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Easy Radiant, Model PH-50-H-R-N
Patio Heater Performance Test

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Specific appreciation is extended to Easy Radiant, for supplying the Food Service Technology Center with the PH-50-H-R-N heater for controlled testing in the appliance laboratory.

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Easy Radiant Patio Heater Performance Testing

Background

Patio heaters are gaining popularity with food service operators as an effective method of extending the outdoor dining season. A deck or patio can be operational earlier in the spring and later into the autumn by providing additional heat to an area that would otherwise be unpleasantly cold. A patio heater can also take the edge off a cool summer night to help keep customers comfortable and relaxed.

Also known as radiant space heaters, their conceivable applications extend well beyond the realm of food service into nearly any situation requiring additional heat. There are countless outdoor, as well as many indoor, uses for patio heaters when people or objects require warmth that is otherwise not available.

While initial capital cost is a determining factor in the selection of a new patio heater, the appliance can also be evaluated with regards to long-term operational cost and performance, as characterized by preheat time, energy consumption, and effective heated area. The Food Service Technology Center (FSTC), operated by Fisher-Nickel, inc, developed a standard testing procedure to evaluate the performance of gas and electric patio heaters. This test procedure was designed to allow evaluation of patio heater performance and energy consumption in a structured laboratory setting.[1]

The primary objective of this procedure is to determine the area under or near the heater where a person could reasonably expect to be comfortable. Relating a person's thermal comfort at specific locations under the heater can be challenging, since the environment is not uniform. Some surfaces are hot, while others may be cold when compared to the surface temperature of a person's body or clothing. Mean radiant temperature is a measure of the combined affect of these non-uniform, hot and cold surfaces on a body (person) within the space.

The test procedure uses mean radiant temperature to characterize the useful output from a radiant patio heater. The useful output is specified as the area under and around the heater having a mean radiant temperature rise of at least 3°F in a design environment of 60°F. While a 3°F temperature rise does not sound significant, it is referring to a rise in radiant temperature, which is more noticeable than a 3°F rise in ambient temperature. Stated another way, a heater producing a 3°F rise in mean radiant temperature in a 60°F environment would feel warmer than an environment with an ambient temperature of 63°F.

Using the 63°F boundary not only determines the area where the heater is delivering the most useful heat, but also sets standard criteria for comparing different heaters.[2,3]

The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report.

Objective

The objective of this report is to examine the operation and performance of the Easy Radiant natural gas-powered patio heater, model PH-50-H-R-N, under the controlled conditions of the FSTC Test Method. The scope of this testing is as follows:

1. Energy input rate is determined to confirm that the heater is operating within 5% of the nameplate energy input rate.
2. Preheat time and energy consumption is determined.
3. The temperature distribution and effective heated area is determined with the heater operating at full output.
4. The heater's heating index is determined to relate the input rate to the effective heated area.

Appliance Description

The Easy Radiant heater, model PH-50-H-R-N, is a hanging, mushroom style, natural gas powered patio heater with an input rate of 50,000 Btu/h (Figure 1). The burner and reflector are surrounded by a steel bracket, which allows the unit to be suspended from overhead. This eliminates the base and pole of a typical mushroom heater. A standing pilot and optional remote electronic switch handle burner ignition. A manual knob controls burner intensity.

Appliance specifications are listed in Table 1, and the manufacturer's literature is included in Appendix B.

Figure 1.
Easy Radiant PH-50-H-R-N Heater.

Table 1. Appliance Specifications.

Manufacturer	Easy Radiant
Model	PH-50-H-R-N
Generic Appliance Type	Patio Heater
Rated Energy Input Rate	50,000 Btu/h
Technology	Natural Gas Fired Burner
Construction	Steel Hanging Bracket Steel Burner Head Aluminum Reflector
Ignition	Standing Pilot/Remote Electronic Switch
Controls	Manual Intensity Control
Overall Dimensions	146" Wide × 13 3/4" Wide × 9 1/2" Deep

Setup and Instrumentation

The PH-50-H-R-N heater was tested at two mounting heights. The first was at a height of 6 feet, as measured from the floor to the bottom of the hanging bracket. This positions the burner and reflector assembly at roughly the same height as similar pole-mounted units. Due to the height of the hanging bracket, this position would be for situations where overhead clearance was not needed, as when the heater is mounted over a large table. The second height measured 8 feet from the floor to the lowest point of the hanging bracket. This represented a typical installation requiring overhead clearance below the hanging bracket.

