Schwank, Model 2313
Patio Heater Performance Test

FSTC Report # 5011.05.06

Food Service Technology Center
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The information in this report is based on data generated at the Food Service Technology Center.

Acknowledgments

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Specific appreciation is extended to Schwank, for supplying the Food Service Technology Center with the 2313 heater for controlled testing in the appliance laboratory.

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Schwank 2313 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.[2,3,4]

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 Schwank model 2313 natural gas-powered patio heater 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 in four mounting positions with the heater operating at full output.
4. The heater's heating index is determined for each position, to relate the input rate to the effective heated area.

Appliance Description

Schwank's 2300 series of high-intensity heaters incorporate 23,000 to 50,000 Btu/h infra-red burners with models available for propane (LP) or natural gas use.[2] The 2300 series heaters can be wall mounted, arm mounted, post mounted, or suspended above the area to be heated.

The Schwank model 2313 heater is a high-intensity, natural gas powered patio heater with an input rate of 35,000 Btu/h. The heater employs a ceramic infrared burner that radiates heat from the stainless steel enclosure. Heater startup is handled by an electronic spark ignition and is available with an optional remote control.

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

Figure 1.
Schwank 2313 Heater.

Table 1. Appliance Specifications.

Manufacturer	Schwank
Model	2313
Generic Appliance Type	Patio Heater
Rated Energy Input Rate	35,000 Btu/h
Technology	High-intensity ceramic burner
Construction	Stainless Steel
Ignition	Electric Spark
Controls	Optional Remote On/Off
Overall Dimensions	43 ½" Long × 13" Wide × 10" Deep

Setup and Instrumentation

The 2313 heater was tested in three different positions. The first position was in accordance with Section 9 of the FSTC test method[1], at a height of 8 feet and a mounting angle of 0 degrees. Mounting height was measured from the lowest point of the heater to the surface of the floor. This position is generally recognized as delivering the maximum amount of radiant flux (heat) to the surrounding area.

While mounting the heater parallel to the ground maximizes the useful heat output, angling the heater provides much more flexibility in placement. Therefore, two additional sets of tests were conducted with the heater at heights of 8 and 9 feet, each with the heater at an angle of 30 degrees from horizontal.

For each set of tests, 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 attached to the geometric center of the burner shield.

The mean radiant temperature at a specific point under the heater can be determined 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 net 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 overall size of the globe thermometer grid was 14 feet by 14 feet. 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.

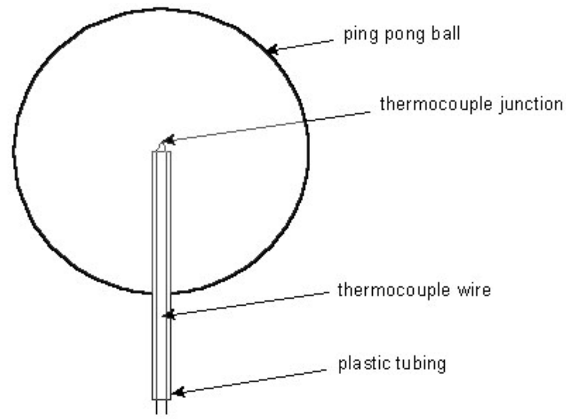


Figure 2.
Globe thermometer design.

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 33,400 Btu/h, which was within 4.5% of the nameplate rate of 35,000 Btu/h. This ensured the heater was operating as per the manufacturer's specification, and testing could continue without adjustment. The 2313 heater also consumed a small amount of electrical energy for the controls—18 Watts.

Preheat Test

The preheat test recorded the time and energy required for the heater to increase the burner shield temperature from 75 ± 5°F to a temperature that equals 95% of its maximum stabilized temperature (as measured by the thermocouple attached to the burner shield). Recording began when the heater was first turned on, so any time delay before the ignition of the burner was included in the test. The test continued until the burner shield temperature had stabilized to within ±3°F over a period of 5 minutes. The point when the burner shield 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 burner shield temperature of 513.9°F, which meant the heater was considered preheated when the burner shield reached 488.2°F (95% of maximum). The heater reached this temperature in 13.5 minutes, while consuming 7170 Btu of energy. The preheat chart for the Schwank 2313 heater is shown in Figure 4.

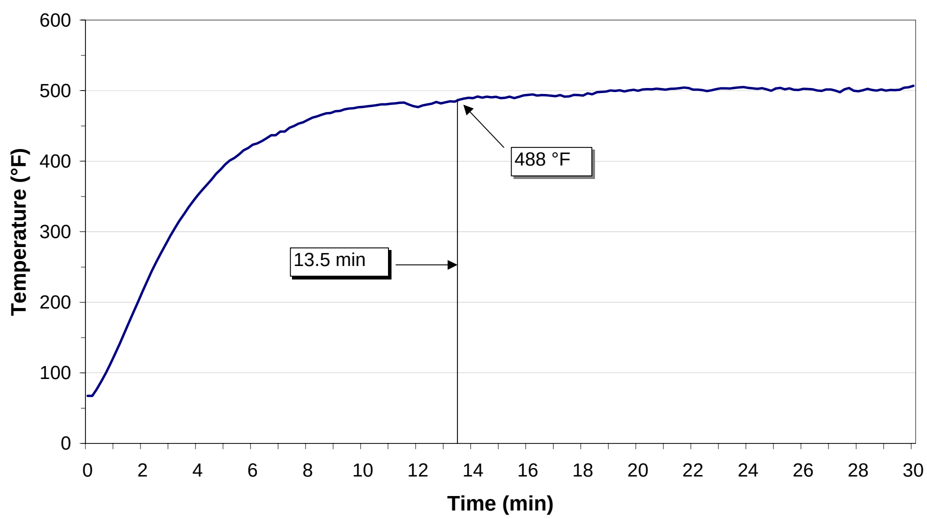


Figure 4.
Preheat characteristics.

