5 Performance

5.1 General

5.1.1

Testing shall be conducted at altitudes or elevations below 2000 ft (610 m).

5.1.2

Heaters submitted for examination under this Standard shall be tested with the type(s) of gas selected by the manufacturer (see Clause 1.1).

5.1.3

When a thermocouple is specified for the measurement of air, flue or vent gas temperatures, a thermocouple or an equivalent temperature measuring device complying with ASME PTC 19.3, shall be used.

5.1.4

Appliances equipped with automatic step rate or automatic modulating controls which provide ignition and operation at ratings less than full input rating shall also be tested at the minimum input rating (see Clause 5.3.5) for testing specified in Clauses 5.4, 5.5, 5.6, 5.7.1 c), 5.7.2, 5.7.3, 5.7.4, 5.8.2, 5.8.4 and 5.20.

5.1.5

Appliances having automatic modulating controls which act to reduce the input rating after ignition of the main burner shall also be tested at the minimum input rating (see Clause <u>5.3.5</u>) for testing specified under Clauses <u>5.4</u>, <u>5.5</u>, <u>5.6</u>, <u>5.7.1</u> d), <u>5.7.3</u>, <u>5.7.4</u>, and <u>5.20</u>.

5.1.6

Tests at the minimum input rating (see Clause 5.3.5) shall be conducted at normal inlet test pressure only.

5.1.7

An appliance having means to provide momentary rate reduction upon ignition shall have all tests applied with such controls in operation.

5.1.8

Infrared patio heaters can take various forms. To avoid restricting design to those forms anticipated by the test procedures outlined in this Standard, the testing agency might deem it necessary to modify a test method or conduct additional tests to determine compliance of other heater designs with the basic standards for safe operation and acceptable performance specified herein. Any such testing shall be conducted with the heater installed in agreement with the manufacturer's published instructions.

5.2 Test gases

In conducting the performance tests specified herein, test gases with characteristics approximately as shown in Table <u>6</u>, shall be used.

a) A heater for use with natural gas shall have the tests specified herein conducted with Test Gas A. Additional tests shall be conducted with Test Gas G at the normal inlet test pressures specified in

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Clause 5.3.1 for Test Gas A, with no change whatever in the natural gas adjustments, and shall comprise those tests specified under Clauses 5.7.1, 5.8.2 and 5.12. Compliance with these supplemental tests does not imply that the heater has been examined under this Standard for use with propane gas-air mixtures.

b) A heater for use with propane gas shall have the tests specified herein conducted with Test Gas E. The tests specified in Clauses <u>5.7</u>, and Clauses <u>5.8.2</u>, <u>5.8.3</u>, <u>5.8.4</u>, <u>5.8.6</u> and <u>5.12</u> shall also be conducted with Test Gas D with no change whatever in burner equipment.

Table 6
Characteristics of test gases
(See Clause 52)

(See Clause <u>5.2</u>)

	Heating value		Sp Gr
Test gas	Btu/ft ³	MJ m ³	Air = 1.0
Gas A (Natural)	1075	40.1	0.65
Gas D (n-Butane)	3200	119.2	2.00
Gas E (Propane HD-5)	2500	93.1	1.55
Gas G (Butane-Air)	1400	52.2	1.42
Gas H (Propane-Air)	1400	52.2	1.30

5.3 Test pressures and burner adjustments

5.3.1

Unless otherwise stated, each test specified herein shall consist of a series of three tests: one at normal inlet test pressure, one at reduced inlet test pressure, and one at increased inlet test pressure using the inlet test pressures shown in Table $\underline{7}$.

If a gas appliance pressure regulator is provided, and the manifold pressure at increased inlet test pressure is not greater than the manifold pressure at normal inlet test pressure, tests at increased inlet test pressure need not be conducted; however, tests at normal inlet test pressure shall be conducted whenever tests at increased inlet test pressure are specified.

Table 7 Inlet test pressures

(See Clauses <u>5.3.1</u> and <u>5.3.3</u>.)