Gas consumption was monitored using a positive displacement meter, which generated a pulse for every 0.1 ft^3 of gas used. Power and energy were measured with a watt/watt-hour transducer that generated an analog signal for instantaneous power and a pulse for every 10 Wh used. Heater temperature was monitored with a 24 gauge, type K, fiberglass insulated thermocouple wire.

The mean radiant temperature can be determined at a specific point under the heater with a globe thermometer. A globe thermometer, shown in Figure 2, consists of a thermocouple junction located in the geometric center of a sphere. The thermocouple measures the average surface temperature of the sphere, and, when combined with the ambient air temperature and the convection heat transfer for the sphere, can be used to calculate the mean radiant temperature for that location. By using an array of globe thermometers, the entire area under the heater can be covered.

After calculating the mean radiant temperature of the space both with and without the heater operating, the effect of the heater can be determined. Once the effect of the heater at a specific ambient temperature is known, its effect on a design environment having a different ambient temperature can be calculated. With a minimum temperature rise specified, a boundary is drawn and the heated area calculated.

A grid of 60 globe thermometers with a spacing of 2 feet was used to measure the radiant heat from the heater, and four 24 gauge, type K, teflon insulated, aspirated thermocouples monitored the ambient temperature. The globe thermometers were positioned 36 inches off the floor, to approximate the position of the center of a sitting person’s chest. Figure 3 shows the globe thermometer grid. The gas meter and all thermocouples were connected to a computerized data acquisition unit that recorded data every 10 seconds.

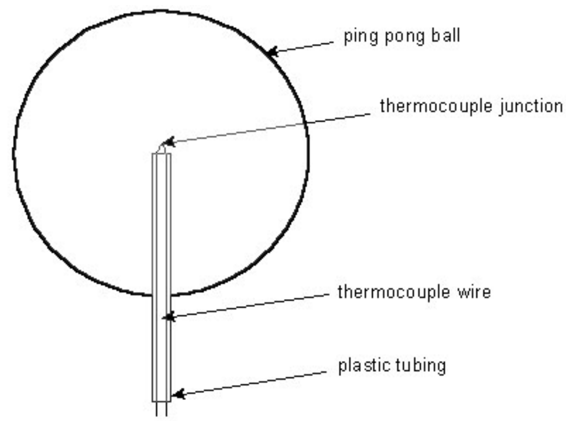

Figure 2.
Globe thermometer design.

Figure 3.
Globe thermometer grid.

Test Procedure and Results

Energy Input Rate

The energy input rate was determined by turning the heater on and measuring the energy consumed for a period of 15 minutes. The energy used and the time elapsed were used to calculate the maximum energy input rate. The energy input rate was calculated at 48,860 Btu/h, which was within 2.3% of the nameplate rate of 50,000 Btu/h. This ensured the heater was operating as per the manufacturer’s specification, and testing could continue without adjustment. The PH-50-H-R-N heater also consumed a small amount of electrical energy for the controls— 11 Watts.

Preheat Test

The preheat test recorded the time and energy required for the heater to increase the reflector temperature from 75 ± 5°F to a temperature that equals 95% of the heater's maximum stabilized temperature (as measured by the thermocouple attached to the reflector). The test continued until the reflector temperature had stabilized to within ±3°F over a period of 5 minutes. The point when the reflector temperature had reached 95% of its maximum temperature was then determined. The elapsed time and the energy consumed by the heater up until this point was reported as preheat time and energy. The preheat test indicated a maximum reflector temperature of 593.6°F, which meant the heater was considered preheated when the reflector reached 563.9°F (95% of maximum). The heater reached this temperature in 7.8 minutes, while consuming 6,390 Btu of energy. The preheat chart for the Easy Radiant PH-50-H-R-N heater is shown in Figure 4.