Table 2 summarizes the results of the input and preheat tests for the Schwank 2313 heater.

Table 2. Input and Preheat Test Results.

Rated Energy Input Rate (Btu/h)	35,000
Measured Energy Input Rate (Btu/h)	33,400
Percentage Difference From Rated (%)	4.5
Electrical Energy Input Rate (W)	18
Preheat	
Time (min)	13.5
Energy (Btu)	7,170

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.

For the 8-foot, 0 degree angle position, the heater was located in the middle of the test cell, such that the center of the heater was directly above the center of the globe thermometer array. For the subsequent tests, the heater was mounted at a 30-degree angle, with the center of the heater positioned 2 ½ feet from the left-hand edge of the globe thermometer array and centered from front-to-back. The heater was aimed towards the right side of the globe thermometer array, ensuring that the entire heat pattern from the heater was measured.

To confirm that all test apparatus was in a stable condition, the temperatures of the globe thermometers and the burner shield 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 heated area 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 heater at the 8-foot, 0 degree position, 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.

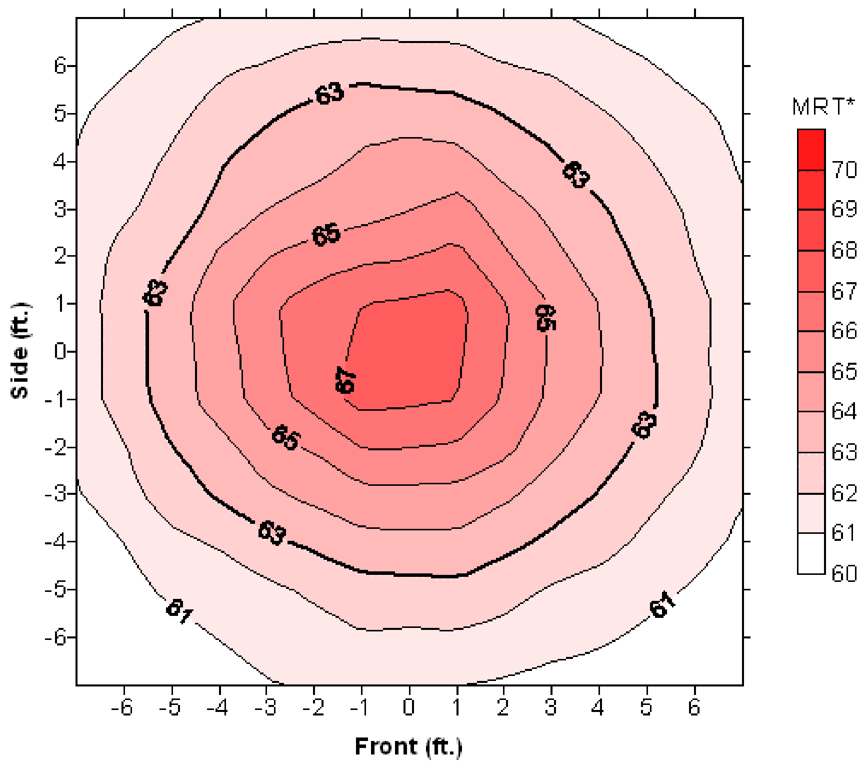


Figure 5. Temperature distribution plot at 8-feet.

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 Schwank 2313 heater at the 8-foot, 0 degree position was 84.6 ± 3.7 ft^2.

Figure 6 characterizes the radiant heat distribution of the 2313 heater at the 8-foot, 0 degree position by showing the average front to back and left to right temperatures across the test grid.

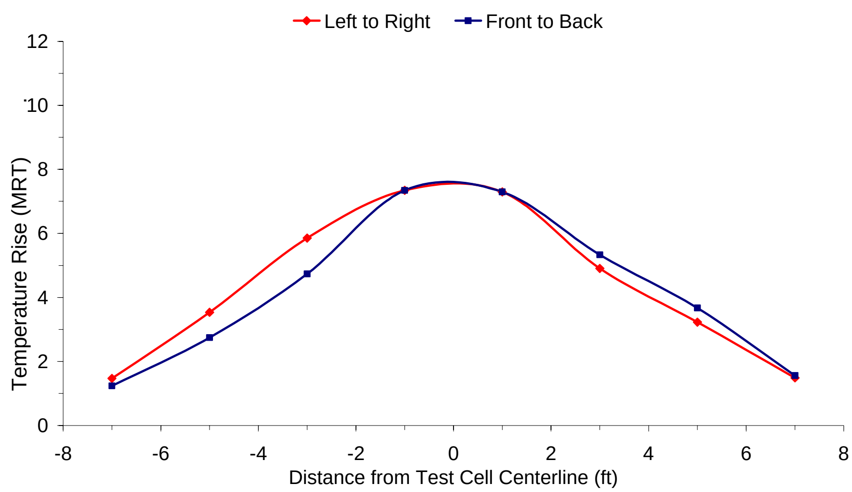


Figure 6. Radiant Heat Distribution at 8-feet.

