Sunpak® Heater Model S25
Patio Heater Performance Test

FSTC Report # 5011.06.20

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Acknowledgments

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Specific appreciation is extended to Infrared Dynamics, for supplying the Food Service Technology Center with the Sunpak® Heater, Model S25 for controlled testing in the appliance laboratory.

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Background

Patio heaters are gaining popularity with food service operators as an effective method of extending the outdoor dining season. A deck or patio with added warmth 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 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, Incorporated, 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 like much, 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.

Infrared Dynamics has developed the Sunpak® line of heaters, which incorporate infrared burners in either a stainless or aluminized steel housing. Models are available with inputs of 25,000 Btu/h or 34,000 Btu/h, and can be configured for propane (LP) or natural gas use. The Sunpak® heaters can be mounted to a wall or suspended above the area to be heated, which provides great placement flexibility.

Objective

The objective of this report is to examine the operation and performance of the Infrared Dynamics Sunpak® natural gas-fired patio heater, model S25, 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 energy and time is determined.
3. The temperature distribution and effective heated area is determined with the heater operating at a height of 7-feet. Note that this is a deviation from the 8-foot height specified by the test method.
4. The heater's heating index is determined to relate the input rate to the effective heated area.

Appliance Description

The Sunpak® heater, model S25, is a natural gas fired patio heater with an input rate of 25,000 Btu/h (Figure 1). Heat is generated by a infrared ceramic burner, which is mounted in an aluminized steel enclosure. The heater measures 47 1/2 inches long, 8 inches wide and 8 inches deep. The S25 can be mounted on a wall or ceiling, or suspended from overhead.

Figure 1.
Infrared Dynamics Sunpak® Heater, Model S25.

Table 1. Appliance Specifications.

Manufacturer	Infrared Dynamics
Model	S25
Generic Appliance Type	High Intensity Infrared Heater
Rated Energy Input Rate	25,000 Btu/h
Technology	Ceramic Infrared Burner
Construction	Aluminized Steel Enclosure Aluminum Grill
Ignition	Direct Spark
Controls	Automatic Ignition with Flame Rectification Sensing
Dimensions	45 1/2" Wide × 8" Wide × 8" Deep

Setup and Instrumentation

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

The Sunpak® S25 heater was installed in accordance with the manufacturer's instructions at a height of 7 feet. This is a deviation from the test method, which specifies a height of 8 feet. This change is also noted in the results reporting sheets of this report. All other aspects of the setup conformed to Section 9 of the FSTC test method, with the heater mounted in a horizontal position, and the face of the heater parallel to the floor.

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 placed in the geometric center of a sphere. The thermocouple measures the 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 transducer and all thermocouples were connected to a computerized data acquisition unit that recorded data every 10 seconds.

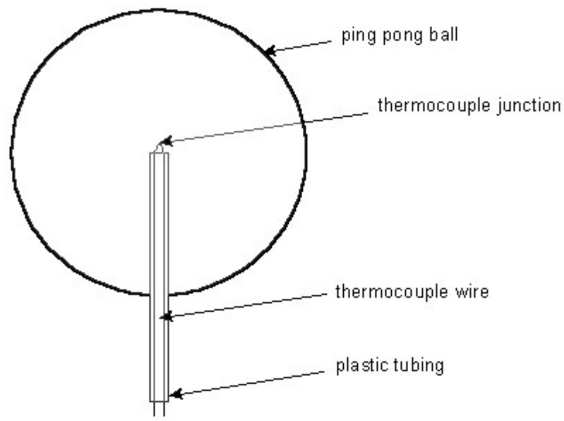

Figure 2.
Globe thermometer design.

