14 7/8" high.

Construction

Frame of range and oven is welded angle iron with stainless steel front, sides and aluminized steel back. Grease troughs are provided for drainage with grease chutes into two wide drawer type receptacles. The RA36C3, RA36C6 and RA36C7 are furnished with splash guards surrounding back and sides of the griddle section. The convection oven section provided with porcelain inner lining and blower baffle, stainless steel throat, vent with damper and gasketed landing shelf type, stainless steel lined door. Easily removable rack supports accommodate six racks. The blower fan is powered by a sealed ball bearing motor. Oven is fully insulated on all sides.

Electrical

Wiring is connected at a terminal compartment in the base. Knockouts are provided in the bottom and back for power supply entrance. (See electrical data table for kW rating of range tops.) Oven kW rating is 6.5. The heating element in the oven is rated at 6.0 kW, motor and controls rated at 0.5 kW.

Heating

Heating is accomplished with formed tubular elements clamped underneath each griddle and rectangular hot plate. The RA36C3 has four heating sections for the 36" surface. The RA36C6 and RA36C7 have two heating sections for the 24" x 24" griddle surface. The oven heating element is located on the side of the oven cavity encircling the oven blower fan. Oven preheats to 450°F within 15 minutes.

Controls

Controls are mounted in a central ventilated control panel, hinged for easy access. 9" round hot plates are controlled by a 4 position, 3 heat switch. The 12" x 24" hot plate sections on the RA36C1 and RA36C2



Ranges

Convection Oven Base

RA36C Series

We reserve the right to change specifications and product design without notice. Such revisions do not entitle the buyer to corresponding changes, improvements, additions or replacements for previously purchased equipment.

INSTALLATION NOTES:

- FOR SUPPLY CONNECTIONS USE COPPER WIRE SIZED IAW THE NEC AND SUITABLE FOR 90°C (194°F) MINIMUM.
- MINIMUM SPACING FROM A WALL:
SIDES - 3" BACK - 0"

KW RATING

MODEL NUMBER	TOTAL KW			OVEN SECTION TOTAL KW		RANGE TOP KW			12" x 24" HOT PLATES KW (EA)			9" ROUND HOT PLATES KW (EA)	HEATING ELEMENTS KW (EA)
	208	240	480	208/240	480	208	240	480	208	240	480		208/240 & 480
RA36C1	16.8	22.4	22.7	4.9/6.5	6.5	11.9	--	15.9	4.0	5.3	5.3	--	--
RA36C2	21.1	21.1	21.4	6.5	6.5	14.6	14.6	14.6	5.3	5.3	--	2.0	--
RA36C3	17.3	23.0	23.3	4.9/6.5	6.5	12.4	16.5	16.5	--	--	--	--	3.1/4.125
RA36C4	18.5	18.5	18.8	6.5	6.5	12.0	12.0	12.0	--	--	--	2.0	--
RA36C6	21.1	21.1	21.4	6.5	6.5	14.6	14.6	14.6	--	--	--	2.0	--
RA36C7	22.4	22.4	22.4	6.5	6.5	15.9	15.9	15.9	5.3	5.3	5.3	--	--

CONNECTED LOAD AND ELECTRICAL DATA

MODEL NUMBER	TOTAL KW 208V/ 240V	3 PHASE LOADING KW PER PHASE			NOMINAL AMPS PER LINE WIRE							
					3 PHASE						1 PHASE	
		X-Y	Y-Z	X-Z	208VAC			240VAC			208V	240V
RA36C1	16.8/22.4	4.9/6.5	8.0/10.6	4.0/5.3	37.0	54.0	50.6	42.7	62.3	58.4	80.8	93.3
RA36C2	21.1	6.5	9.3	5.3	49.2	66.1	61.5	42.7	57.3	53.3	101.4	87.9
RA36C3	17.3	4.9/6.5	6.2/8.25	6.2/8.25	46.3	46.3	51.6	53.3	53.3	59.5	83.2	95.8
RA36C4	18.5	6.5	8.0	4.0	44.1	60.5	50.9	38.2	52.4	44.1	88.9	77.1
RA36C6	21.1	6.5	9.3	5.3	49.2	66.1	61.5	42.7	57.3	53.3	101.4	87.9
RA36C7	22.4	6.5	10.6	5.3	49.2	71.9	67.4	42.7	62.3	58.4	107.7	93.3