The next set of tests was performed with the heater mounted at a height of 8 feet, and at an angle of 30 degrees from horizontal. The center of the heater was 2 ½ feet from the left edge of the globe thermometer array, facing the right edge.

Figure 7 shows the distribution plot for the heater when mounted 8-feet from the floor, and at an angle of 30 degrees from horizontal.

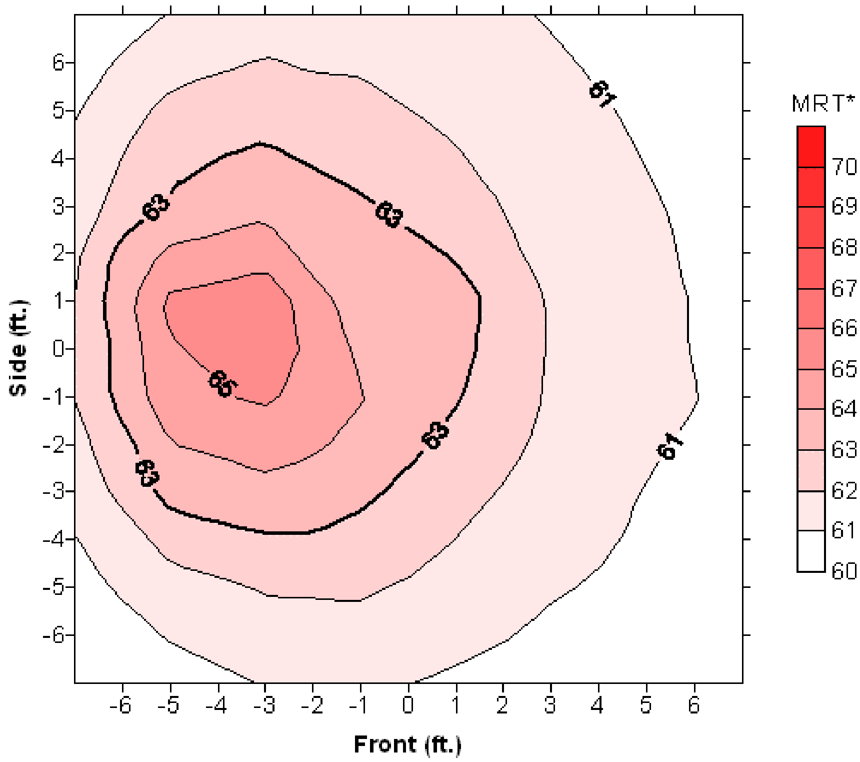


Figure 7. Temperature distribution plot at 8-feet and angled at 30-degrees.

The effective heated area for the Schwank 2313 heater at the 8-foot, 30-degree position was 47.4 ± 4.5 ft^2. Part of the reduction in heated area was due to a rising of the burner position by approximately 6-inches when the heater was angled. The distribution plot now showed a slight oblong shape from left to right that fell off more slowly from the center of the heater, remembering that it was mounted 2 ½ feet from the left edge of the globe array, aiming towards the right.

Figure 8 characterizes the radiant heat distribution of the 2313 heater at the 8-foot, 30-degree position by showing the average front to back and left to right temperatures across the test grid.

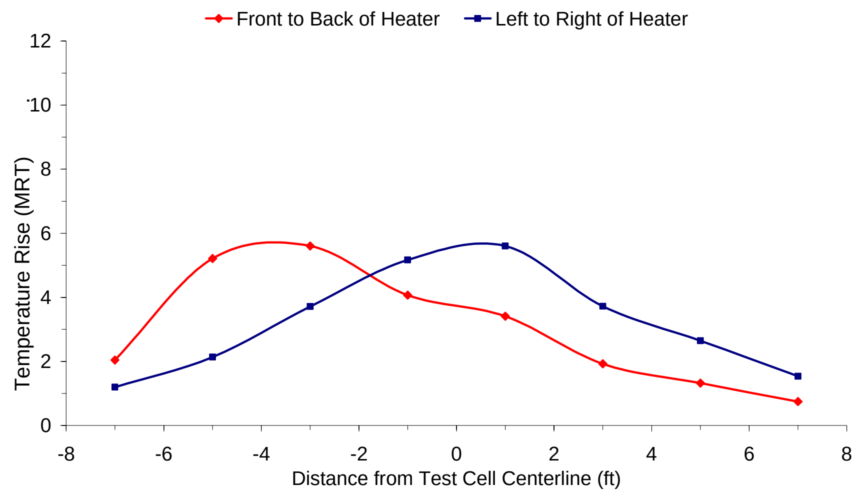


Figure 8.
Radiant Heat Distribution at 8-feet and angled at 30-degrees.

The next tested position had the heater at 9 feet above the floor while keeping the same 30-degree angle. The heater was raised straight up in the test cell so it did not shift in any other direction.

Figure 9 shows the distribution plot for the heater when mounted 9 feet from the floor, and at an angle of 30 degrees from horizontal.