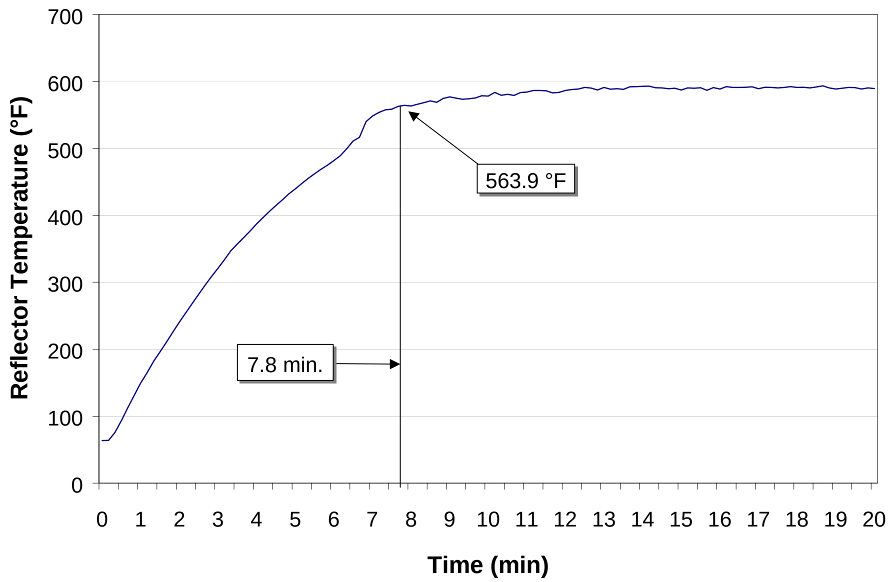

Figure 4.
Preheat characteristics.

Table 2 summarizes the results of the input and preheat tests for the Easy Radiant heater.

Table 2. Input and Preheat Test Results.

Rated Energy Input Rate (Btu/h)	50,000
Measured Energy Input Rate (Btu/h)	48,860
Percentage Difference From Rated (%)	2.3
Electrical Energy Input Rate (W)	11
Preheat	
Time (min)	7.8
Energy (Btu)	6,390

Temperature Distribution and Effective Heated Area

Temperature distribution and effective heated area tests are used to determine the specific boundary where the heater has raised the mean radiant temperature of the globe thermometers to 3°F above the design temperature of 60°F. With this information, the size and shape of the heat pattern can be determined and the heater's heating index can be calculated.

To confirm that all test apparatus was in a stable condition, the temperatures of the globe thermometers and the heater reflector were monitored for a period of 5 minutes before the heater was turned on. Each temperature was verified to be stable to within ± 0.5° F during this period, indicating the test cell was not in a transitional state of heating up or cooling down. The heater was then turned on and allowed to run for 15 minutes, after which time the globe thermometer temperatures were recorded for 5 minutes. This test was performed in triplicate to ensure the accuracy of the results.

In order to generate the plots, each average globe thermometer temperature from the 5-minute test was first normalized to the design mean radiant temperature. To determine the exact location of the distribution plot boundary, the linear interpolation procedure described in the FSTC Test Method is applied to the areas where one globe is above the threshold temperature and an adjacent globe is below it. The distribution plot for the PH-50-H-R-N heater at the 6-foot height, shown in Figure 5, includes the 63°F temperature boundary specified by the test method, as well as additional boundaries indicating further temperature rises in increments of 1°F.