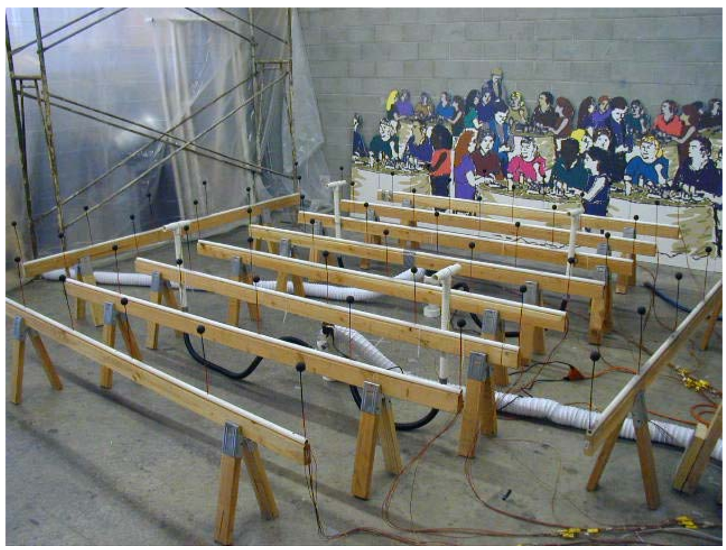

Figure 3.
Globe thermometer grid.

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 maximum energy input rate was 24,300 Btu/h, which is within 2.8% of the heater's nameplate rating (25,000 Btu/h). This ensured the heater was operating as per the manufacturer's specification, and testing could continue without adjustment. The S25 heater also consumed a small amount of electrical energy (14 Watts) for the controls.

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). 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 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 grill temperature of 280.1°F, which meant the heater was considered preheated when the grill reached 266.1°F (95% of maximum). The heater reached this temperature in 9.3 minutes, while consuming 3660 Btu of energy. The preheat chart for the Sunpak® S25 heater is shown in Figure 4.

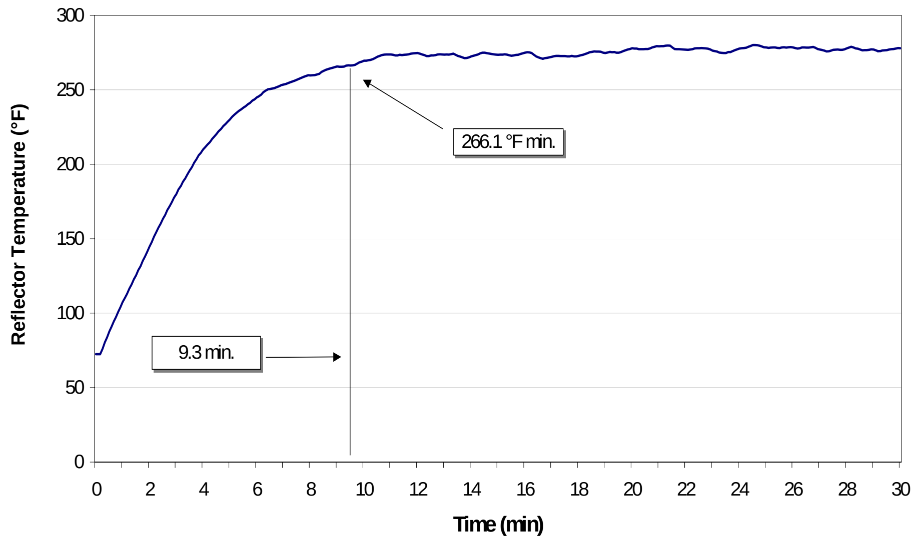

Figure 4.
Preheat characteristics.

Table 2 summarizes the results of the input and preheat tests for the Sunpak® model S25 heater.

Table 2. Input and Preheat Test Results.

Rated Energy Input Rate (Btu/h)	25,000
Measured Energy Input Rate (Btu/h)	24,300
Percentage Difference From Rated (%)	2.8
Electrical Energy Input Rate (W)	14
Preheat	
Time (min)	9.3
Energy (Btu)	3,660

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.

The S25 heater was mounted at a height of 7 feet, as measured from the floor to the face of the reflector, which was parallel to the floor. Note that this is a deviation from the height of 8-feet specified by the test method, and is also noted in the results reporting sheets of this report.

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 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.