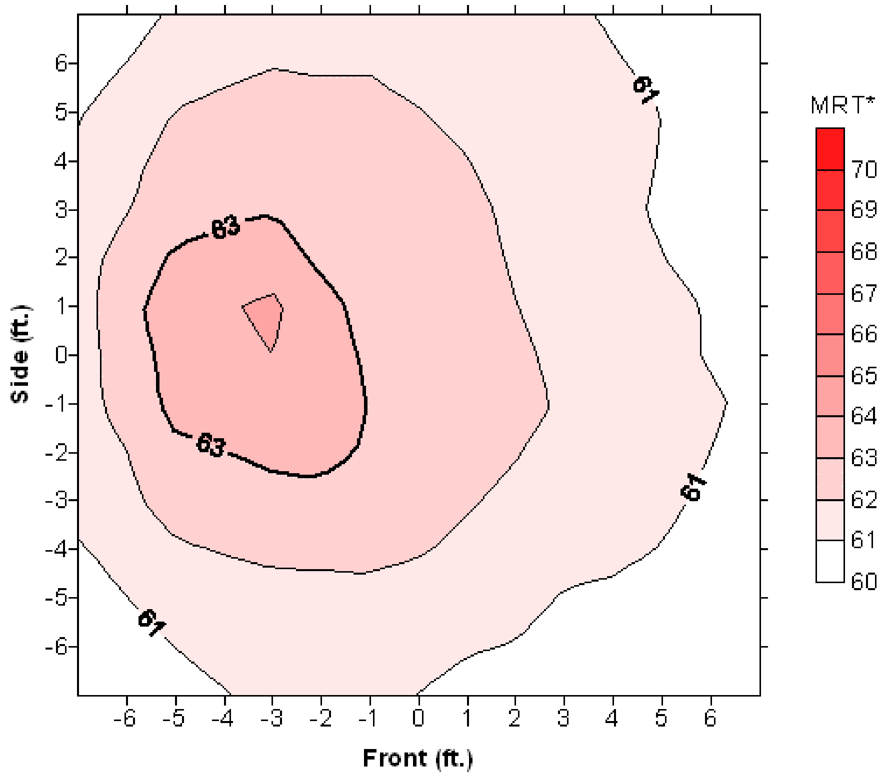


Figure 9. Temperature Distribution Plot at 9-feet and angled at 30-degrees.

The effective heated area for the heater at the 9-foot, 30-degree position was 18.3 ± 1.8 ft^2. As shown by the Figures, the heated area and maximum intensity results were both significantly reduced from when the heater was at the 8-foot height.

Figure 10 characterizes the radiant heat distribution of the 2313 heater at the 9 -foot, 30-degree position by showing the average front to back and left to right temperatures across the test grid.

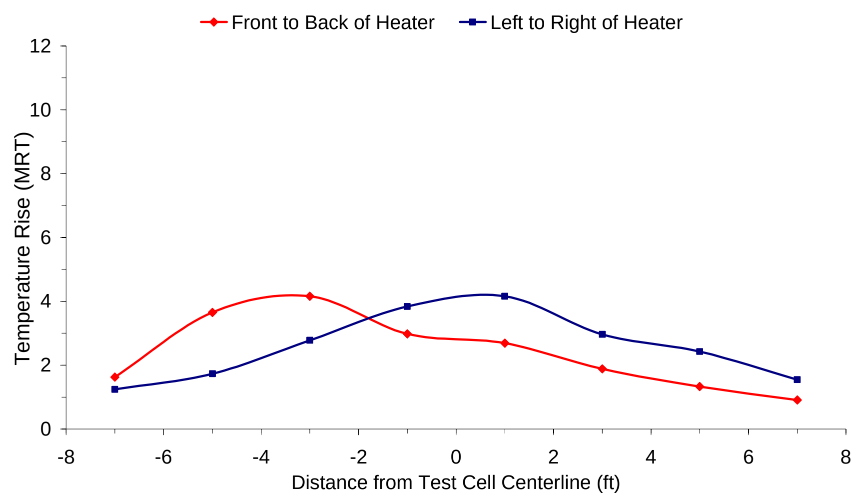


Figure 10.
Radiant Heat Distribution at 9-feet and angled at 30-degrees.

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 was 2.53 ft^2/kBtu/h for the 2313 heater at the 8-foot, 0 degree position. At the 8-foot 30-degree position, the heating index was 1.42 ft^2/kBtu/h. For the mounting position of 9 feet and 30 degrees, the heating index was 0.56 ft^2/kBtu/h.

The results of the effective heated area tests for each of the three mounting positions are shown in Table 3.

Table 3. Effective Heated Area Results.

Mounting Position (Height, Angle)	Measured Input (Btu/h)	Effective Heated Area (ft^2)	Heating Index (ft^2/kBtu/h)
8 feet, 0 degree angle	33,400	84.6 ± 3.7	2.53
8 feet, 30 degree angle	33,400	47.4 ± 4.5	1.42
9 feet, 30 degree angle	33,400	18.3 ± 1.8	0.56

Conclusions

The 2313 high-intensity patio heater tested by the Food Service Technology Center is the mid-powered model from Schwank's 2300 series.

Mounted horizontally at the 8-foot height, the 2313 heater produced a round-shaped temperature distribution pattern with an effective heated area of 84.6 ± 3.7 ft^2. This is roughly 75% of the heated area produced by the higher-powered 2315 heater, which is not surprising since the output of the 2313 is about 75% of the 2315. The maximum mean radiant temperature in the center of the heat pattern was 67°F at this position, 2°F less than the 2315 when mounted in the same position.

When placed at a 30-degree angle and 8 feet from the floor, the 2313 heater produced a heated area of 47.4 ± 4.5 ft^2 and a maximum mean radiant temperature of 65°F. The angling of the heater gave the temperature distribution pattern a slightly oval shape, with the majority of the heat delivered in the direction the heater was facing. While the heater did not provide as much useable output as when mounted flat, the heater could now be mounted close to walls and other objects, providing more installation options.