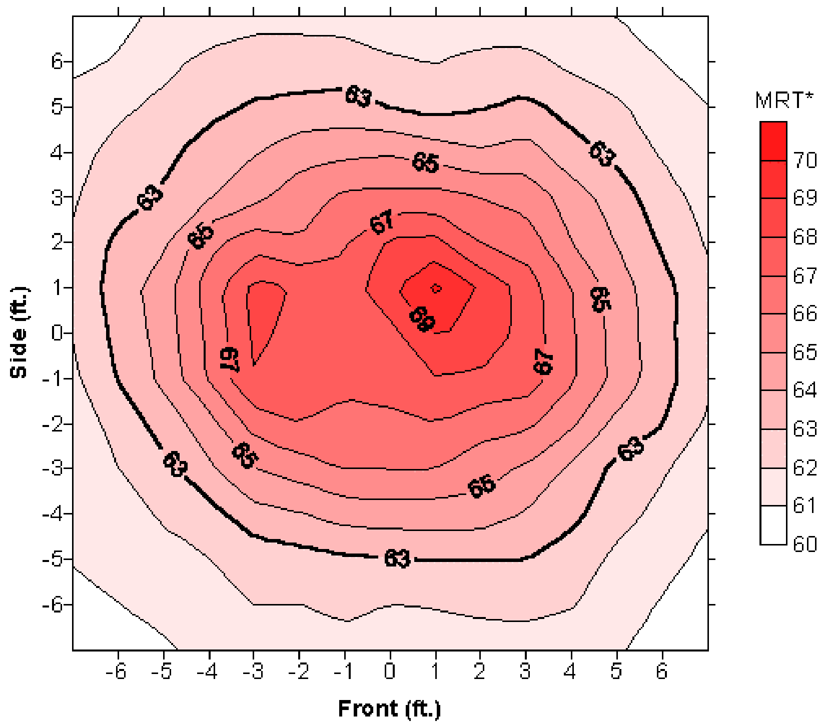

Figure 5. Temperature distribution plot with heater at height of 6 feet.

The effective heated area is the area contained within the boundary of the 63°F contour line shown in the temperature distribution plot. The heated area for the PH-50-H-R-N heater was 105.3 ± 4.1ft^2.

Figure 6 characterizes the radiant heat distribution of the PH-50-H-R-N heater at the 6-foot height by showing the average front to back and left to right temperatures across the test grid.

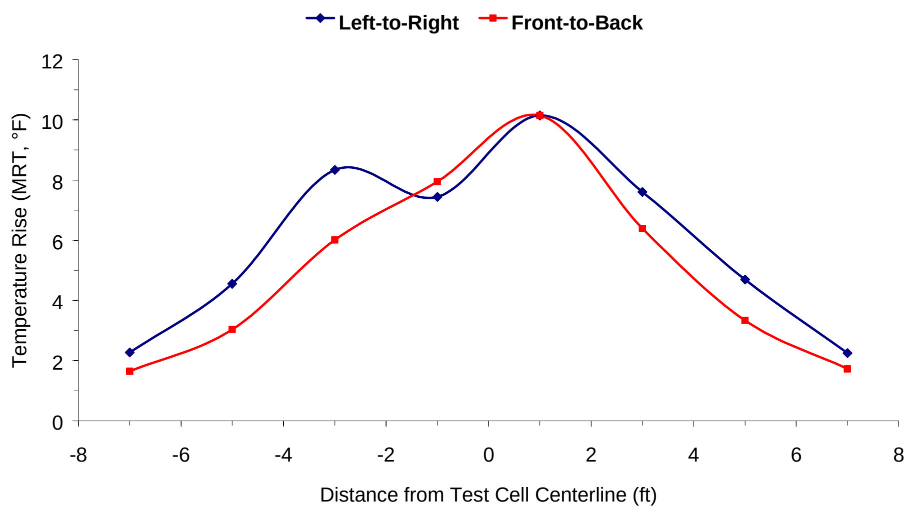

Figure 6.
Radiant Heat Distribution with heater at height of 6 feet.

After completion of the tests at the 6-foot mounting height, the heater was moved straight up to the 8-foot mounting height. The temperature distribution plot is show in Figure 7.