Test pressure — Inches water column (kPa)				
Test gas	Reduced	Normal	Increased	
Gas A (Natural)	3.5 (0.87)	7.0 (1.74)	10.5 (2.61)	
Gas D (n-Butane)	8.0 (1.99)	11.0 (2.74)	13.0 (3.23)	
Gas E (Propane HD-5)	8.0 (1.99)	11.0 (2.74)	13.0 (3.23)	
Gas G (Butane-Air)	3.5 (0.87)	7.0 (1.74)	10.5 (2.61)	
Gas H (Propane-Air)	3.0 (0.75)	6.0 (1.49)	9.0 (2.24)	

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5.3.2

The inlet test pressures in Table $\frac{7}{2}$ shall be the pressures immediately ahead of all controls. The manifold pressure shall approximate that recommended by the manufacturer, unless otherwise specified herein.

5.3.3

On appliances for connection to a self-contained propane gas supply system, the self-contained fuel system, including the cylinder regulator, shall be disconnected and propane gas shall be supplied directly to the inlet of the appliance at the inlet test pressures specified in Table <u>7</u>.

The appliance shall then be tested in the same manner prescribed for an appliance for connection to a fixed fuel piping system for use with propane gas.

5.3.4

Burners shall be adjusted to their Btu rating at normal inlet test pressure, unless otherwise specified herein. Starting with all parts of the heater at room temperature, the heater shall be operated for 15 min and the rate shall then be adjusted to within ± 5% of the manufacturer's specified hourly Btu input rating. The manifold pressure shall be within 10% of that printed on the rating plate. Primary air, if adjustable, shall be set to give a good flame at this adjustment and neither burner ratings nor primary air adjustment shall be changed during a series of tests with any one test gas. Any adjustment resulting in the deposit of carbon during any of the tests specified herein shall not be acceptable.

5.3.5

The minimum input rating for test purposes on appliances provided with controls which will reduce the input rating by automatic means, shall be 87% of the minimum input rating specified by the manufacturer. The manufacturer's specified minimum input rating shall not be less than 20% of the manufacturer's specified normal input rating.

5.4 Combustion — General

A heater shall not produce a concentration of carbon monoxide greater than 0.08% in an air-free sample of the flue gases when the heater is tested in an atmosphere having approximately a normal oxygen supply. Testing shall be conducted as follows:

The burner and primary air adjustments shall be made in accordance with Clause 5.3.4.

After adjustment and with all parts of the appliance at room temperature, the appliance shall be placed in operation and allowed to operate for 15 min at normal inlet test pressure, at which time a sample of the flue gases shall be secured.

Immediately upon securing the sample at normal inlet test pressure, the reduced inlet test pressure shall be applied, and following a brief purge period, (at least 2 min) another sample of the flue gases shall be secured.

A heater not equipped with an appliance pressure regulator shall then have the increased inlet test pressure applied. Following a brief purge period, (at least 2 min) another sample of flue gases shall be secured.

If a gas appliance pressure regulator is provided, the regulator shall be adjusted to provide an increased input rate of 112% of the manufacturer's specified input rating for appliances for use with natural, and 109% of the manufacturer's specified input rating for appliances for use with propane gas. Following a brief purge period, (at least 2 min) another sample of the flue gases shall be secured.

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When the increased input rate cannot be readily obtained by adjustment of the gas appliance pressure regulator, this increase may be obtained with the regulator removed or locked in its full open position.

The procedure for securing samples shall be left to the discretion of the testing agency. The flue gas samples shall be analyzed for carbon dioxide and carbon monoxide.

5.5 Combustion — Tabletop heaters

5.5.1

A heater intended for tabletop use shall also comply with the following combustion requirements:

- a) when operated in an enclosed room of 100 ft³ (2.84 m³) volume at air exchange rates of 0.5, 1.0, and 1.5 air changes per hour, the heater shall not deplete the oxygen level below 16% by volume; and
- b) when operated in an enclosed room of 100 ft³ (2.84 m³) volume at air exchange rates of 0.5, 1.0, and 1.5 air changes per hour, the maximum CO level shall at no time exceed 100 ppm.