When the 2313 was mounted at the 30-degree angle and at a height of 9 feet, the heated area was 18.3 ± 1.8 ft^2 and the maximum mean radiant temperature was 64°F. At this height the heater is still providing useable heat, only not as efficiently as when mounted closer to the floor.

References

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

2. Sorensen, G. 2005. *Schwank Model 2315 Patio Heater Performance Test.* Food Service Technology Center Report 5011.05.05, March.

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

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

A Glossary

Burner Shield

Part of the heater, typically metal and positioned across the entire burner, that protects people or objects from direct contact with the burner.

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.

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

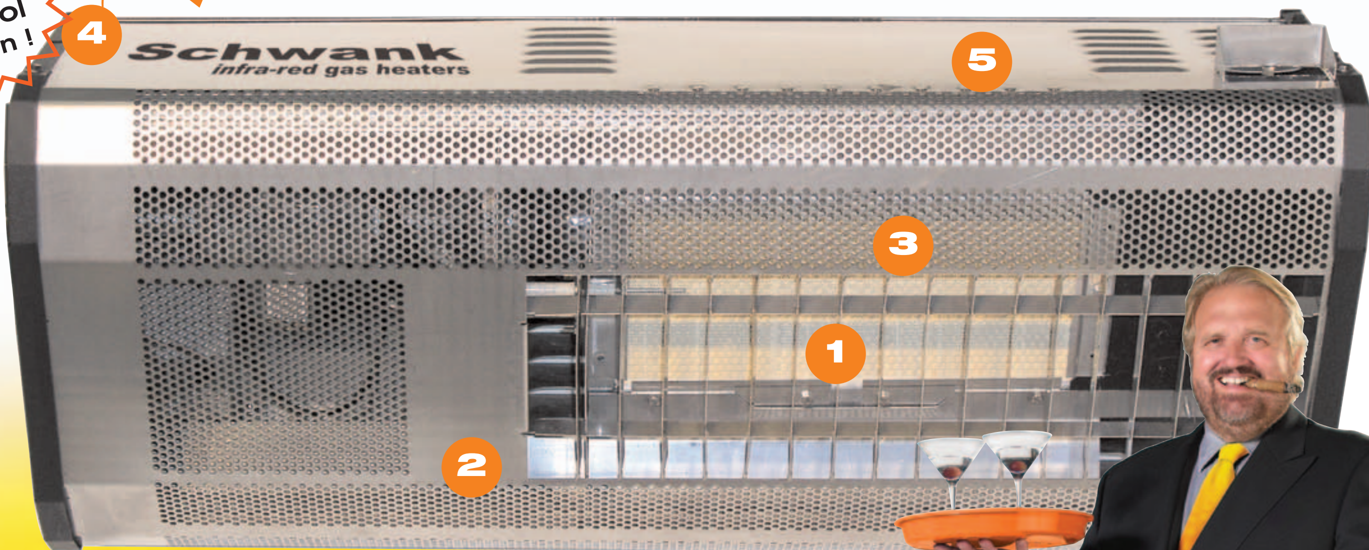
Appendix B includes the product literature for the Schwank patio heater, Model 2313.

Schwank
infra-red gas heaters

May we take your order?

With Schwank, you choose from the industry's premier selection of heaters for wide-open patios, "tight spots" and even under canopies.

New Remote Control Option !



The new patioSchwank 2300 is the perfect overhead mounted solution for outdoor spaces where radiant heat needs to be directed at specific areas and floor space is at a premium. Discreet, efficient and comfort-driven, a patioSchwank 2300 will heat up your profits as customers stay longer in the evening and later in the season.

Just compare patioSchwank 2300 series features:

1) Three Firing Rates: 23,000, 35,000 and 50,000 BTUs in natural gas or propane - all based on our leading-edge burner technology

2) Insulated Cabinet: traps convection heat to create additional infrared heat - improved comfort and lower fuel costs

3) Stainless Steel Enclosure Lens: provides durability, long life and the ability to withstand higher temperature output

4) Balanced Suspension Points: coupled with multiple suspension hardware options facilitates quicker, lower cost installations

5) Weather Resistant Housing: provides durability and maintains the heater's aesthetic appeal on your patio

Schwank invented the infra-red heater and we remain the world leader over 50 years later. So choose one of our patio heaters and throw away the express menu. Your customers are staying for last call.

Bernd Schwank, Chairman
Schwank International
Group of Companies

SP-P230-BX-01A

patioSchwank

patioSchwank
SERIES 2300

Schwank invented the infra-red heater and we remain the world leader over 50 years later.

patioSchwank SERIES 1100

High Efficiency Perimeter Mount Luminous Heaters

patioSchwank SERIES 2300

Mini Luminous for "tight"spots

patioSchwank SERIES 4000

Portable or post mount.

patioSchwank SERIES 3000

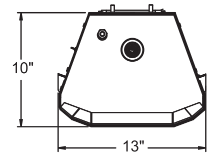
Tube Type Heaters Under Roof/Canopy

2300 Series Specifications

DIMENSIONS AND CONFIGURATIONS

MODEL	VOLTAGE VAC	CURRENT AMPS	Btu/hr INPUT	TOTAL WEIGHT (lbs.)	HEATER LENGTH
2312-N/L 2313-N/L 2315-N/L	24	40 VA*	23,000 35,000 50,000	32 44 48	30 1/2" 43 1/2" 43 1/2"

