

**(This foreword is not part of this standard but is included for information purposes only.)**

## FOREWORD

*This standard prescribes uniform methods of testing for rating pool heaters and comes under the classification of an ASHRAE Standard Method of Measurement or Test. Unlike previously published methods of testing pool heaters, this standard applies to all pool heaters operated by gas, oil, or electricity, including heat pumps using outdoor ambient air as a heat source.*

### 1. PURPOSE

The purpose of this standard is to provide methods of testing and rating pool heaters.

### 2. SCOPE

**2.1** This standard provides methods of testing for heating capacity and energy efficiency.

**2.2** This standard applies to heaters operated by gas, oil, or electricity, including heat pumps using outdoor ambient air as a heat source.

### 3. DEFINITIONS

**apparatus:** refers exclusively to test room facilities and instrumentation.

**coefficient of performance (COP):** as applied to a heat pump, the ratio of heat output in kilowatts (Btu/h) to the total power input in kilowatts (Btu/h).

**coil, outdoor:** the heat exchanger that absorbs heat from the outdoor air.

**equipment:** refers exclusively to the equipment to be tested.

**heat output:** the rate at which heat is passed to the water in kilowatts (Btu/h) under specified conditions of operation.

**heating capacity:** the rate at which heat is passed to the water in kilowatts (Btu/h) when the pool heater is operating at rated input and achieving the rated thermal efficiency or COP.

**outdoor side:** that part of the system that absorbs heat from a source external to the pool.

**pool heater:** an appliance designed for heating nonpotable water contained at atmospheric pressure, including heating water in swimming pools, spas, hot tubs, and similar applications.

**rated input:** energy-using capacity of a pool heater, as specified by the manufacturer and as specified in Section 8 of this standard.

**standard conditions:** the conditions of temperature and pressure at which the higher heating value of gas is reported, namely, 15.556°C (60°F) and 101.325 kPa (29.921 inches of mercury).

**standard COP:** the ratio of heat output in kilowatts (Btu/h) to total power input in kilowatts (Btu/h) as defined when equipment is operating at standard rating conditions.

**standard rating conditions:** the temperature and pressure conditions specified in Section 8 at which the pool heater input and efficiency are reported.

**total power input:** for electrical pool heaters, the total electrical input to the appliance in kilowatts.

## 4. CLASSIFICATION

Pool heaters are classified by energy source and include

- (a) gas-fired pool heaters;
- (b) oil-fired pool heaters;
- (c) air-to-water heat pump pool heaters employing a compressor, water-cooled condenser, and outdoor air coil in a single package assembly;
- (d) electric resistance pool heaters.

## 5. REQUIREMENTS

The pool heaters for which compliance with this standard is claimed shall be tested and calculations made to verify capacity and efficiency using the following procedures as appropriate:

- (a) a steady-state heating capacity test for a pool heater at standard rating conditions;
- (b) a steady-state efficiency test for gas, oil, and electric resistance pool heater or coefficient of performance (COP) for heat pump pool heater;
- (c) a standby energy consumption test for all except heat pump pool heaters.

## 6. INSTRUMENTS

**6.1 General.** Instruments are required for the following measurements with the minimum precision noted. Instruments shall be calibrated at a minimum of once a year. A record shall be kept containing, as a minimum, the date of calibration, the method of calibration, and the reference standard used.

**6.2 Temperature.** Temperature-measuring devices and any associated instrumentation systems shall be in accordance with *ASHRAE Standard 41.1-1986 (RA 91), Standard Method for Temperature Measurement*.<sup>1</sup> Measurement of water temperature shall be to an accuracy better than 1.0% of the temperature rise.

**6.3 Pressure.** Pressure-measuring instruments shall have errors no greater than the following:

- (a) Gas —  $\pm 25$  Pa (0.1 inch water column)
- (b) Oil —  $\pm 3.4$  kPa (0.5 pounds per square inch)
- (c) Atmospheric —  $\pm 33.8$  Pa (0.01 inch mercury)
- (d) Water —  $\pm 6.9$  kPa (1.0 pounds per square inch)

**6.4 Draft.** Draft gauges shall have an accuracy of  $\pm 1.2$  Pa (0.005 in. water column). Minimum divisions on the draft gauge shall be 1.2 Pa (0.005 in. water column).