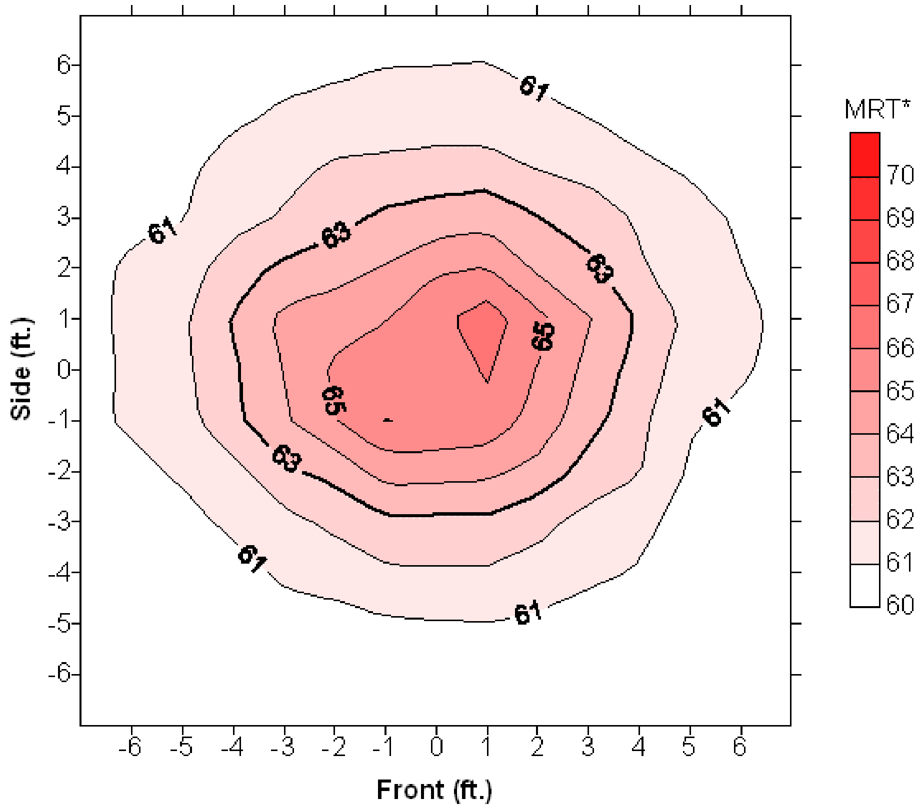

Figure 5. Temperature distribution plot.

*MRT- Mean Radiant Temperature, normalized to a 60°F ambient.

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 Sunpak® S25 heater was 39.1 ± 2.7 ft^2.

Figure 6 characterizes the radiant heat distribution of the S25 heater by showing the average front to back and left to right temperatures across the test grid.

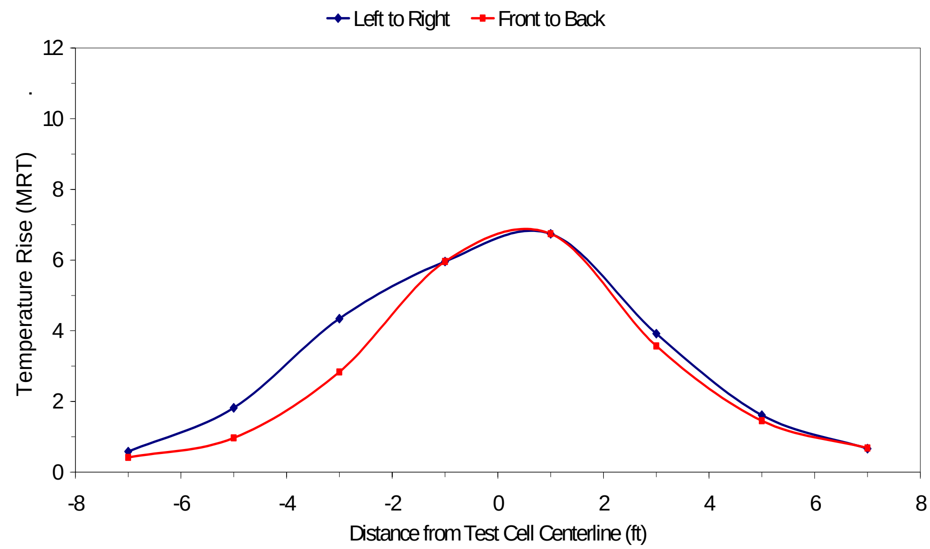

Figure 6. Radiant Heat Distribution.

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 1.61 ft^2/kBtu/h for the Sunpak® S25 heater.

Conclusions

The Sunpak® S25 heater produced a round-shaped temperature distribution with an effective heated area of 39.1 ± 2.7 ft^2. The effective heated area represents the part of the test cell raised to at least 3°F above the ambient design environment, and as the mean radiant globe temperature and temperature distribution plots show, the model S25 heater generated a 66°F maximum mean radiant temperature in the center of the heat pattern.