*For a multipe installations: size transforms at 40 VA for the first heater plus 20 VA for each additional heater

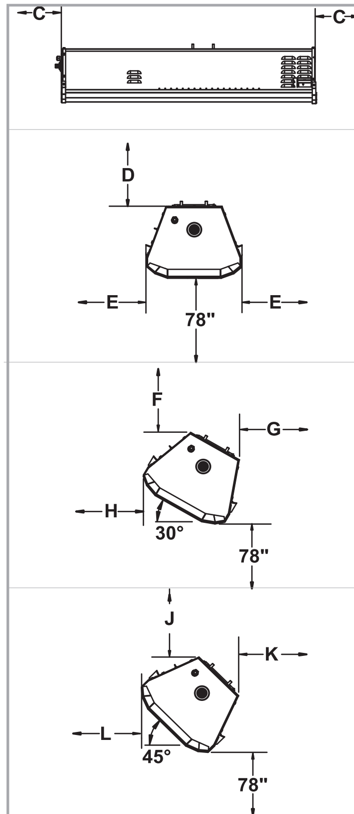


CLEARANCES TO COMBUSTIBLES

MODEL		ENDS	HORIZONTAL		30° ANGLE			45° ANGLE		
		C	D	E	F	G	H	J	K	L
2312 N/L	OUTDOOR	3"	5.5"	7"	9.5"	1"	9.5"	12.5"	1"	11.5"
2312 N/L	INDOOR	4"	8"	10"	12.5"	2.5"	14"	16"	2"	15.5"
2313 N/L	OUTDOOR	5"	7.5"	9"	9.5"	1.5"	21"	10.5"	1.5"	23"
2313 N/L	INDOOR	6"	10.5"	14.5"	14.5"	2.5"	26"	17"	2.5"	28"
2315 N/L	OUTDOOR	16"	8"	13.5"	10"	2"	21"	12.5"	2"	24.5"
2315 N/L	INDOOR	17"	11"	19"	16.5"	3"	28.5"	18.5"	4"	30"

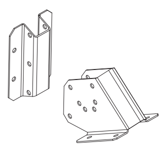
Schwank recommends that for most applications the mounting angle should not exceed 30°

CLEARANCES

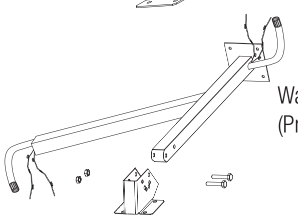


Each 2300 Series Heater is supplied with a hanging bracket for overhead suspension

<u>Optional Mounting Accessories</u>



Wall Mounting Bracket (30° Mounting Angle) — JP-2300-MB



Wall Mounting Arm Kit (Prepiped & prewired) — JP-2300-MK

SUGGESTED MOUNTING FOR COMFORT***

MOUNTING PARAMETERS	MODEL 2312		MODEL 2313		MODEL 2315	
MOUNTING ANGLE	HORIZONTAL	30°	HORIZONTAL	30°	HORIZONTAL	30°
Mounting height to patio floor	9' 0"	9' 0"	10' 0"	10' 0"	11' 0"	11' 0"
Side distance to patio edge	3' 6"	3' 6"	4' 0"	4' 0"	5' 0"	5' 0"
Side distance between heaters	6' 0"	6' 0"	8' 0"	8' 0"	10' 0"	10' 0"

***Note: These mounting distances are suggested, and are subject to on site conditions. If in doubt, please contact your Schwank distributor.

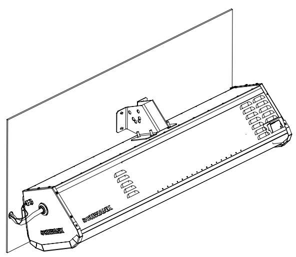
Schwank infra-red gas heaters
ISO 9001:2000 REGISTERED

Canada
5285 Bradco Blvd.
Mississauga, On. L4W 2A6
Telephone: 905-712-4766
Fax: 905-712-8336
www.schwankheaters.com

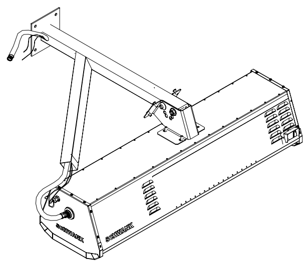
U.S.A.
2 Schwank Way,
Waynesboro, GA 30830
Telephone: 706-554-6191
Fax: 706-554-9390
info@schwankheaters.com

Mounting options for Schwank 2300 Series heaters:

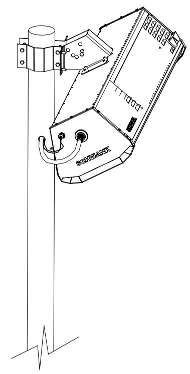
WALL MOUNTING



ARM MOUNTING

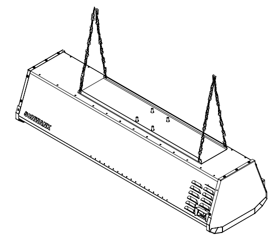


POST MOUNTING



CHAIN HANGING

(CHAIN HANGING SUPPORT SUPPLIED WITH THE HEATER)



C Results Reporting Sheets

Manufacturer	Schwank
Model	2313
Date:	February, 2005

Test Patio Heater:

Description of operational characteristics: The 2313 is a high-intensity, natural gas fired, infrared heater with a rated input of 35,000 Btu/h. The ceramic burner is mounted in a stainless steel enclosure, and is lit by an electronic ignition module.