**6.5 Mass.** Scales shall have an accuracy sufficient to ensure an error no greater than 1.0% of the total mass measured.

**6.6 Time.** Timing instruments shall have an error no greater than  $\pm 0.5$  s/h.

### 6.7 Electrical Instruments

**6.7.1 Electrical Measurements.** Electrical measurements shall be made with indicating or integrating instruments.

**6.7.2 Instruments.** Instruments used for measuring the electrical input to heaters or other apparatus furnishing heat loads shall be accurate to  $\pm 1.0\%$  of the quantity measured. Instruments used for measuring the electrical input to fan motors, compressor motors, or other equipment accessories shall be accurate to  $\pm 2.0\%$  of the indicated value.

**6.7.3 Voltages.** Voltages shall be measured at the equipment terminals.

**6.8 Higher Heating Value.** Devices used to measure the higher heating value of either natural gas, propane, or fuel oil shall have an error no greater than  $\pm 1.0\%$ .

**6.9 Water Flow.** A flowmeter may be used in lieu of a tank and scale for determining water flow rate and quantity. Conversion to mass of water, where required, shall be based upon the specific volume listed in the *1997 ASHRAE Handbook—Fundamentals*, Chapter 6, Table 3,<sup>2</sup> for the temperature of the water metered. Water-flow meters shall have an error no greater than 1% of indicated value. Concurrent water meter calibration as described in Appendix B may be conducted as an alternative to calculation based on specific volume.

Water-flow meters shall have a full-scale rating not more than three times the flow rate to be measured.

**6.10 Combustion Products.** Instruments used to measure the concentration of carbon dioxide shall have an error no greater than  $\pm 0.1\%$  of the reading.

**6.11 Smoke.** Smoke-measuring instruments shall comply with requirements for smoke meters as outlined in *ASTM-D2156-94, Test Method for Smoke Density in the Flue Gases from Burning Distillate Fuels*.<sup>3</sup>

## 7. APPARATUS

**7.1 Test Platform.** The equipment to be tested shall be installed in the test room in accordance with the manufacturer's installation instructions using recommended installation procedures and accessories. In all cases the manufacturer's recommendations with respect to distances from adjacent walls shall be followed. For a pool heater not approved for installation on combustible flooring, suitable noncombustible material shall be placed under it.

**7.2 Water Piping.** Water piping shall be installed according to the manufacturer's recommendations. Unions may be used to facilitate installation and removal of the piping arrangements.

Any piping components or insulation supplied with the pool heater shall be included. Install a pressure gauge in the water supply line.

When required for conduct of this test, an optional recirculating loop of minimum length and a pump shall be provided, as shown in Figure 1b. If the optional recirculation loop is used in the test, it shall be insulated with insulation having an R-value of  $0.7 \text{ m}^2\cdot\text{K}/\text{W}$  ( $4 \text{ h}\cdot\text{ft}^2\cdot^\circ\text{F}/\text{Btu}$ ). The recirculation pump electricity consumption shall be measured.

### 7.3 Thermocouple Locations

**7.3.1 Water Pipe.** Install thermocouples or temperature-measuring devices as illustrated in Figure 1a or Figure 1b as appropriate. The junction of the thermocouples shall not extend more than 0.15 m (6 in.) into the pipe from the appropriate outlet of the tee.

**7.3.2 Flue Pipe.** Thermocouple grids shall be constructed of equally spaced thermocouples wired in parallel in a test plane less than half the distance ( $J/2$ ) to the point of dilution from the heater flue outlet perpendicular to the axis of the flue, vent, or venting system as part of the outdoor appliance, as illustrated in Figure 2.<sup>5</sup> The thermocouple leads shall be equalized in length before paralleling. If there is a possibility that the thermocouples could receive direct radiation from flame, install radiation shields on the flame side of the thermocouple only and position the shields so that they do not touch the thermocouple junctions. The thermocouples shall be the bead type having a wire size no greater than 0.50 mm (No. 24 American wire gauge).