5.5.2

Testing to determine compliance with the minimum oxygen and maximum carbon monoxide levels specified in Clause 5.5.1 shall be conducted as follows:

Heaters shall be equipped with the test gas(es) specified in Clause 5.2. Heaters shall not be warmed up prior to testing.

The heater shall be tested in a 100 ft³ (2.84 m³) room constructed so as to control the air exchange from 0 to at least 1.5 air changes per hour with an accuracy of 0.1 air changes per hour. The test room shall be designed to maintain a room temperature of 70 ± 5 °F (21.1 ± 2.8 °C). The test room shall be adjusted to establish the air exchange rate for the specific test. The heater shall then be ignited in the room and the room sealed to start the test.

A sample of the room air shall be withdrawn at the start of the test and analyzed for carbon monoxide, oxygen and carbon dioxide.

During each test, sufficient samples shall be withdrawn and analyzed for carbon monoxide, oxygen, and carbon dioxide to permit accurate determination of compliance with the oxygen and carbon monoxide limits specified in Clause <u>5.5.1</u>.

Each test shall continue either to extinguishment or equilibrium (see Clause <u>5.5.3</u>), at which time the test shall be discontinued.

Tests shall be conducted at both the maximum and minimum input ratings to determine compliance with limits specified in Clause 5.5.1.

5.5.3

Equilibrium shall be reached after the following conditions are met:

- a) the tabletop heater is operated for a minimum of 8 h when tested at 0.5 air change per hour, a minimum of 4 h when tested at 1.0 air change per hour, and a minimum of 2 h and 40 min when tested at 1.5 air changes per hour; and
- b) samples of the room air, withdrawn at a minimum of three consecutive ½-hour intervals after the minimum operating time for the specific test condition and analyzed for carbon monoxide in parts per million and for oxygen in percent by volume, do not indicate an increase of more than 1 part

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per million for carbon monoxide and a decrease of 0.16% by volume for oxygen between each consecutive reading.

Extinguishment shall be reached when combustion of the gas supplied to the heater ceases to occur at the burner ports, within the burner body, within the burner venturi, and on the face of the burner orifice.

5.6 Combustion — Power burners

5.6.1

On an appliance provided with a variable voltage power burner or induced draft, the concentration of carbon monoxide in an air-free sample of the flue gases shall not exceed 0.08% when the heater is tested in an atmosphere having a normal oxygen supply with the supply voltage reduced to 85% of the appliance rating plate voltage. Testing shall be conducted as follows:

The appliance shall be operated for at least 15 min at normal inlet test pressure. The voltage to the appliance shall then be reduced to 85% of the appliance rating plate voltage. A sample of the flue gases shall then be secured and analyzed as specified in Clause 5.4.

5.6.2

With the flue outlet or air-intake terminal, if so equipped, blocked to any degree, up to and including complete closure, the concentration of carbon monoxide in an air-free sample of the flue gases shall not exceed 0.08% when the heater is tested in an atmosphere having a normal oxygen supply. Testing shall be conducted as follows:

The appliance shall be operated for at least 15 min at normal inlet test pressure. When the appliance incorporates a control to automatically shut off the main gas supply under blocked flue conditions, the area of the flue outlet or air-intake terminal, if so equipped, shall be gradually decreased to the lowest point at which the control will remain in its open position. A sample of the flue gases shall then be secured and analyzed as specified in Clause 5.4.

In case of outage, the blocked condition shall be maintained for 3 min to allow for operation of safety devices, and then removed and observation made. Should outage occur, raw gas shall not be discharged into the combustion chamber on reopening the flue outlet.

5.7 Burner operating characteristics

5.7.1

Burner flames shall not flash back, flash out excessively, cause damage to the appliance or burn the operator's hand during ignition under any of the following test conditions:

- a) turned on and off at the burner adjustment and inlet test pressures specified by Clause <u>5.3</u>;
- b) the gas valve is turned to reduce the gas supply to 50% of the full supply at normal inlet test pressure;
- c) turned on and off at 87% of the lowest input rating if the heater is equipped with automatic step rate or automatic modulating controls which provide for ignition and operation at a reduced input rating; and
- d) adjusted to 87% of the lowest input rating if the appliance is equipped with automatic modulating controls which act to reduce the input rating after ignition of the main burner gas, if this results in an input rating of less than 50% of the normal input rating.

