STANDARD

ANSI/ASHRAE Standard 124-2007 (RA 2016)
(Reaffirmation of ANSI/ASHRAE Standard 124-2007)

Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances

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NOTE

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FOREWORD

This is a reaffirmation of Standard 124-2007. This standard was prepared under the auspices of ASHRAE. It may be used in whole or in part by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interest of obtaining uniform guidelines throughout the industry. This version of the reaffirmation has no changes.

1. PURPOSE

The purpose of this standard is to establish a method of test to rate the performance of a combination space-heating and water-heating appliance.

2. SCOPE

2.1 This test method is intended to cover electric, gas-fired, and oil-fired combination space-heating and water-heating appliances.

2.2 This standard covers appliances up to 300,000 Btu/h (87.9 kW) rated input.

3. DEFINITIONS AND NOMENCLATURE

3.1 Definitions

automatic vent damper: for purposes of this standard, an electrically operated or thermally actuated mechanical device installed downstream of the draft hood.

boiler, low-pressure steam or hot water: an electric, gas, or oil-burning appliance designed to supply low-pressure steam or hot water for space-heating applications. A low-pressure steam boiler operates at or below 15 psig (103.4 kPa) steam pressure; a hot water boiler operates at or below 160 psig (1102.4 kPa) water pressure and 250°F (121°C) water temperature.

combination space-heating and water-heating appliance: a unit that is designed to provide space heating and potable water heating from a single primary energy source.

control, single-stage: a control that cycles a burner between the maximum heat input rate and off.

control, modulating: a manual or automatic step-modulating control. Also referred to as a *two-stage control*.

control, two-stage: a modulating control that both cycles a burner between a reduced heat input rate and OFF and cycles a burner between the maximum heat input rate and OFF. It may also switch from OFF to reduced fire to high fire to OFF again under certain load conditions.

control, step modulating: a modulating control that cycles a burner between the reduced input rate and OFF if the heating load is light. If a higher heating load is encountered that cannot be met with the reduced input rate, the control goes into a modulating mode where it either gradually or incrementally increases the input rate to meet the higher heating load. At that point, if a lower heating load is encountered, the control either gradually or incrementally decreases to the reduced input rate.

(a) ***automatic modulating control:*** a step-modulating control that is capable of controlling the burner fuel input rate between maximum and the minimum adjustable input rate in response to a varying heating load.

(b) ***manually adjusted modulating control:*** a step-modulating control adjusted for reduced input at the time of installation of the furnace or boiler.

draft hood: a devise built into a gas-fired appliance, or external to it, that is designed to (a) provide for the ready escape of flue gases in the event of no draft, back draft, or stoppage beyond the draft hood, (b) prevent a back draft from entering the appliance, and (c) neutralize the effect of stack action of the chimney or gas vent on the operation of the appliance.

direct exhaust system: an appliance venting system supplied or recommended by the manufacturer through which the products of combustion pass directly from the appliance to the outside and that does not employ a means of draft relief. This system includes units with small air passages in the flue (air passages that do not have an opening area in excess of 10% of the cross-sectional area of the vent).

direct vent system: a manufacturer-supplied system that provides outdoor air directly to a unit for combustion and discharges all flue gases to the outside atmosphere.

first-hour rating: an estimate of the maximum volume of "hot" water that a storage-type water heater or an integrated heater can supply within an hour from the time that the water heater is fully heated (i.e., with all thermostats satisfied). This rating is a function of both the storage volume and the recovery rate.

flue: a conduit between the flue outlet of the appliance and the integral draft diverter, draft hood, barometric draft regulator, vent terminal, or any other point of draft relief.

flue collar: a projection or recess provided to accommodate the vent connector or draft hood.

flue gases: all gases in the flue during the duration of combustion in the combustion chamber, including reaction products, inerts, and any excess air.

flue outlet: the opening provided in an appliance for the escape of flue gases.

maximum gpm (L/s) rating: the maximum gallons per minute (liters per second) of domestic hot water that can be supplied continuously by an instantaneous water heater or a tankless heater while maintaining a nominal temperature rise of 77°F (42.8°C) during steady-state operation.

"shall": where "shall" or "shall not" is used, a provision is mandatory if compliance with this standard is claimed.

"should," "it is recommended," or "it is not recommended": terms used to indicate provisions that are not mandatory but are desirable as good practice.

stack: the portion of the exhaust system downstream of the draft diverter, draft hood, or barometric draft regulator.

storage water heater: an appliance that heats and stores potable water within the appliance at a thermostatically controlled temperature for delivery on demand and has an input rate of less than 4,000 Btu/h per gallon (310W/L) of stored water.

tankless heater: a heat exchanger for indirect heating of domestic water. Designed to be used without a domestic water storage tank, it may be attached directly to the boiler or installed external to the boiler and connected by piping.

thermostat, tank: a device that senses changes in stored water temperature and that controls, by means of separate components, the flow of energy to maintain selected temperatures.

vent connector: the portion of the venting system that connects the gas appliance or its draft hood to the chimney or vent terminal.

vent pipe: passages and conduits in a direct vent or direct exhaust system through which gases pass from the combustion chamber to the outdoor air.

water temperature control: a device that senses boiler water temperature and controls burner operation.