#### 7.3.3 Test Room.

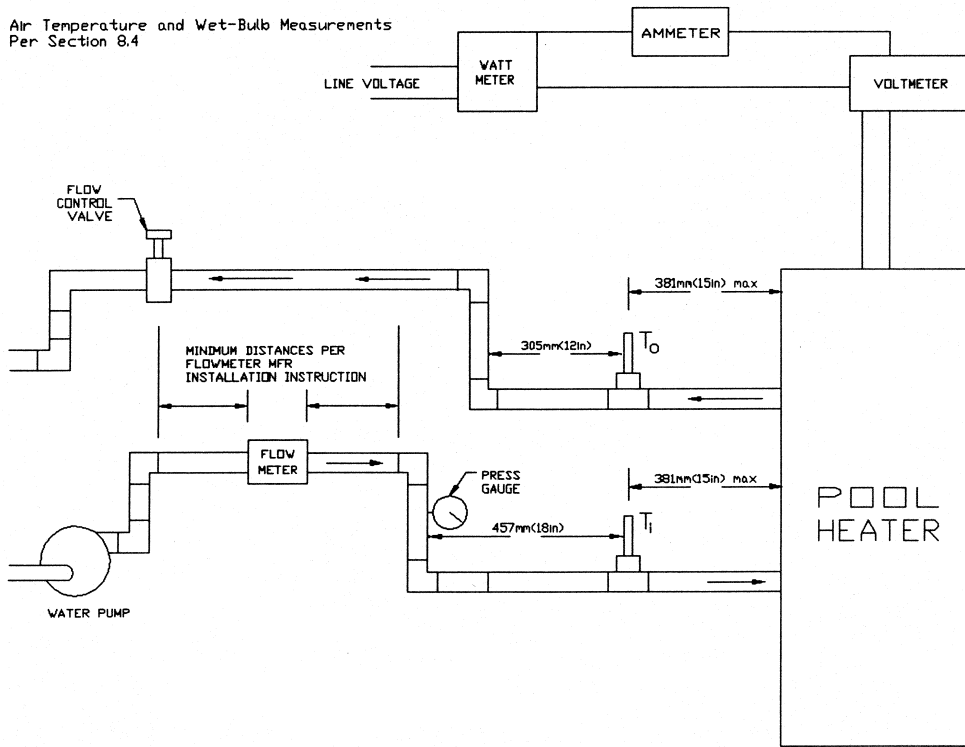
**7.3.3.1 For Fossil Fuel and Electric Resistance Pool Heaters.** Install in the test room a thermocouple with junction shielded against radiation from the pool heater and positioned at the vertical midpoint of the heater at a perpendicular distance of approximately 0.60 m (24 in.) from the surface of the pool heater jacket.

**7.3.3.2 For Heat Pump Pool Heaters.** An outdoor test room or space is required for testing heat pump water heaters. This test room shall be of sufficient volume and shall circulate air in a manner such that it does not change the normal air circulating pattern of the equipment under test. It shall be of dimensions such that the distance from any room surface to any equipment surface from which air is discharged is not less than 1.8 m (6 ft) and the distance from any other room surface to any other equipment surface is not less than 0.9 m (3 ft), except for floor or wall relationships required for normal equipment installation. The room conditioning apparatus should handle air at a rate not less than the outdoor airflow rate and preferably should take this air from the direction of the air discharge and return it at the desired conditions uniformly and at low velocities.

**7.3.3.2.1 Outdoor Air Inlet Temperatures.** Outdoor air inlet temperatures shall be measured at locations such that the following conditions are fulfilled:

- (a) The measured temperatures shall be representative of the temperature surrounding the outdoor section and simulate the conditions encountered in an actual application.
- (b) At the point of measurement, the temperature of air must not be affected by the air discharged from the outdoor section. This makes it mandatory that the