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Testing shall be conducted with the burner(s) both hot and cold. If the controls operate to close off the main gas supply when the gas input is reduced as specified above, the heater shall be considered as complying with this provision.

5.7.2

The arrangement of main burners and ignition devices shall be such that the gas from any burner or combination of burners will be effectively ignited without delayed ignition, excessive flashout from the heater, ignition at the orifice, or danger to the appliance under the test conditions specified in Clause 5.7.1.

5.7.3

There shall be no back pressure at the burner mixer face under any of the test conditions specified in Clause 5.7.1. With the heater operating under each of the conditions specified in Clause 5.7.1, back pressure shall be determined by playing a flame on the mixer face in such a manner that any gas-air mixture escaping from the mixer head would be ignited.

5.7.4

Burners shall ignite, operate and extinguish without objectionable noise. Testing shall be conducted at the burner adjustments specified in Clause <u>5.7.1</u>.

5.7.5

A heater provided with a power burner or induced draft shall also be subject to testing with the supply voltage adjusted to both 85% and 110% of the appliance rating plate voltage, and, unless otherwise specified, at both normal and reduced inlet test pressures at the burner adjustment as specified in Clause 5.3.4. Under each of these test conditions,

- a) Burners shall effectively ignite without delayed ignition or flashback;
- b) Burners shall extinguish without flashback;
- c) There shall be no back pressure at the burner mixer face; and
- d) There shall be no back pressure at the mixer face when an automatic control device for reduction of gas flow to a low rate operates in a normal manner at normal inlet test pressure.

5.8 Pilot burners and safety shutoff devices

5.8.1

The pilot(s) shall effect ignition of gas at the main burner(s) immediately after gas reaches the main burner port(s) and, except for designed turnoff of intermittent and interrupted pilots, shall not become extinguished and remain extinguished when the gas to the main burner(s) is turned on or off in a normal manner. Testing shall be conducted at all the applicable inlet test pressures specified herein as follows:

Pilot(s), main burner(s) and automatic igniter(s) shall be adjusted according to manufacturer's instructions, and the gas turned off at the main burners.

At least 10 successive ignition tests shall be conducted with the gas flow maintained for 30 seconds and interrupted for 30 seconds for each cycle. Failure to effect ignition immediately after gas reaches the main burner port(s) in any one instance, or continued extinction of the pilot, shall be considered noncompliance with this provision.

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5.8.2

A pilot shall not deposit appreciable carbon during any tests specified herein when adjusted according to the manufacturer's instructions.

5.8.3

The pilot shall effect ignition of the gas at the main burner(s) and shall become extinguished after having completed main burner ignition. The control manufacturer's specified maximum flame failure response time for the automatic gas ignition system shall be used for all tests specified below.

Testing shall be conducted based upon the specific configuration of the pilot burner(s) as follows:

a) Single-flame pilot burners (pilot burners which produce a single flame with substantially uniform contour under turndown conditions):

The pilot shall effect ignition of gas within 4 seconds from the time that gas reaches the main burner port(s) when the pilot gas supply is reduced to an amount just sufficient to keep the valve of the safety shutoff device open, or just above the point of flame extinction, whichever represents the higher pilot gas rate.

A flame can be considered as being equivalent to a substantially uniform contour flame if its deviation from uniform contour is occasioned by a flame baffle(s) or channel(s).

b) Multi-flame pilot burners (pilot burners which produce a flame(s) with substantial variation in contour under turndown conditions):

The pilot shall effect ignition of the gas within 4 seconds from the time that gas reaches the main burner port(s) when all the pilot flame ports except those for heating the thermal element are blocked, and the pilot gas supply is reduced to an amount just sufficient to keep the valve of the safety shutoff device open, or just above the point of flame extinction, whichever represents the higher pilot gas rate.