Since no one heater can be a perfect fit for every installation, the food service operator is best served by choosing a patio heater that will best meet his or her particular needs. In that regard, the Sunpak® model S25 heater is well suited to applications requiring an overhead mounted, gas-fired patio heater.

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

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5. Sorensen, G., Zabrowski, D., 2005. *Schwank, Model 2313 Patio Heater Performance Test.* Food Service Technology Center Report 5011.05.06, March.

6. Sorensen, G. 2005. *Easy Radiant Model PH-50-H-R-N Patio Heater Performance Test.* Food Service Technology Center Report 5011.05.04, December.

7. Sorensen, G., Zabrowski, D., 2006. *Sunpak® Heater Model S34 Patio Heater Performance Test*. Food Service Technology Center Report 5011.06.11, August.

8. Sorensen, G., Zabrowski, D., 2006. *Sunglo™ Heater Model A242 Patio Heater Performance Test*. Food Service Technology Center Report 5011.06.16, November.

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).

Efficiency Index (Btu/ft^2)

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

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 ($ft^2/kBtu/h$)

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

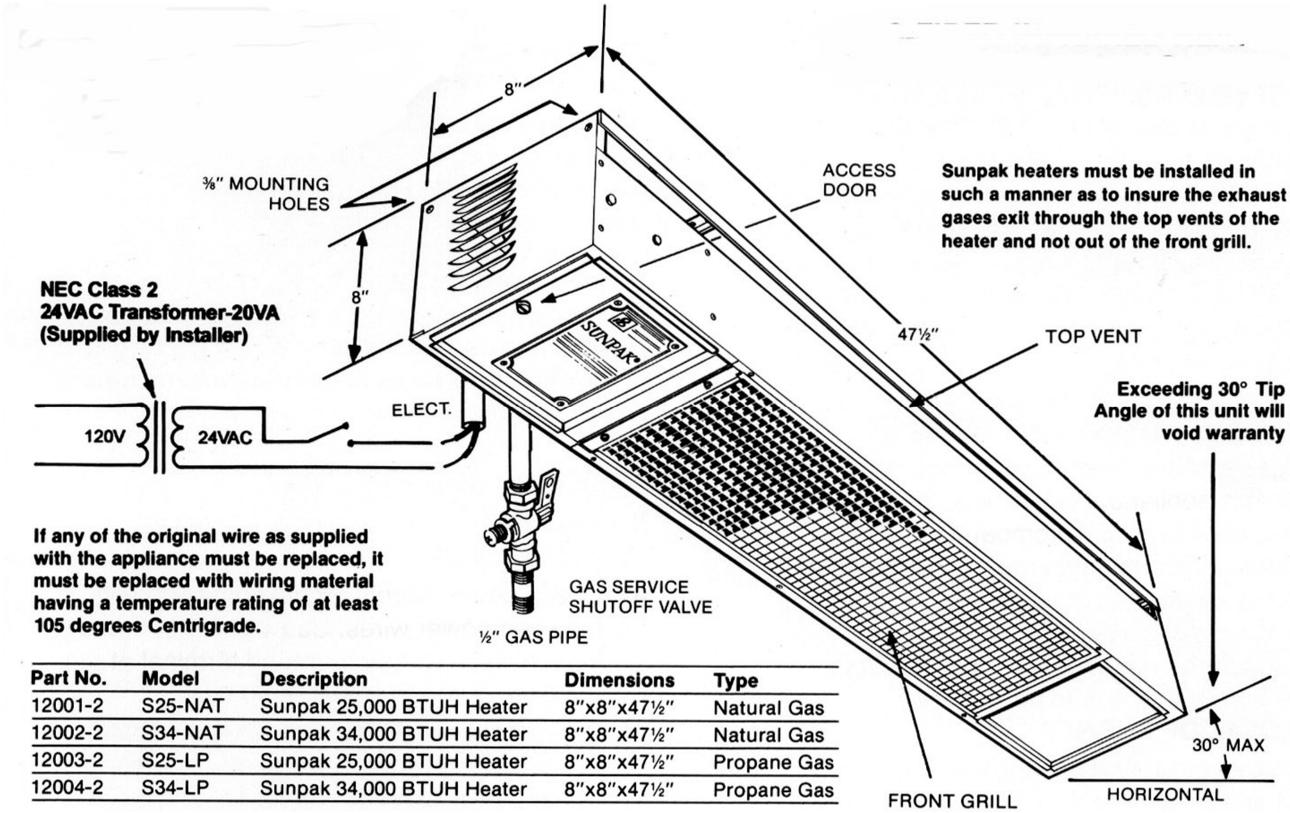
The time required for an appliance to "pre-heat" from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

