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An American National Standard

Standard Test Method for Performance of Commercial Patio Heaters[1]

This standard is issued under the fixed designation F2644; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the heating performance and energy consumption of commercial radiant patio heaters. The food service operator can use this evaluation to select a commercial patio heater and understand its energy performance and effective heated area.

1.2 This test method is applicable to commercial gas and electric radiant patio heaters.

1.3 The patio heater can be evaluated with respect to the following:

1.3.1 Energy input rate (10.2),

1.3.2 Preheat energy consumption and time (10.3),

1.3.3 Temperature distribution (10.4), and

1.3.4 Effective heated area (10.4).

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3588 Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels

2.2 *ANSI Documents:*[3]

ANSI Z83.19 Gas-Fired High-Intensity Infrared Heaters

ANSI Z83.20 Gas-Fired Low-Intensity Infrared Heaters

2.3 *ASHRAE Documents:*[4]

ASHRAE 55–1992 Thermal Environmental Conditions for Human Occupancy

3. Terminology

3.1 *Definitions:*

3.1.1 *boundary, n*—the edge of the area being warmed under a patio heater that corresponds to 3°F above the design environment mean radiant temperature.

3.1.2 *design environment, n*—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.

3.1.3 *effective heated area, n*—the amount of square footage that can be warmed to a specified temperature (3°F above the design environment mean radiant temperature) under a patio heater.

3.1.4 *energy input rate, n*—peak rate at which a patio heater consumes energy (kW or Btu/h), typically reflected during preheat.

3.1.5 *heating index, n*—the quotient of the effective heated area and the measured energy input rate.

3.1.6 *mean radiant temperature, n*—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.

NOTE 1—Since all environments radiate thermal energy, the mean radiant temperature can be determined for an unheated as well as a heated environment.

3.1.7 *operative temperature, n*—the uniform temperature of an imaginary black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual non-uniform environment. Operative temperature is numerically the average of the air temperature (T_a) and the mean radiant temperature (T_r), weighted by their respective heat transfer coefficients (h_c and h_r) (see ASHRAE 55–1992):

$$T_o = \frac{(h_c \times T_a + h_r \times T_r)}{(h_c + h_r)}$$

[1] This test method is under the jurisdiction of ASTM Committee F26 on Food Service Equipment and is the direct responsibility of Subcommittee F26.06 on Productivity and Energy Protocol.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

NOTE 2—In the absence of air movement, the operative temperature is equal to the mean radiant temperature.

3.1.8 *patio heater, n*—an appliance that is designed for warming outdoor areas using radiant heat.

3.1.9 *preheat energy, n*—amount of energy consumed by the patio heater while preheating the patio heater from ambient room temperature (75 ± 10°F) to its operating temperature.

3.1.10 *preheat rate, n*—average rate (°F/min) at which the patio heater comes up to its operating temperature from a 75 ± 10°F ambient temperature.

3.1.11 *preheat time, n*—time required for the patio heater to preheat from ambient room temperature (75 ± 10°F) to its operating temperature.

3.1.12 *uncertainty, n*—measure of systematic and precision errors in specified instrumentation or measure of repeatability of a reported test result.

4. Summary of Test Method

4.1 The patio heater is connected to the appropriate metered energy source, and energy input rate is determined to confirm that the appliance is operating within 5 % of the nameplate energy input rate.

4.2 The amount of energy and time required to preheat the patio heater to its operating temperature is determined.

4.3 The amount of square footage that could be effectively warmed by a heater is determined and characterized.

5. Significance and Use

5.1 The energy input rate test is used to confirm that the patio heater is operating properly prior to further testing.

5.2 Preheat energy and time can be useful to food service operators to manage energy demands and to know how quickly the patio heater can be ready for operation.

5.3 The temperature distribution of a patio heater can be used by operators and designers to determine the most effective layout for a patio heating system.

5.4 The effective heated area can be used by operators to choose a patio heater that meets their heating needs.

6. Apparatus

6.1 *Aspirated Thermocouples,* for measuring average bulk air temperature in the test space.