The above test shall also be conducted under sufficient conditions of increased pilot burner input rating to determine that main burner ignition will take place within 4 seconds from the time that gas reaches the main burner port(s) with the pilot burner input at any level from the turndown condition described above, up to and including that providing normal flow through the unblocked port(s) based on the manufacturer's specified normal input rating for the pilot burner.

c) Pilot burner and thermal element assemblies which supply electrical energy for an automatic control system:

When the thermal element is the only source of electric power for operation of the automatic valve, the tests under Items a) and b) above shall be conducted with the pilot adjusted to the minimum size (pull in milli-voltage) required to open the automatic valve. This test condition shall be based on the performance of the system when only the thermal element and automatic valve are present. Under these conditions, the pilot shall effect ignition of the gas within 4 seconds from the time the gas reaches the main burner port(s).

Any other system components shall be excluded during this test.

When a multi-flame pilot burner is provided, the tests outlined under Item b) at increased pilot input ratings shall also be conducted.

d) Recycling pilot burners (gas ignited):

In the case of a pilot burner which operates every time the main burner(s) is turned on or off, either manually or by automatic controls, the ignition flame(s) shall provide ignition of the gas within 4 seconds from the time that gas reaches the main burner port(s) when the gas supply to the ignition flame is just sufficient to prevent the system from shutting off the main burner gas.

5.8.4

The combined time required for the safety shutoff device and the automatic valve to function to turn on the main gas supply after the pilot has been lighted shall not exceed 2 min, when the heater is operated at normal inlet test pressure in accordance with the manufacturer's instructions, except that for those devices which operate every time the main burner(s) with which they are used is turned on or off, the combined time for main gas turn on shall not exceed 1-1/2 min.

For purposes of this test, the control manufacturer's specified maximum flame establishing period for the automatic gas ignition system shall be used.

5.8.5

The time required for the automatic gas ignition system to shut off the gas supply following loss of the supervised flame shall not exceed 180 seconds.

For purposes of this test, the control manufacturer's specified maximum flame failure response time for the automatic gas ignition system shall be used. Testing shall be conducted as follows:

The heater shall be operated for 30 min at normal inlet test pressure. All gas shall then be turned off and the gas flow to a continuous or intermittent pilot immediately reestablished but not ignited. The combined flame failure response time and valve closing time shall be recorded and shall not exceed the limits specified in this provision.

An interrupted pilot having a separate sensing device from that for the main burner flame shall also be tested by turning off all gas after the pilot has been proved but before the main burner gas is ignited.

5.8.6

Flames shall travel freely to all pilot burner ports when the gas is ignited at any one port. Burner port ignition test shall be conducted as follows:

Burner port ignition testing shall be applied only to those pilot burners in which separate ports are used for heating the thermal element of the safety shutoff device and for ignition of gas at the main burners. The pilot burner shall be adjusted according to the manufacturer's instructions and the gas at the pilot burner ignited. The flames shall then be extinguished by means other than interrupting the gas supply, and the gas from the ports that serve to heat the thermal element of the safety shutoff device immediately reignited. The flames shall travel freely to all other ports on the pilot burner.

5.8.7

The temperatures developed on an automatic gas ignition system component shall not exceed those for which the component is designed. Testing shall be conducted as follows:

The pilot and main burner(s) shall be operated at normal inlet test pressure until equilibrium pilot burner temperatures have been attained, at which time temperatures shall be recorded at the points listed below, as applicable to the component provided.

- a) pilot burner tip;
- b) pilot burner orifice fitting;
- c) electric igniter;
- d) flame sensor;
- e) surfaces of the hot and cold junction of thermoelectric types;
- f) valve body;
- g) electric switch;

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h) contact mechanism; and

i) magnetic assembly.

5.9 Direct ignition systems

5.9.1

Direct ignition systems shall provide a lockout timing of not more than 60 seconds and shall comply with the applicable performance provisions of ANSI Z21.20/CSA C22.2 No. 199,

ANSI Z21.20 • CAN/CSA-C22.2 No. 60730-2-5/UL 60730-2-5, or ANSI Z21.78 • CSA 6.20. For test purposes, the control manufacturer's specified maximum lockout time for the automatic gas ignition system shall be used.