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

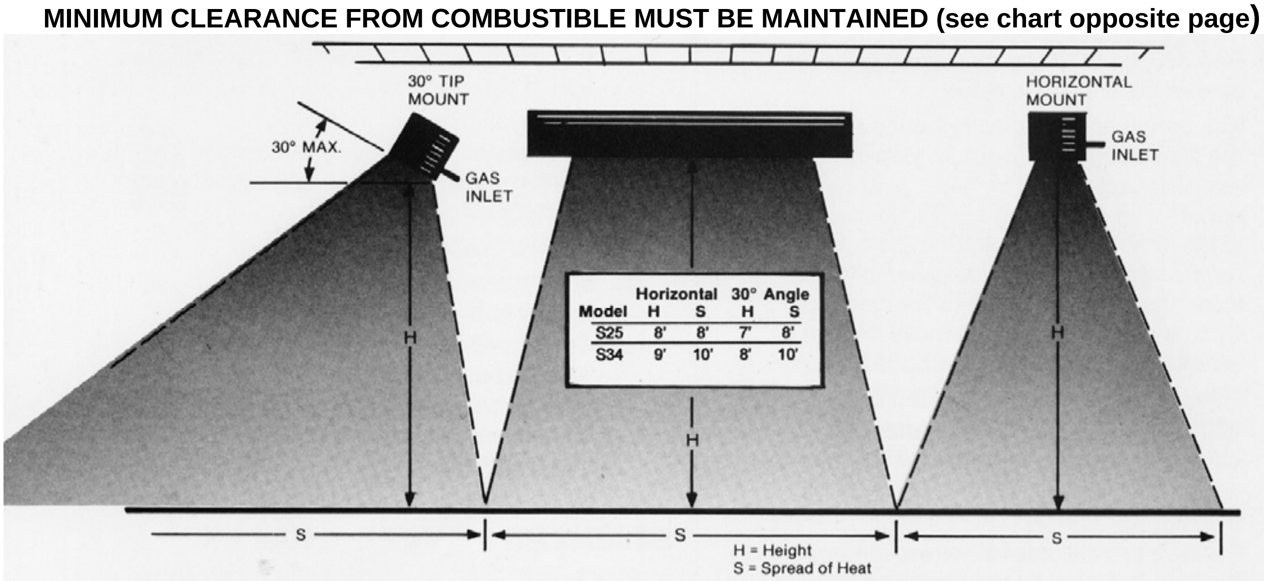
Appendix B includes the product literature for the Infrared Dynamics Sunpak® heater, Model S25.



Part No.	Model	Description	Dimensions	Type
12001-2	S25-NAT	Sunpak 25,000 BTUH Heater	8"x8"x47½"	Natural Gas
12002-2	S34-NAT	Sunpak 34,000 BTUH Heater	8"x8"x47½"	Natural Gas
12003-2	S25-LP	Sunpak 25,000 BTUH Heater	8"x8"x47½"	Propane Gas
12004-2	S34-LP	Sunpak 34,000 BTUH Heater	8"x8"x47½"	Propane Gas

CEILING

MINIMUM CLEARANCE FROM COMBUSTIBLE MUST BE MAINTAINED (see chart opposite page)



Model	Horizontal H	Horizontal S	30° Angle H	30° Angle S
S25	8'	8'	7'	8'
S34	9'	10'	8'	10'

SUNPAK will raise the comfort level 5-10º Fahrenheit outdoors. The above coverage table was based on still breeze conditions. Under windy conditions more heat will be required. It is recommended that a windswept patio be designed with wind breaks to stabilize the patio environment. Wind breaks shall NOT interfere with the ventilation of combustion air requirement of the heater(s).