6.2 *Barometer,* for measuring absolute atmospheric pressure, to be used for adjustment of measured gas volume to standard conditions. Shall have a resolution of 0.2 in. Hg and an uncertainty of 0.2 in. Hg.

6.3 *Data Acquisition System,* for measuring energy and temperatures, capable of multiple channel displays updating at least every 2 s.

6.4 *Gas Meter,* for measuring the gas consumption of a patio heater, shall be a dry positive displacement type with a resolution of at least 0.01 ft^3 and a maximum uncertainty no greater than 1 % of the measured value for any demand greater than 2.2 ft^3/h. If the meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution of at least 0.01 ft^3 and a maximum uncertainty no greater than 2 % of the measured value.

6.5 *Globe Thermometer,* comprised of a beaded-junction thermocouple located in the geometric center of a 2-star, precise round, ping-pong ball for determining mean radiant temperature. The globe shall be mounted on a length of 3⁄16-in. plastic tubing, which will house the thermocouple wire, and the entire assembly (globe and tubing) shall be painted flat black. See Fig. 1.

6.6 *Pressure Gauge,* for monitoring gas pressure. Shall have a range of zero to 15 in. H_2O, a resolution of 0.5 in. H_2O, and a maximum uncertainty of 1 % of the measured value.

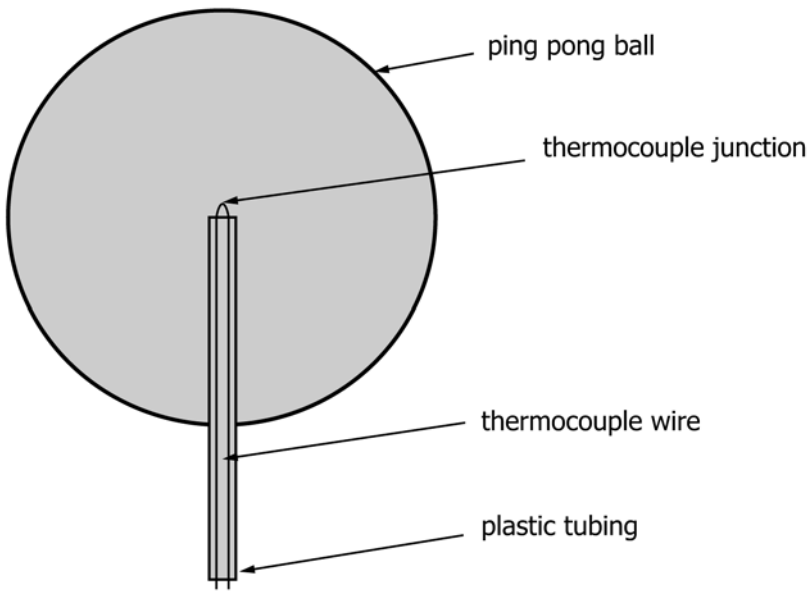

FIG. 1 Globe Thermometer

6.7 *Stop Watch,* with a 1 s resolution.

6.8 *Temperature Sensor,* for measuring gas temperature in the range of 50 to 100°F with an uncertainty of ±1°F.

6.9 *Thermocouple(s),* for measuring globe and ambient temperatures, industry standard type T or type K, 24 gauge thermocouple wire, welded and calibrated, with a range of 0 to 150°F and an uncertainty of ±1°F.

6.10 *Thermocouple Wire,* for measuring reflector temperature, shall be type K thermocouple wire with a range of 0 to 1000°F and an uncertainty of ±1°F.

6.11 *Watt-Hour Meter,* for measuring the electrical energy consumption of a patio heater, shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 1.5 % of the measured value for any demand greater than 100 W. For any demand less than 100 W, the meter shall have a resolution of at least 10 Wh and a maximum uncertainty no greater than 10 %.

7. Reagents and Materials

7.1 *Ping-Pong Balls,* two-star, precise round, weighing 2.5 ± 0.5 g for constructing globe thermometers.

7.2 *Model Airplane Control Rods,* for supporting the globe thermometers, shall be a minimum of 12 in. long with a nominal outside diameter of 3⁄16 in.