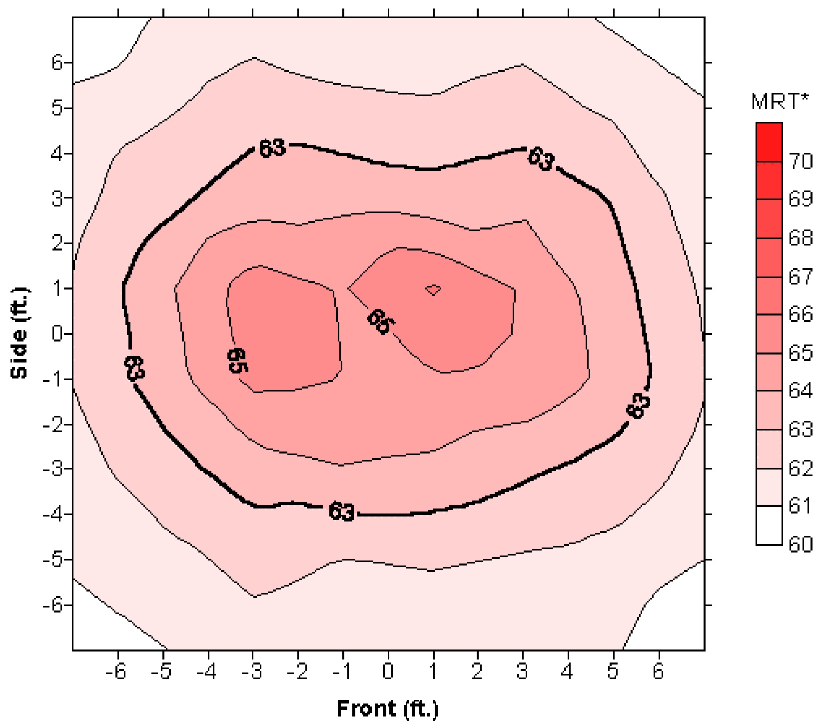

Figure 7.
Temperature Distribtution Plot with heater at height of 8 Feet

The heated area for the 8-foot mounting height was 77.3 ± 3.9 ft^2. Figure 8 characterizes the radiant heat distribution of the PH-50-H-R-N heater at the 8-foot mounting height.

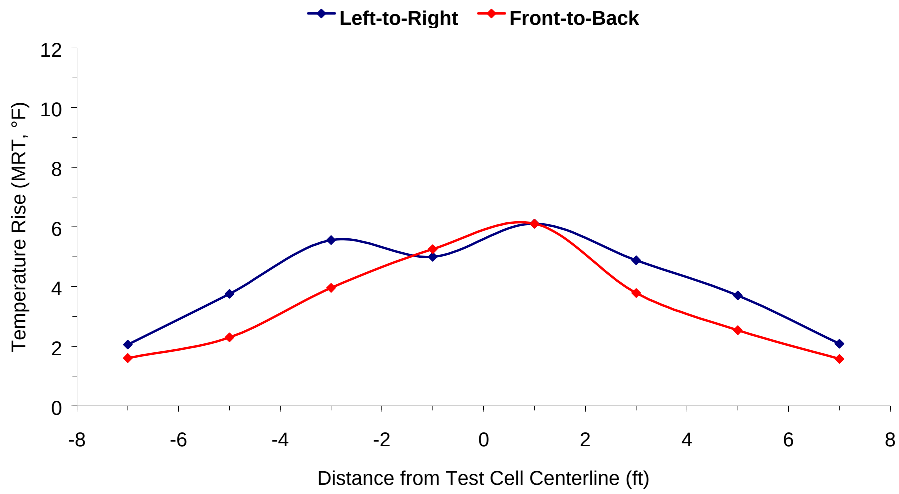

Figure 8.
Radiant Heat Distribution with heater at height of 8 feet.

Heating Index

The heating index relates the effective heated area to how much energy is consumed by the patio heater in one hour. It is calculated by dividing the effective heated area by the patio heater input rate. The heating index at the 6-foot height was 2.15 ft^2/kBtu/h for the PH-50-H-R-N heater. At 8 feet, the heating index was 1.58 ft^2/kBtu/h.