ANGLE MOUNTING: Most models of the SUNPAK heater may be angle-mounted to a maximum of 30º to accommodate mounting the heaters around the edges of the patio. Note that the top clearance to combustibles increase when heater is tipped from the horizontal.

NOTE: Local codes may have special requirement regarding head clearance requirements. Some local codes require all portions of overhead radiant heaters to be located at least 8 foot above the floor.

C Results Reporting Sheets

Manufacturer: Infrared Dynamics

Model: Sunpak® S25

Date: November, 2006

Test Patio Heater:

Description of operational characteristics: Gas-fired, infrared burner patio heater.

Apparatus:

The heater was installed in a 20 by 20-foot space, at a height of 7-feet. Note that this differs from the height of 8-feet specified by the test method. 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.

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	24,300 Btu/h
Rated	25,000 Btu/h
Percent Difference between Measured and Rated	2.8 %
Electrical Energy Input Rate	14 W

Preheat:

Preheat Time	9.3 min.
Preheat Energy	3660 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.

Effective Heated Area: 39.1 ± 2.7 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 the S34 heater are shown in Table C-1.

Table C-1. Heating Index.

Energy Input Rate	24,300 Btu/h
Heated Area	39.1 ft^2
Heating Index	1.61 ft^2/kBtu/h
Efficiency Index	621 Btu/ft^2

D Test Cell Data

Mean Radiant Temperature Distribution:

Table D-1 shows the average normalized mean radiant temperatures from the three test replicates.

Test Cell Data

Table D-1. Normalized Mean Radiant Temperatures.

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	60.1	60.2	60.3	1	-3	62.7	63.0	62.8
3	7	60.4	60.3	60.4	-1	-3	62.8	62.9	62.8
1	7	61.2	60.6	60.7	-3	-3	62.0	61.9	61.7
-1	7	61.6	60.7	60.6	-5	-3	60.8	60.7	60.7
-3	7	61.5	60.5	60.4	5	-5	60.2	60.2	60.2
-5	7	61.1	60.1	60.2	3	-5	60.6	60.6	60.6
5	5	60.4	60.5	60.5	1	-5	61.0	61.0	61.0
3	5	60.9	61.1	61.0	-1	-5	60.9	60.9	60.9
1	5	62.0	61.2	61.4	-3	-5	60.6	60.6	60.6
-1	5	63.3	61.6	61.3	-5	-5	60.2	60.2	60.2
-3	5	63.2	61.0	61.1	5	-7	60.0	59.9	60.0
-5	5	62.2	60.5	60.6	3	-7	60.1	60.1	60.1
5	3	61.0	61.0	61.3	1	-7	60.4	60.3	60.4
3	3	61.6	62.4	62.5	-1	-7	60.4	60.3	60.5
1	3	63.7	63.8	63.6	-3	-7	60.2	60.2	60.4
-1	3	66.9	63.3	63.2	-5	-7	59.8	59.7	59.9
-3	3	65.0	62.2	62.1	-7	5	60.1	59.9	60.1
-5	3	64.5	61.0	61.0	-7	3	60.4	60.3	60.5
5	1	61.9	61.5	61.7	-7	1	60.6	60.5	60.7
3	1	61.4	64.0	64.1	-7	-1	60.6	60.4	60.7
1	1	63.9	66.8	66.5	-7	-3	60.3	60.2	60.2
-1	1	66.2	64.8	65.0	-7	-5	59.9	59.9	59.9
-3	1	65.9	64.2	64.3	7	5	60.2	60.1	60.2
-5	1	64.1	61.8	61.9	7	3	60.4	60.3	60.4
5	-1	61.8	61.4	61.1	7	1	60.6	60.6	60.8
3	-1	60.7	63.9	63.4	7	-1	60.5	60.6	60.5
1	-1	61.8	65.8	65.7	7	-3	60.2	60.1	60.1
-1	-1	60.1	66.0	66.0	7	-5	59.9	59.8	60.0
-3	-1	60.4	64.2	63.8	-7	-7	60.0	60.0	60.0
-5	-1	61.2	61.6	61.7	-7	7	60.0	60.0	60.0
5	-3	61.6	60.8	60.7	7	7	60.0	60.0	60.0
3	-3	61.5	62.0	61.7	7	-7	60.0	60.0	60.0

[†] Distance from test cell centerline, in feet