8. Sampling, Test Units

8.1 *Patio Heater*—Select a representative production model for performance testing.

9. Preparation of Apparatus

9.1 Install the patio heater in accordance with the manufacturer's instructions in the center of a 20 ft. square area (hereafter called, test cell) at the manufacturer's recommended working height. The test cell shall be free of drafts and obstructions of any kind. Record the distance from the bottom of the heating unit to the floor (mounted heaters).

NOTE 3—A high bay area may be required to provide suitable vertical clearances for testing mounted style patio heaters.

9.2 Connect the patio heater to a calibrated energy test meter. For gas installations, install a pressure regulator downstream from the meter to maintain a constant pressure of gas for all tests. Install instrumentation to record both the pressure and temperature of the gas supplied to the patio heater and the barometric pressure during each test so that the measured gas flow can be corrected to standard conditions. For electric installations, a voltage regulator may be required during tests if the voltage supply is not within ±2.5 % of the manufacturer's nameplate voltage.

9.3 For a gas patio heater, adjust (during maximum energy input) the gas supply pressure downstream from the appliance's pressure regulator to within ±2.5 % of the operating manifold pressure specified by the manufacturer. Make adjustments to the appliance following the manufacturer's recommendations for optimizing combustion. Proper combustion may be verified by measuring air-free CO in accordance with ANSI Z83.19 and ANSI Z83.20.

9.4 Confirm (while the elements are energized) that the supply voltage is within ±2.5 % of the operating voltage specified by the manufacturer. Record the test voltage for each test.

NOTE 4—It is the intent of the testing procedure herein to evaluate the performance of a patio heater at its rated electric voltage. If an electric unit is rated dual voltage (that is, designed to operate at either 208 or 240 V with no change in components), the voltage selected by the manufacturer and/or tester shall be reported. If a patio heater is designed to operate at two voltages without a change in the resistance of the heating elements, the performance of the unit (for example, preheat time) may differ at the two voltages.

9.5 Construct an array of globe thermometers for characterizing the heated area under the test patio heater. The globes shall be positioned at a height of 36 ± 1 in. from the floor, with no more than 24 in. horizontal spacing between adjacent globes. The globes shall be no closer than 24 in. to any wall or other partition.

NOTE 5—The globe thermometers can be effectively held in place by implanting the tubing into a length of 1-in. PVC pipe that has been mounted on a 2- by 4-in. sawhorse kit. See Fig. 2.

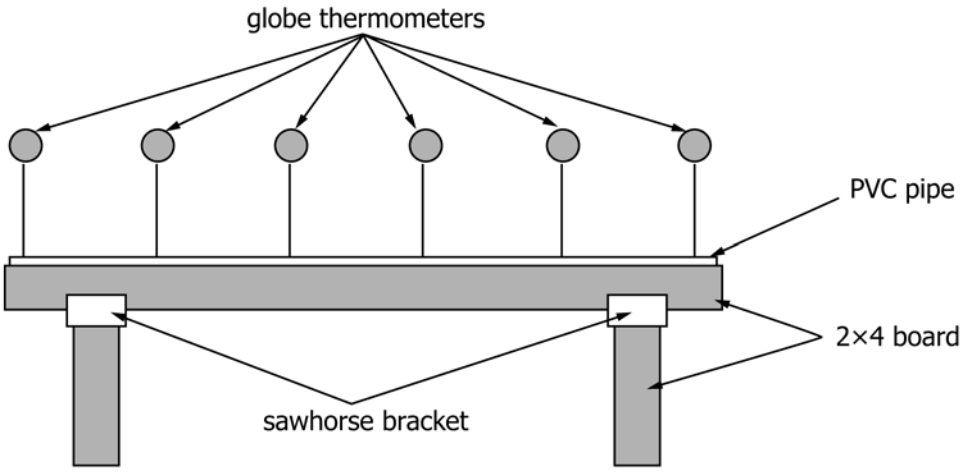

FIG. 2 Globe Thermometer Array