CONNECTED LOAD AND ELECTRICAL DATA

MODEL NUMBER	TOTAL KW 480V	3 PHASE LOADING KW PER PHASE			NOMINAL AMPS PER LINE WIRE				
					480 Volt				1 PHASE
		X-Y	Y-Z	X-Z	3 PHASE				
RA36C1	22.7	6.8	10.6	5.3	21.9	31.6	29.2	47.3	
RA36C2	21.4	6.8	9.3	5.3	21.9	29.2	26.7	44.6	
RA36C3	23.3	6.8	8.25	8.25	27.2	27.2	29.8	48.5	
RA36C4	18.8	6.8	8.0	4.0	19.7	26.7	22.0	39.1	
RA36C6	21.4	6.8	9.3	5.3	21.9	29.2	26.7	44.6	
RA36C7	22.7	6.8	10.6	5.3	21.9	31.6	29.2	47.3	

GENERAL DATA TABLE (DIMENSIONS)

MODEL NUMBER	HEIGHT TO COOKING SURFACE		WIDTH	DEPTH (OVERALL)	WEIGHTS	
	LESS LEGS	WITH LEGS			INSTALLED	SHIPPING
RA36C1	30" (762)	36" (914.4)	36" (914.4)	38.5" (977.9)	569	610
RA36C2	30" (762)	36" (914.4)	36" (914.4)	38.5" (977.9)	515	570
RA36C3	30" (762)	36" (914.4)	36" (914.4)	38.5" (977.9)	588	610
RA36C4	30" (762)	36" (914.4)	36" (914.4)	38.5" (977.9)	455	485
RA36C6	30" (762)	36" (914.4)	36" (914.4)	38.5" (977.9)	515	570
RA36C7	30" (762)	36" (914.4)	36" (914.4)	--	--	--

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Elgin, IL 60120-9272 USA

Appendix C
TEST RESULTS-DATA SHEETS

Data Sheet for Range Top UTP

company: Toastmaster®
 fuel: electric

model: RA36C1
 notes: Hot top range top

pilot energy: na Btu/h

energy input rate: test sequence was left, center, right

kW	nameplate	% diff
unit 1 <u>5.3</u>	unit 1 <u>5.3</u>	0.0
unit 2 <u>5.1</u>	unit 2 <u>5.3</u>	3.8
unit 3 <u>5.1</u>	unit 3 <u>5.3</u>	3.8
unit 4 <u>na</u>	unit 4 _____	
unit 5 <u>na</u>	unit 5 _____	
unit 6 <u>na</u>	unit 6 _____	
unit 7 <u>na</u>	unit 7 <u>na</u>	
unit 8 <u>na</u>	unit 8 <u>na</u>	
all units <u>15.5</u>	all units <u>15.9</u>	2.5

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

position on cooking unit = front - back

°F	°F	°F
1 <u>275 - 302</u>	7 <u>276 - 288</u>	13 <u>269 - 279</u>
2 <u>253 - 303</u>	8 <u>261 - 285</u>	14 <u>288 - 280</u>
3 <u>260 - 298</u>	9 <u>254 - 295</u>	15 <u>270 - 273</u>
4 <u>267 - 290</u>	10 <u>241 - 301</u>	16 <u>246 - 266</u>
5 <u>278 - 291</u>	11 <u>251 - 291</u>	17 <u>240 - 283</u>
6 <u>285 - 292</u>	12 <u>249 - 275</u>	<i>input rate:</i> <u>1.41 - 1.35</u> kW