Conclusions

The Easy Radiant PH-50-H-R-N heater is a solution for operators who desire a mushroom-style heater but don't have room for the typical base and pole that come with it. Since it is suspended from overhead, the heater does not require the operator to worry about giving up valuable floor space. This would be especially useful for installations above tables, high-traffic walkways, or any other space where floor area cannot be sacrificed.

When mounted at a height of 6-feet, as measured from the floor to bottom of the hanging bracket, the PH-50-H-R-N heater produced a slightly oval-shaped temperature distribution pattern with an effective heated area of 105.3 ± 4.1 ft^2. The effective heated area represents the part of the test cell raised to at least 3°F above the ambient design environment. As the mean radiant globe temperature and temperature distribution plots show, the PH-50-H-R-N heater generated a 70°F maximum mean radiant temperature slightly to the side of the center of the heater. The heat index for the 6-foot mounting height was 2.15 kBtu/ft^2. This mounting configuration would be suitable for placement over a table or other immovable object where pedestrian head clearance is not required.

The 8-foot mounting height represents a typical installation requiring overhead clearance. The temperature distribution pattern at this height was still slightly oval, with a heated area of 77.3 ± 3.9 ft^2. The maximum mean radiant was 66°F, and the heating index was 1.58 kBtu/ft^2.

When selecting a patio heater, the ability to mount the unit in a certain location can be an important factor. With the hanging design of the PH-50-H-R-N heater, Easy Radiant has provided the performance of a mushroom-style heater without the need to provide space for the base and pole.

References

1. Food Service Technology Center. 2002. *FSTC Test Method for the Performance of Patio Heaters*. #025-02, Version 6.2.

2. Sorensen, G. 2003. *Infratech Model W-3024 Patio Heater Performance Test.* Food Service Technology Center Report 5011.03.11, August.

3. Sorensen, G. 2004. *Roberts-Gordon Model HE-40 Patio Heater Performance Test*. Food Service Technology Center Report 5011.04.11, December.

A Glossary

Design Environment

Unheated environment for which test unit's performance is to be evaluated. Design environment is specified as having a mean radiant temperature of 60°F.

Effective Heated Area (ft^2)

The amount of square footage under a patio heater that can be warmed to a specified mean radiant temperature (3°F above the design environment).

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

The peak rate at which an appliance will consume energy, typically reflected during preheat.

Heating Index (ft^2/kW)

The quotient of the measured energy input rate and the effective heated area.

Heating Value (Btu/ft^3)
Heating Content

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

Measured Input Rate (kW or Btu/h)
Measured Energy Input Rate
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during preheat.

Mean Radiant Temperature (°F)

The uniform surface temperature of an imaginary black enclosure in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform space.

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

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

Pilot Energy Rate (kBtu/h)
Pilot Energy Consumption Rate

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

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

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

Glossary

Preheat Time (min)
Preheat Period

The time required for an appliance to "pre-heat" from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

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.

B Manufacturer's Specifications

Appendix B includes the product literature for the Easy Radiant patio heater, Model PH-50-H-R-N.

C Results Reporting Sheets

Manufacturer Easy Radiant

Model PH-50-H-R-N

Date: November, 2004

Test Patio Heater:

Description of operational characteristics: The PH-50-H-R-N is a high-intensity hanging mushroom-type heater with a rated input of 50,000 Btu/h. The burner and reflector are mounted in a steel hanging bracket which surrounds the entire assembly.

Apparatus:

The heater was installed in a 20 by 20-foot space at heights of 6-feet and 8-feet, as measured from the floor to the bottom of the hanging bracket.

An array of 60 globe thermometers was arranged beneath the heater at a height of 36-inches above the floor to monitor mean radiant temperature. The globes in the array were spaced 24-inches apart, making a 14 by 14-foot test grid. Each of the four quadrants contained an aspirated thermocouple at a height of 36-inches above the floor for measuring ambient air temperature (see Figure 1).