3.2 Nomenclature

CAE = combined annual efficiency, %.

C_{aux} = auxiliary electric input associated with the production of domestic hot water, kWh (MJ).

$C_{aux\text{-}d}$ = auxiliary electric input during draw period, kWh (MJ).

$C_{aux\text{-}sb}$ = auxiliary electric input during standby loss test, kWh (MJ).

$C_{aux\text{-}r1}$ = auxiliary electric input during recovery from standby, kWh (MJ).

$C_{aux\text{-}r2}$ = auxiliary electric input during recovery from the draw period, kWh (MJ) .

CE_{hs} = combined heating season efficiency, %.

CE_{ns} = non-heating season efficiency, %.

D_h = average heating season days.

D_n = average non-heating season days.

EF = energy factor, water heating.

E_r = recovery efficiency, dimensionless.

$Effy_{hs}$ = space-heating seasonal efficiency, %.

$Effy_{ss}$ = space-heating steady-state efficiency, %.

F = first-hour rating of a storage-type water heater or an integrated heater, gal (L).

FR = flow rate for systems with storage of domestic water, gpm (L).

FR_{max} = steady-state flow rate at the rated input for an instantaneous water heater or tankless heater to give a discharge temperature of 135°F±5°F (57.2°C±2.8°C), gpm (L/s).

FR_{min} = flow rate at reduced output for an instantaneous water heater or tankless heater, gpm (L/s).

G = volume of water drawn during first hour test, gal (L).

HHV = fuel higher heating value, Btu/lb, Btu/ft^3, Btu/gal (kJ/kg, J/L, kJ/L).

c_p = specific heat of water, Btu/lb°F (kJ/kg K).

n = for storage-type water heaters or integrated heaters, total number of draws during the first-hour rating test.

NHF = non-heating season water-heating factor.

Q_1 = corrected standby energy consumption for 24 hours, Btu (kJ).

Q_2 = corrected draw period energy consumption for water drawn, Btu (kJ).

Q_d = draw period measured energy consumption, Btu (kJ).

q_{in} = energy input rate, Btu/h (W).

Q_{rs} = total energy input, Btu (kJ).

Q_{r1} = recovery energy after 18-hour standby test, Btu (kJ).

Q_{r2} = recovery energy after the draw period, Btu (kJ).

Q_{sb} = standby loss test energy input, Btu (kJ).

R = ratio of non-heating season days to heating season days.

S = standby loss, storage type, h^{-1}.

SHF = space-heating factor.

t_{fhr} = total time of first-hour draw test, min.

t_0 = start time of first-hour draw test.

t_{run} = burner operating time during draw period, min.

T_a = air temperature, °F (°C).

T_{avg} = average outdoor temperature during the heating season, °F (°C).

T_b = boiler water temperature at control location, °F (°C).

T_c = nominal cold water supply temperature, °F (°C).

$\overline{T}_{del}$ = For instantaneous water heaters or tankless heaters, average outlet water temperature during a 10-minute continuous draw interval in the maximum gpm (L/min) rating test, °F (°C).

T_i = inlet water temperature, °F (°C).

$\overline{T}_{in}$ = average inlet water temperature, °F (°C).

T_m = arithmetic mean of outlet water temperature, °F (°C).

T_{min} = nominal minimum temperature for usable hot water, °F (°C).

T_o = outlet water temperature, °F (°C).

$T_{o(max)}$ = maximum outlet water temperature, first-hour draw test, °F (°C).

T_r = nominal room temperature, °F (°C).

T_s = mean tank temperature, °F (°C).

T_t = nominal tank temperature for systems with storage of domestic hot water and nominal discharge temperature for instantaneous water heaters and tankless heaters, °F (°C).

$\overline{T}^*_{del,i}$ = for storage-type water heaters or integrated heaters, average outlet water temperature during the i-th draw (i =1 to n) of the first-hour rating test, °F (°C).

$T^*_{max,i}$ = for storage-type water heaters or integrated heaters, maximum outlet water temperature during the i-th

draw (i =1 to n) of the first-hour rating test, °F (°C).

$T^*_{min,i}$ = for storage-type water heaters or integrated heaters, minimum outlet water temperature during the i-th draw (i = 1 to n) of the first-hour rating test, °F (°C).