Apparatus:

The heater was installed in a 20 by 20-foot space, in three positions. The first was at a height of 8-feet above the floor, according to the FSTC test method. The remaining positions were at heights of 8 feet and 9 feet above the floor, both at an angle of 30 degrees from horizontal.

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 C-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	33,400 Btu/h
Rated	35,000 Btu/h
Percent Difference between Measured and Rated	4.5 %
Electrical Energy Input Rate	18 W

Preheat:

Preheat Time	13.5 min.
Preheat Energy	7,170 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 mounting positions are shown in Table C-1.

Table C-1. Effective Heated Area Results.

8-foot height, 0-degrees	84.6 ± 3.7 ft^2
8-foot height, 30-degrees	47.4 ± 4.5 ft^2
9-foot height, 30-degrees	18.3 ± 1.8 ft^2

Patio Heater 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 results for each of the three mounting positions are shown in Tables C-2 to C-4.

Table C-2. Heating Index with heater at 8 feet.

Energy Input Rate	33,400 Btu/h
Heated Area	84.6 sqf
Heating Index	2.53 ft^2/kBtu/h
Efficiency Index	395 Btu/ft^2

Table C-3. Heating Index with heater at 8 feet, angled at 30 degrees.

Energy Input Rate	33,400 Btu/h
Heated Area	47.4 sqf
Heating Index	1.42 ft^2/kBtu/h
Efficiency Index	704 Btu/ft^2

Table C-4. Heating Index with heater at 9 feet, angled at 30 degrees.

Energy Input Rate	33,400 Btu/h
Heated Area	18.3 sqf
Heating Index	0.56 ft^2/kBtu/h
Efficiency Index	1790 Btu/ft^2

D Test Cell Data

Mean Radiant Temperature Distribution:

Tables D-1 to D-3 show the average normalized mean radiant temperatures from the three test replicates at each mounting height. The tables are for the mounting heights of 8-feet at 0-degrees, 8-feet at 30-degrees, and 9-feet at 30-degrees, respectively.

Test Cell Data

Table D-1. Normalized Mean Radiant Temperatures for 8-foot, 0-degree 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	60.3	60.6	60.6	1	-3	62.3	62.3	62.3
3	7	61.0	61.2	61.1	-1	-3	63.5	63.7	63.7
1	7	61.4	61.6	61.6	-3	-3	64.6	64.8	64.8
-1	7	61.4	61.6	61.6	-5	-3	64.3	65.1	64.8
-3	7	61.2	61.3	61.3	5	-5	63.7	63.9	63.9
-5	7	60.8	60.9	60.9	3	-5	62.6	62.4	62.4
5	5	61.5	61.8	61.5	1	-5	61.3	61.2	61.3
3	5	62.5	62.6	62.6	-1	-5	61.9	61.9	61.9
1	5	63.2	63.5	63.5	-3	-5	62.7	62.9	62.7
-1	5	63.9	63.5	63.6	-5	-5	62.6	62.7	62.6
-3	5	62.8	62.9	62.9	5	-7	61.9	61.8	61.7
-5	5	61.8	61.8	61.8	3	-7	61.1	61.1	61.1
5	3	62.4	62.6	62.5	1	-7	60.3	60.5	60.4
3	3	63.8	63.7	63.7	-1	-7	60.7	60.7	60.7
1	3	65.6	65.2	65.2	-3	-7	61.0	61.0	61.0
-1	3	64.5	64.6	64.6	-5	-7	61.1	61.4	61.2
-3	3	64.0	64.0	64.0	-7	5	60.9	61.1	60.8
-5	3	62.4	62.4	62.5	-7	3	60.5	60.5	60.5
5	1	63.0	63.0	63.1	-7	1	60.9	60.9	60.8
3	1	64.8	64.7	65.2	-7	-1	61.2	61.2	61.2
1	1	67.2	67.2	67.5	-7	-3	61.4	61.5	61.5
-1	1	67.0	67.0	67.0	-7	-5	61.4	61.5	61.4
-3	1	65.8	65.8	66.0	7	5	60.8	61.0	60.9
-5	1	63.4	63.6	63.6	7	3	60.5	60.6	60.6
5	-1	63.1	63.2	63.4	7	1	60.8	60.8	60.7
3	-1	64.5	64.9	64.9	7	-1	61.1	61.2	61.0
1	-1	67.0	67.1	67.0	7	-3	61.4	61.5	61.5
-1	-1	67.1	67.6	67.4	7	-5	61.3	61.6	61.4
-3	-1	65.4	65.5	65.5	-7	-7	61.0	61.2	61.1
-5	-1	63.5	63.5	63.4	-7	7	60.4	60.7	60.5
5	-3	60.3	60.6	60.6	7	7	60.0	60.0	60.0
3	-3	61.0	61.2	61.1	7	-7	60.0	60.0	60.0