Energy was monitored using a positive displacement meter that generated a pulse for every 0.1ft^3 of gas used. The gas meter and thermocouples were connected to an automated data acquisition unit that recorded data every 5 seconds.

Energy Input Rate:

Measured	48,860 Btu/h
Rated	50,000 Btu/h
Percent Difference between Measured and Rated	2.3 %
Electrical Energy Input Rate	11 W

Preheat:

Preheat Time	7.8 min.
Preheat Energy	6,390 Btu

Effective Heated Area:

The effective heated area is defined as the area under the heater with a normalized mean radiant temperature of 63°F and higher. The average results from the three tests are shown in Table C-1.

Table C-1. Effective Heated Area Results.

6-foot height	105.3 ± 4.1 ft^2
8-foot height	77.3 ± 3.9 ft^2

Heating Index:

The heating index is the number of square feet of patio effectively heated for each unit of energy (kBtu) consumed by the heater. The heating indices for the two mounting heights are shown in Tables C-2 and C-3.

Table C-2. Heating Index with heater at 6 feet.

Energy Input Rate	48,860 Btu/h
Heated Area	105.3 ft^2
Heating Index	2.15 ft^2/kBtu/h
Efficiency Index	465 Btu/ft^2

Table C-3. Heating Index with heater at 8 feet.

Energy Input Rate	48,860 Btu/h
Heated Area	77.3 ft^2
Heating Index	1.58 ft^2/kBtu/h
Efficiency Index	632 Btu/ft^2

D Test Cell Data

Mean Radiant Temperature Distribution:

Tables D-1 and D-2 show the average normalized mean radiant temperatures from the three test replicates at each mounting height. The tables are for the mounting heights of 6-feet and 8-feet, respectively.

Test Cell Data

Table D-1. Normalized Mean Radiant Temperatures for 6-foot position.

Globe Position[†] X	Y	Test Replicate Test 1	Test 2	Test 3	Globe Position[†] X	Y	Test Replicate Test 1	Test 2	Test 3
5	7	61.0	61.0	60.4	1	-3	64.0	63.9	63.5
3	7	61.8	61.9	61.1	-1	-3	64.2	63.9	63.8
1	7	61.4	61.7	61.1	-3	-3	63.6	63.4	63.6
-1	7	61.5	61.7	61.1	-5	-3	62.5	62.6	62.6
-3	7	61.9	61.8	61.0	5	-5	61.9	61.7	61.4
-5	7	60.9	61.7	60.8	3	-5	62.0	61.9	61.8
5	5	61.6	62.0	61.9	1	-5	62.2	62.0	62.2
3	5	62.3	62.2	62.7	-1	-5	62.1	62.0	61.8
1	5	62.0	62.2	62.1	-3	-5	62.3	62.4	62.2
-1	5	62.3	62.0	62.2	-5	-5	61.6	61.7	61.7
-3	5	62.5	62.8	62.3	5	-7	61.2	60.9	61.2
-5	5	61.7	62.2	61.7	3	-7	61.2	61.0	61.1
5	3	63.1	62.9	62.8	1	-7	61.2	61.1	60.9
3	3	63.9	63.6	63.8	-1	-7	61.4	61.5	61.3
1	3	63.3	63.5	63.4	-3	-7	61.8	61.5	61.4
-1	3	63.5	63.9	63.9	-5	-7	61.0	61.0	60.8
-3	3	63.4	63.8	63.4	-7	5	61.2	61.7	61.2
-5	3	62.6	62.9	62.5	-7	3	61.6	61.8	61.7
5	1	63.4	63.5	63.4	-7	1	61.9	62.0	62.2
3	1	65.3	64.7	64.6	-7	-1	61.8	62.2	62.1
1	1	66.3	66.1	65.9	-7	-3	61.4	61.8	61.6
-1	1	65.3	64.6	64.9	-7	-5	61.1	61.4	61.3
-3	1	65.5	65.4	65.8	7	5	61.0	61.3	61.1
-5	1	63.6	63.7	64.0	7	3	61.6	61.2	61.3
5	-1	64.0	63.5	63.7	7	1	62.0	61.5	62.1
3	-1	65.1	64.4	64.8	7	-1	62.4	61.9	62.0
1	-1	65.0	64.9	64.9	7	-3	61.9	61.6	61.5
-1	-1	65.2	64.9	64.9	7	-5	61.3	60.9	60.8
-3	-1	65.3	65.2	65.2	-7	-7	60.0	60.0	60.0
-5	-1	63.3	63.5	63.6	-7	7	60.0	60.0	60.0
5	-3	62.8	62.6	62.4	7	7	60.0	60.0	60.0
3	-3	63.5	63.1	63.0	7	-7	60.0	60.0	60.0