average plate temperature (average of 17 temperatures): 262 - 288 °F

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

position on cooking unit = front - back

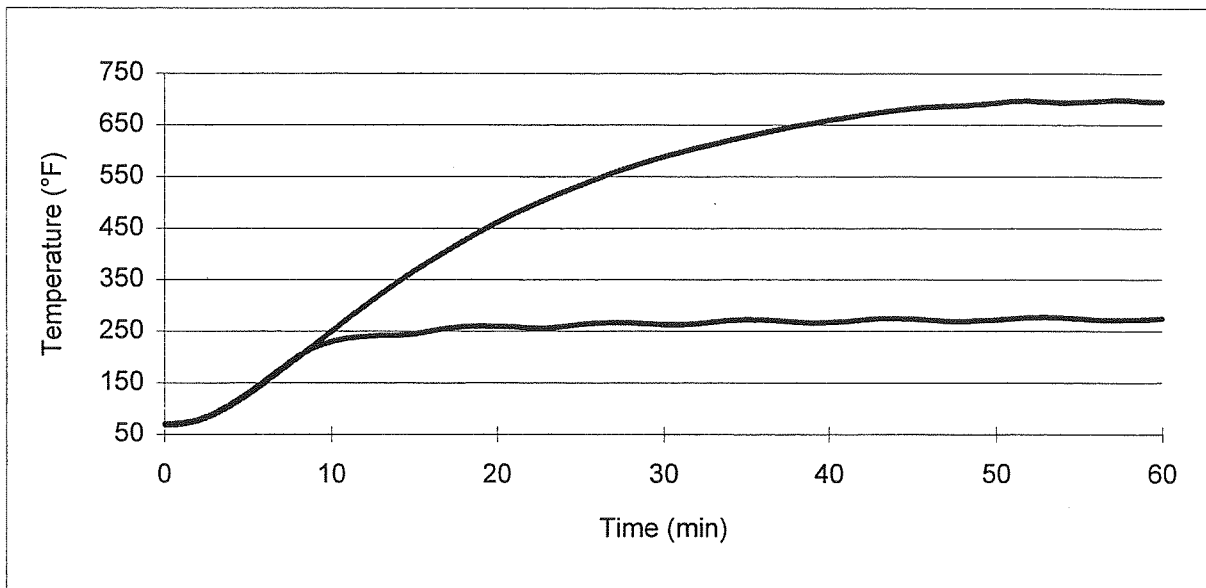
°F	°F	°F
1 <u>734 - 766</u>	7 <u>739 - 718</u>	13 <u>699 - 660</u>
2 <u>640 - 774</u>	8 <u>684 - 718</u>	14 <u>769 - 666</u>
3 <u>675 - 759</u>	9 <u>654 - 751</u>	15 <u>707 - 652</u>
4 <u>702 - 723</u>	10 <u>570 - 769</u>	16 <u>615 - 638</u>
5 <u>742 - 719</u>	11 <u>615 - 727</u>	17 <u>581 - 701</u>
6 <u>767 - 721</u>	12 <u>625 - 652</u>	<i>input rate:</i> <u>4.88 - 4.81</u> kW

average plate temperature (average of 17 temperatures): 677 - 713 °F

company: Toastmaster®
fuel: electric

page: 2
model: RA36C1
notes: Hot top range top

Temperature Plots:



company: Toastmaster®
 fuel: electric

page: 3
 model: RA36C1
 notes: Hot top range top

	half input				
run	1	2	3	4 average	
pot wt	11.34	11.34	11.34	11.34	
H2O wt	40	40	40	40	
delta t	131.2	128.8	129.1	129.3	
time	68.5	61.0	60.0	59.5	
lb/h	35.0	39.3	40.0	40.3	38.7
wh	2990	2820	2710	2730	
avg kw	2619.0	2773.8	2710.0	2752.9	2713.9
Btu	10204.9	9624.7	9249.2	9317.5	
sens pot	297.5	292.2	292.9	293.3	
sens H2O	5247.1	5154.0	5165.5	5172.0	
eff w/pot	54.3	56.6	59.0	58.7	57.1
eff w/o pot	51.4	53.5	55.8	55.5	54.1
% uncertainty					6.0

	full input			
run	1	2	3 average	
pot wt	11.34	11.34	11.34	
H2O wt	40	40	40	
delta t	130.7	130.9	130.3	
time	29.0	29.5	30.0	
lb/h	82.8	81.4	80.0	81.4
wh	2370	2410	2440	
avg kw	4903.4	4901.7	4880.0	4895.0
Btu	8088.8	8225.3	8327.7	
sens pot	296.4	296.9	295.5	
sens H2O	5228.0	5236.0	5212.0	
eff w/pot	68.3	67.3	66.1	67.2
eff w/o pot	64.6	63.7	62.6	63.6
% uncertainty				4.0