† Distance from test cell centerline, in feet

Table D-2. Normalized Mean Radiant Temperatures for 8-foot, 30-degree 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	60.8	60.5	60.2	1	-3	61.0	61.0	60.8
3	7	61.1	61.0	60.7	-1	-3	61.7	61.5	61.5
1	7	61.5	61.3	61.2	-3	-3	62.4	62.3	62.3
-1	7	61.6	61.5	61.5	-5	-3	63.4	63.2	63.0
-3	7	61.6	61.5	61.4	5	-5	63.9	63.6	63.7
-5	7	61.2	61.0	61.0	3	-5	63.4	63.3	63.2
5	5	61.0	61.0	60.5	1	-5	60.8	60.8	60.6
3	5	61.6	61.2	61.1	-1	-5	61.2	61.0	61.1
1	5	62.0	61.4	61.9	-3	-5	61.7	61.6	61.6
-1	5	62.2	62.1	62.5	-5	-5	62.2	62.0	62.2
-3	5	62.5	62.6	62.9	5	-7	62.2	62.0	62.0
-5	5	62.5	62.1	62.3	3	-7	61.6	61.4	61.6
5	3	61.3	61.2	60.8	1	-7	60.5	60.5	60.3
3	3	61.6	61.7	61.3	-1	-7	60.6	60.4	60.4
1	3	62.5	62.2	62.5	-3	-7	60.9	60.8	60.9
-1	3	63.0	63.2	63.2	-5	-7	61.2	61.2	61.2
-3	3	63.5	63.6	64.0	-7	5	61.0	60.9	61.2
-5	3	63.2	63.1	63.2	-7	3	60.7	60.5	60.7
5	1	61.3	61.3	61.1	-7	1	61.0	60.9	60.8
3	1	61.9	61.9	62.0	-7	-1	61.7	61.5	61.4
1	1	63.5	63.3	63.4	-7	-3	62.2	62.0	62.0
-1	1	63.3	63.8	63.1	-7	-5	62.2	62.1	61.8
-3	1	65.6	65.6	65.7	7	5	61.4	61.2	61.2
-5	1	65.3	65.1	65.2	7	3	60.8	60.6	60.6
5	-1	61.4	61.5	61.1	7	1	60.5	60.4	60.4
3	-1	62.1	62.0	61.5	7	-1	60.7	60.6	60.6
1	-1	63.2	63.1	62.9	7	-3	60.8	60.7	60.7
-1	-1	64.3	64.1	63.9	7	-5	60.8	60.8	60.7
-3	-1	65.3	65.1	65.1	-7	-7	60.5	60.4	60.3
-5	-1	64.7	64.6	64.6	-7	7	60.4	60.3	60.1
5	-3	60.8	60.5	60.2	7	7	60.0	60.0	60.0
3	-3	61.1	61.0	60.7	7	-7	60.0	60.0	60.0

† Distance from test cell centerline, in feet

Table D-3. Normalized Mean Radiant Temperatures for 9-foot, 30-degree 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	60.6	60.7	60.6	1	-3	61.2	61.1	61.0
3	7	61.0	61.3	61.2	-1	-3	61.4	61.4	61.4
1	7	61.3	61.5	61.4	-3	-3	62.1	62.3	61.9
-1	7	61.4	61.7	61.6	-5	-3	62.9	62.8	62.6
-3	7	61.4	61.6	61.5	5	-5	62.9	62.5	62.6
-5	7	61.1	61.2	61.1	3	-5	62.6	62.3	62.3
5	5	61.0	61.0	61.0	1	-5	60.8	60.9	60.8
3	5	61.3	61.6	61.3	-1	-5	61.0	60.9	61.0
1	5	61.9	61.9	61.6	-3	-5	61.4	61.4	61.4
-1	5	62.2	62.3	62.3	-5	-5	61.8	61.9	61.5
-3	5	62.4	62.4	62.4	5	-7	61.9	61.6	61.7
-5	5	62.0	62.0	62.1	3	-7	61.4	61.2	61.4
5	3	61.1	60.8	61.0	1	-7	61.1	60.7	60.5
3	3	61.1	61.4	61.3	-1	-7	60.5	60.7	60.4
1	3	62.1	62.3	62.4	-3	-7	60.7	60.9	60.7
-1	3	62.8	63.1	62.7	-5	-7	61.1	61.3	61.3
-3	3	62.9	63.1	62.9	-7	5	61.2	61.3	61.2
-5	3	62.4	62.6	62.7	-7	3	60.7	60.7	60.7
5	1	61.0	61.0	61.2	-7	1	60.9	60.9	61.0
3	1	61.2	61.9	61.3	-7	-1	61.3	61.3	61.4
1	1	62.4	63.1	62.3	-7	-3	61.6	61.6	61.7
-1	1	62.5	62.9	62.5	-7	-5	61.6	61.6	61.6
-3	1	64.0	64.3	64.2	7	5	61.2	61.2	61.2
-5	1	63.5	63.7	63.7	7	3	60.7	60.6	60.7
5	-1	61.4	61.5	61.1	7	1	60.7	60.7	60.7
3	-1	61.8	62.0	61.8	7	-1	60.8	60.8	60.7
1	-1	62.6	62.8	62.7	7	-3	60.9	60.8	60.9
-1	-1	63.0	63.0	62.9	7	-5	60.9	60.9	60.8
-3	-1	64.1	63.6	63.8	-7	-7	60.9	60.7	60.4
-5	-1	63.4	63.1	63.3	-7	7	60.7	60.7	60.7
5	-3	60.6	60.7	60.6	7	7	60.0	60.0	60.0
3	-3	61.0	61.3	61.2	7	-7	60.0	60.0	60.0

† Distance from test cell centerline, in feet