[†] Distance from test cell centerline, in feet

Test Cell Data

Table D-2. Normalized Mean Radiant Temperatures for 8-foot position.

Globe Position†		Test Replicate			Globe Position†		Test Replicate		
X	Y	Test 1	Test 2	Test 3	X	Y	Test 1	Test 2	Test 3
5	7	61.0	61.0	60.4	1	-3	62.8	62.6	62.4
3	7	61.8	61.9	61.1	-1	-3	63.5	63.1	63.0
1	7	61.4	61.7	61.1	-3	-3	64.0	63.9	63.5
-1	7	61.5	61.7	61.1	-5	-3	64.2	63.9	63.8
-3	7	61.9	61.8	61.0	5	-5	63.6	63.4	63.6
-5	7	60.9	61.7	60.8	3	-5	62.5	62.6	62.6
5	5	61.6	62.0	61.9	1	-5	61.9	61.7	61.4
3	5	62.3	62.2	62.7	-1	-5	62.0	61.9	61.8
1	5	62.0	62.2	62.1	-3	-5	62.2	62.0	62.2
-1	5	62.3	62.0	62.2	-5	-5	62.1	62.0	61.8
-3	5	62.5	62.8	62.3	5	-7	62.3	62.4	62.2
-5	5	61.7	62.2	61.7	3	-7	61.6	61.7	61.7
5	3	63.1	62.9	62.8	1	-7	61.2	60.9	61.2
3	3	63.9	63.6	63.8	-1	-7	61.2	61.0	61.1
1	3	63.3	63.5	63.4	-3	-7	61.2	61.1	60.9
-1	3	63.5	63.9	63.9	-5	-7	61.4	61.5	61.3
-3	3	63.4	63.8	63.4	-7	5	61.8	61.5	61.4
-5	3	62.6	62.9	62.5	-7	3	61.0	61.0	60.8
5	1	63.4	63.5	63.4	-7	1	61.2	61.7	61.2
3	1	65.3	64.7	64.6	-7	-1	61.6	61.8	61.7
1	1	66.3	66.1	65.9	-7	-3	61.9	62.0	62.2
-1	1	65.3	64.6	64.9	-7	-5	61.8	62.2	62.1
-3	1	65.5	65.4	65.8	7	5	61.4	61.8	61.6
-5	1	63.6	63.7	64.0	7	3	61.1	61.4	61.3
5	-1	64.0	63.5	63.7	7	1	61.0	61.3	61.1
3	-1	65.1	64.4	64.8	7	-1	61.6	61.2	61.3
1	-1	65.0	64.9	64.9	7	-3	62.0	61.5	62.1
-1	-1	65.2	64.9	64.9	7	-5	62.4	61.9	62.0
-3	-1	65.3	65.2	65.2	-7	-7	61.9	61.6	61.5
-5	-1	63.3	63.5	63.6	-7	7	61.3	60.9	60.8
5	-3	61.0	61.0	60.4	7	7	60.0	60.0	60.0
3	-3	61.8	61.9	61.1	7	-7	60.0	60.0	60.0

† Distance from test cell centerline, in feet