U = daily hot water consumption, gal (L). An assigned value, nominally 64.3 gal (243.3 L) for residential-sized water heaters and boilers and 120 gal (454 L) for commercial-sized water heaters and boilers, where input ratings covered by ASHRAE Standards 118.1 and 118.2 serve as a reasonable demarcation of residential and commercial units.

U_s = gallons (L) drawn during the 24 hours of the simulated-use test.

V^*_i = volume of water removed during the i-th draw (i =1 to n) during the first-hour rating test, gal (L).

V_{10m} = for instantaneous water heaters or tankless heaters, total volume of water drawn continuously over a 10-minute interval in the maximum gpm (L/s) rating test, gal (L).

V = storage volume, gal (L).

v_t = specific volume of water at a temperature of T_t, ft^3/lb (L/kg).

W = total weight of water drawn during first-hour draw test, lb (kg).

wc = water column, in. (Pa).

WHF = heating-season water-heating factor.

W^*_i = for storage-type water heaters or integrated heaters, mass of water removed during the ith draw (i =1 to n) during the first-hour rating test, lb (kg).

W_{10m} = for instantaneous water heaters or tankless heaters, total mass of water drawn continuously over a 10-minute interval in the maximum gpm (L/s) rating test, lb (kg).

4. CLASSIFICATIONS

Combination space-heating and water-heating appliances are classified as follows:

4.1 Type I Appliance. An appliance where the space-heating function is provided by heat exchange with low-pressure steam or recirculated nonpotable boiler water.

Subcategories include the following:

4.1.1 Tankless Heater Directly in Appliance. This includes a heat exchanger within the appliance for heating domestic water but does not have an external tank for storing domestic hot water. (See Figure 4-1.)

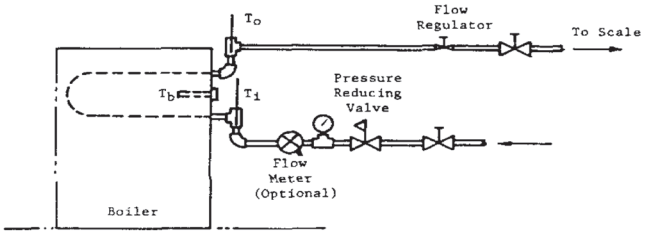

Figure 4-1 Type I appliances—typical piping arrangement, tankless heater in boiler.

4.1.2 Tankless Heater in External Tank. This includes an external tank within a tank for storing domestic hot water where the volume of low-pressure steam or boiler water is greater than the volume of domestic water. (See Figure 4-2.)

4.1.3 Integrated Heater. This includes an external tank within a tank for storing domestic hot water where the volume of domestic water is greater than the volume of low-pressure steam or boiler water. (See Figure 4-3.)

4.2 Type II Appliance. An appliance where the space-heating function is provided by heat exchange with recirculated potable domestic hot water.

Subcategories include the following:

a. Storage water heater

b. Instantaneous water heater

5. REQUIREMENTS

5.1 Space-Heating Performance

5.1.1 Type I Appliance. The space-heating performance shall be determined from tests conducted in accordance with *ASHRAE Standard 103-1993*, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers*.[1]

5.1.2 Type II Appliance. Space-heating performance parameters shall be determined from tests conducted in accordance with *ASHRAE Standard 103-1993*, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers*,[1] as supplemented by the additional provisions of Sections 6 through 11 of this standard.

5.2 Water-Heating Performance

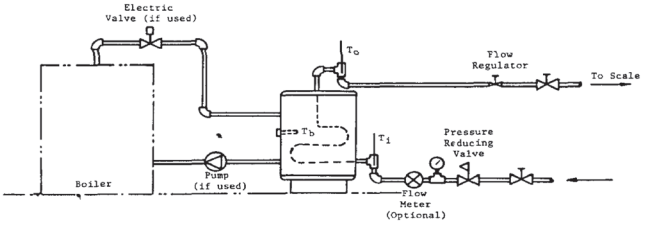

Figure 4-2 Type I appliances—typical piping arrangement, tankless heater, boiler water or low-pressure steam in external tank.

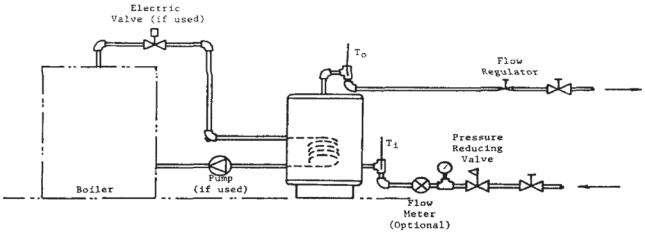

Figure 4-3 Type I appliances—typical piping arrangement, integrated heater, domestic water in external tank.