5.9.2

For direct ignition systems which incorporate an ignition activation period (see Clause $\underline{3}$), the time between deactivation of the ignition means and the maximum lockout time shall not exceed 4 seconds.

5.9.3

The direct ignition system shall effect ignition of the gas at the main burner(s) immediately after gas reaches the main burner port(s) when operated at appliance rating plate voltage. Testing shall be conducted as follows:

While maintaining appliance rating plate voltage to the heater, the ignition system shall be placed in operation and ignition observed.

The procedure described above shall be repeated 10 times, and in each instance, ignition shall occur immediately after gas reaches the main burner port(s).

5.9.4

5.9.4.1

When a direct ignition system is subject to conditions of voltage variation, the system shall either

- 1) ignite the main burner gas within 4 seconds after gas reaches the main burner port(s); or
- 2) at voltages to the igniter of less than 85% of the appliance rating plate voltage, lock out within the control manufacturer's specified maximum lockout time.

5.9.4.2

Testing shall be conducting using the control manufacturer's specified maximum lockout time for the ignition system as follows:

- a) Undervoltage:
 - i) The voltage to the heater shall be adjusted to 85% of the appliance rating plate voltage.
 - ii) The ignition source circuit shall be separated from the other circuits of the ignition system and the heater, and the voltage to this circuit adjusted to 70% of the appliance rating plate voltage. If separation of the circuits is not possible, the energy content to the ignition source shall be measured at 70% of the appliance rating plate voltage, and this energy level shall be used to conduct this test. The voltage to the remaining circuits shall be adjusted to 85% of the appliance rating plate voltage.
- b) Overvoltage:
 - i) The voltage to the heater shall be adjusted to 110% of the appliance rating plate voltage

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For each voltage condition specified above, ignition cycles shall be repeated 25 times, and in each case, the direct ignition system shall meet the requirements outlined in Item 1) or 2) above.

If ignition time is determined by measuring the time interval between opening the gas controlling device and ignition of the main burner gas, the time required for gas to reach the main burner port(s) after opening the gas controlling device shall be determined separately and added to the specified 4 seconds ignition time. This may be done with a lighted match held at the ignition ports of the burner and measuring the time interval between opening the gas controlling device and ignition of the gas at the port(s).

5.9.5

With the heater at equilibrium temperatures while operating at normal inlet test pressure, the time required for the main burner gas supply to be shut off in the event of flame outage during an operational cycle shall not exceed 90 seconds.

If the ignition means is reactivated, the time to reenergize the ignition means shall not exceed 0.8 seconds following flame outage if the heater is not of the open-flame type. If the appliance is of the open-flame type, the time to reenergize the ignition means shall not exceed 30 seconds.

When the ignition means is reenergized, it shall reignite the main burner gas without excessive flame flashout or damage to the appliance. On an appliance where all air for combustion is supplied by mechanical means, the ignition means may be reactivated after a purge period (recycle time) sufficient to provide a minimum of 4 air changes of the combustion chamber and flue passages. For purposes of this test, the control manufacturer's specified maximum flame failure response time shall be used.

If the ignition means is reactivated, the control manufacturer's specified maximum flame failure reignition time or minimum recycle time for the automatic ignition system shall be used.

5.9.6

The construction of the heater and the arrangement of the direct ignition system shall be such that in the event of a delay in ignition of the main burner gas, as might be caused by foreign debris or electrical shorting of the ignition means, the heater will vent itself without damage or excessive flame flashout.

Testing shall be conducted using the control manufacturer's specified maximum lockout time for the automatic gas ignition system. For systems which deactivate the ignition means prior to the end of the lockout time, the test shall be conducted using the control manufacturer's specified maximum ignition activation period timing.

Testing shall be conducted at normal inlet test pressure with the heater at room temperature. The appliance shall be placed into operation with the ignition means temporarily circumvented for varying intervals of time up to the control manufacturer's specified maximum lockout time or specified maximum ignition activation period, whichever is shorter. For recycling systems, attempts to ignite shall be made for varying intervals of time for each cycle throughout the total operating sequence up to lockout.

The resulting ignition in each trial shall be observed for excessive flame flashout or damage to the heater.

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