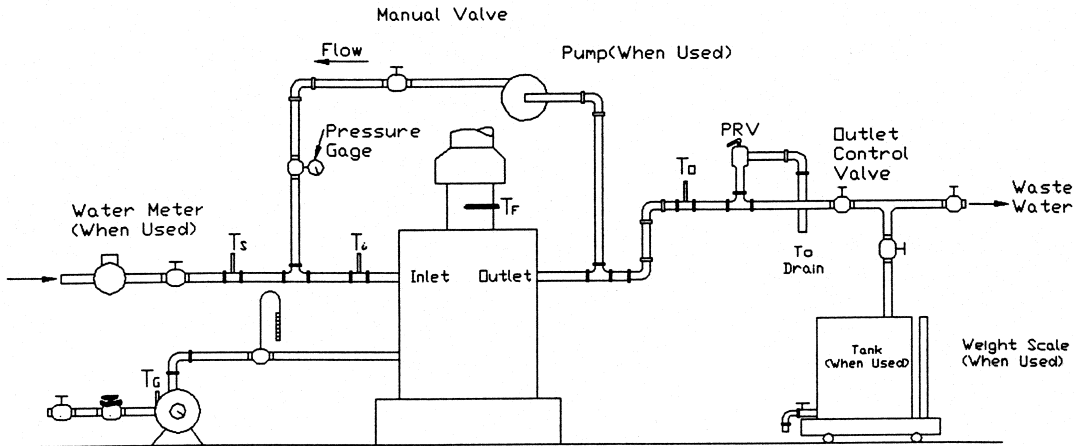
Air Temperature and Wet-Bulb Measurements  
Per Section 8.4



$T_o$  = OUTLET WATER TEMPERATURE MEASUREMENT

$T_i$  = INLET WATER TEMPERATURE MEASUREMENT

Figure 1a Plumbing layout and location of water temperature measurements (heat pump pool heaters).



$T_s$  = Location for Temperature Measurement in Supply Water Line

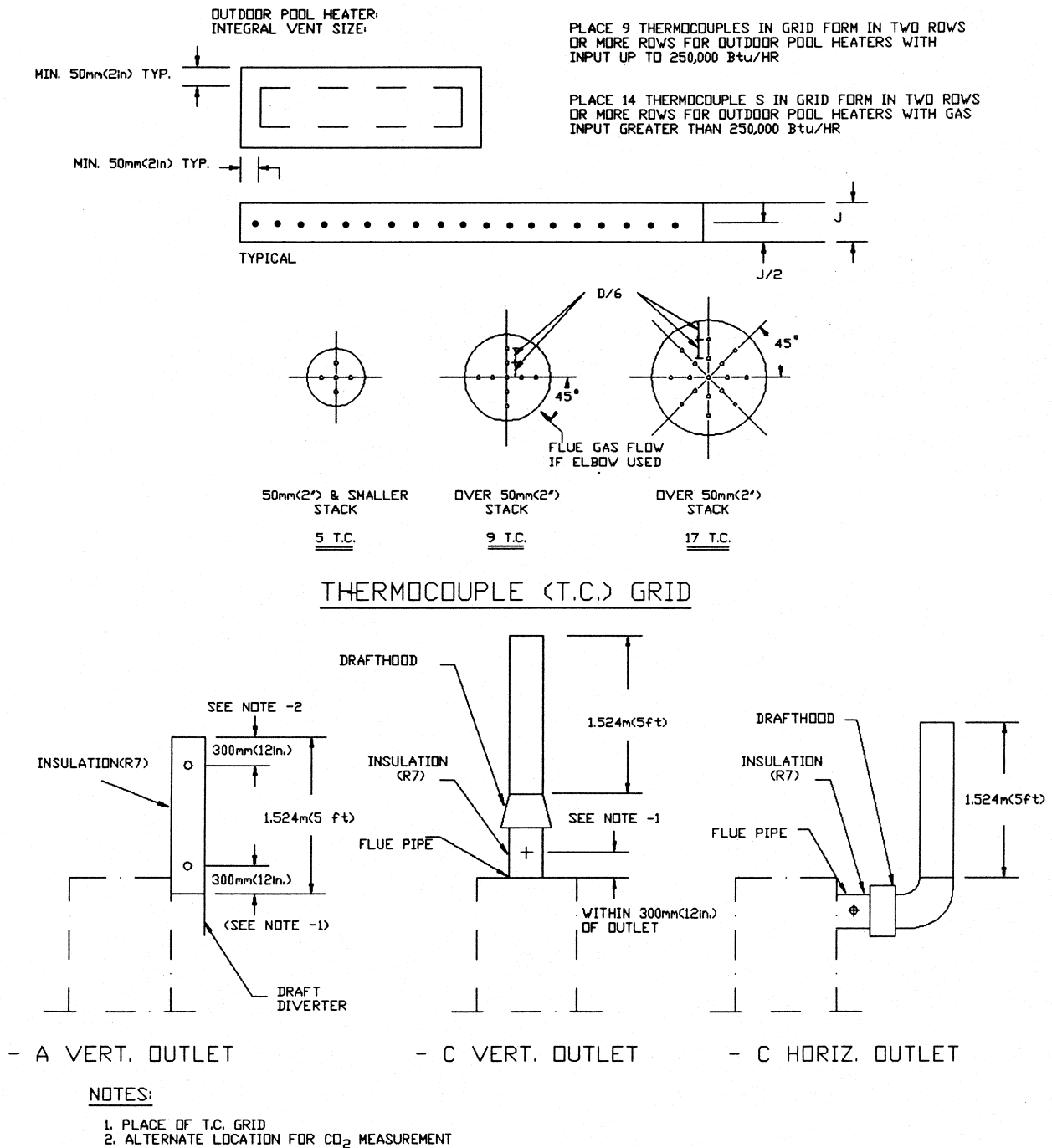
$T_o$  = Location for Temperature Measurement in Outlet Water Line

$T_f$  = Location for Temperature Measurement in Flue

$T_g$  = Location for Temperature Measurement in Gas Line

$T_i$  = Location for Temperature Measurement in Inlet Water Line

Figure 1b Plumbing layout and location of water temperature measurements (gas, oil, and electric resistance pool heaters).



**Figure 2 Flue configuration and thermocouple grid (gas pool heaters).**

temperatures be measured upstream of any recirculation produced.

It is intended that the specified test temperatures surrounding the outdoor section under test shall simulate as nearly as possible a normal installation operating at ambient air conditions identical with the specified test temperatures.

**7.3.3.2.2 Air Speed over the Wet-Bulb Temperature-Measuring Instrument.** Air speed over a wet-bulb temperature-measuring instrument shall be approximately 5 m/s (1000 fpm). It is recommended that the same airspeed be used at inlet and outlet measurements. Wet-bulb measurement

above or below 5 m/s (1000 fpm) must be corrected in accordance with ASHRAE Standard 41.1.<sup>1</sup>

#### 7.4 Flue Requirements

**7.4.1 Gas-Fired Pool Heaters.** For indoor units, a vertical 1.5 m (5 ft) length of flue pipe shall be connected to the flue gas outlet. If the outlet discharges horizontally, a suitable 90° elbow shall be installed first. For outdoor units, no modifications to the integral vent shall be made (and no vent pipe is needed). The flue gas sample shall be taken at the location shown in Figure 2 for indoor units and at the flue outlet for outdoor units.

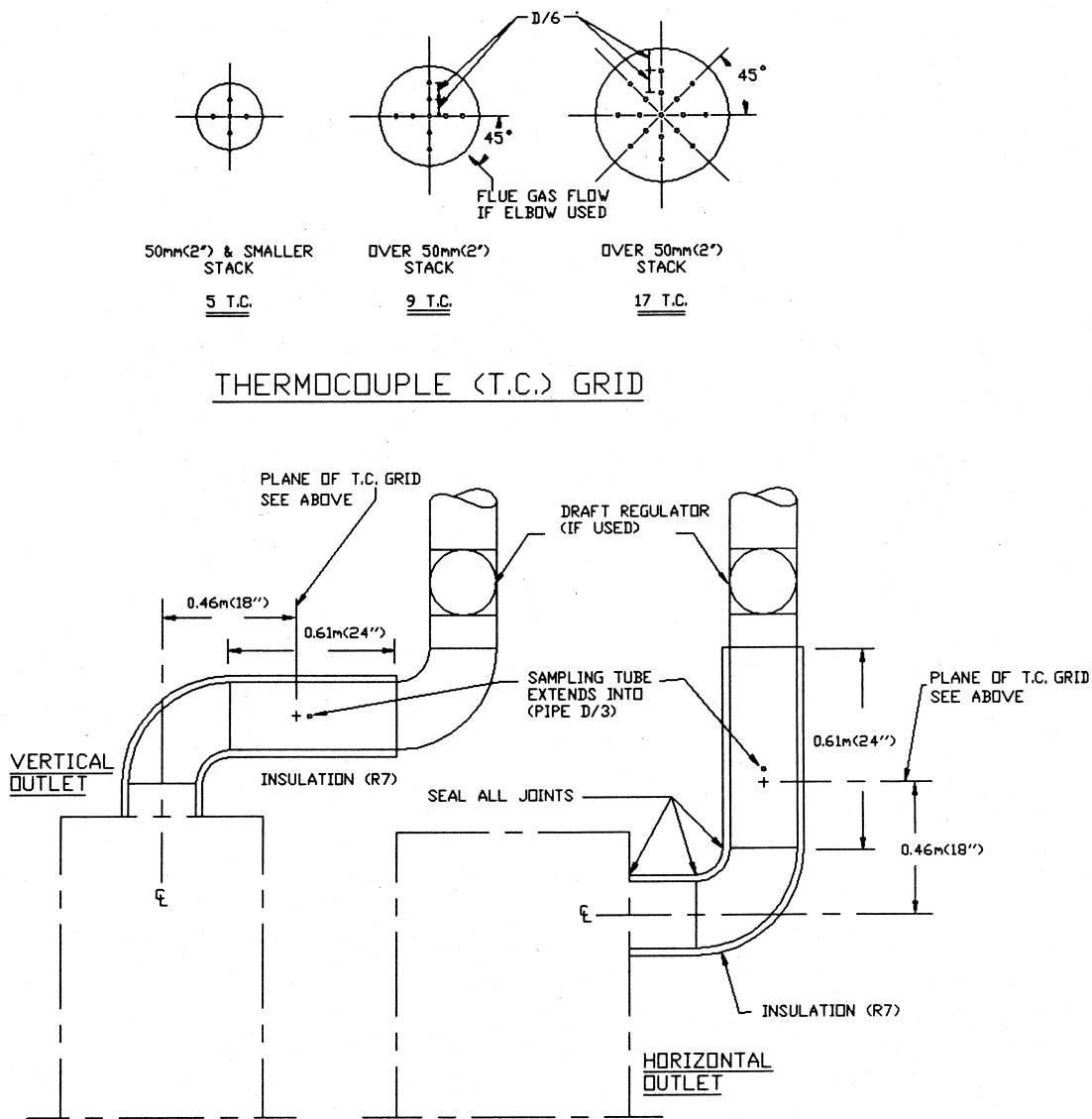
Pool heaters designed for other than natural draft venting, or for a specific venting system, shall be installed with the venting arrangement specified in the manufacturer's instructions using the minimum lengths of vertical and horizontal vent pipe recommended by the manufacturer.

**7.4.2 Oil-Fired Pool Heaters.** On indoor units, a vertical 1.5 m (5 ft) length of vent pipe shall be connected to the flue gas outlet to establish the minimum draft at the flue collar as specified in the manufacturer's installation instructions. Additional stack height or a mechanical draft inducer may be used. If the outlet discharges horizontally, a suitable 90° elbow shall be installed first. For outdoor units, no modification to the integral vent shall be made (and no vent is needed). The flue gas sample shall be taken at the location shown in Figure 3 for indoor units and at the flue outlet for outdoor units.

Pool heaters designed for other than natural draft venting, or for a specific venting system, shall be installed with the venting arrangement specified in the manufacturer's instructions using the minimum lengths of vertical and horizontal vent pipe recommended by the manufacturer.

**7.4.3 Insulation Requirements.** Insulation with an R-value of no less than  $1.2 \text{ m}^2 \cdot \text{K/W}$  ( $7^\circ\text{F} \cdot \text{ft}^2 \cdot \text{h/Btu}$ ) shall be provided on flue pipe and elbow (if installed) up to the plane where flue gas temperature is measured. For gas-fired heaters with draft hood and for oil-fired heaters, there shall be no opening between the heater and point where the flue gas sample (for  $\text{CO}_2$ ) is taken and the flue gas temperature is measured.

**7.5 Fuel or Energy Consumption Measurement.** Install one or more instruments that measure, as appropriate, the



WHERE  $D = \text{FLUE/STACK DIAMETER}$

**Figure 3 Flue configuration and thermocouple grid (oil pool heaters).**