ANSI Z83.4-2003
CSA 3.7-2003

American National Standard/ CSA Standard For

Non-Recirculating Direct Gas-Fired Industrial Air Heaters

AMERICAN NATIONAL STANDARD
ANSI Z83.4-2003

CSA STANDARD
CSA 3.7-2003

Second Edition - 2003

This Standard is based on
the Standards for

NON-RECIRCULATING DIRECT GAS-FIRED
INDUSTRIAL AIR HEATERS

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CSA America, Inc.
8501 East Pleasant Valley Road
Cleveland, Ohio 44131

Canadian Standards Association
5060 Spectrum Way, Suite 100
Mississauga, Ontario, Canada L4W 5N6

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Canadian Standards Association

The Canadian Standards Association (CSA), under whose auspices this Standard has been produced, was chartered in 1919 and accredited by the Standards Council of Canada to the National Standards system in 1973. It is a not-for-profit, nonstatutory, voluntary membership association engaged in standards development and certification activities.

CSA standards reflect a national consensus of producers and users — including manufacturers, consumers, retailers, unions and professional organizations, and governmental agencies. The standards are used widely by industry and commerce and often adopted by municipal, provincial, and federal governments in their regulations, particularly in the fields of health, safety, building and construction, and the environment.

Individuals, companies, and associations across Canada indicate their support for CSA's standards development by volunteering their time and skills to CSA Committee work and supporting the Association's objectives through sustaining memberships. The more than 7000 committee volunteers and the 2000 sustaining memberships together form CSA's total membership from which its Directors are chosen. Sustaining memberships represent a major source of income for CSA's standards development activities.

The Association offers certification and testing services in support of and as an extension to its standards development activities. To ensure the integrity of its certification process, the Association regularly and continually audits and inspects products that bear the CSA Mark.

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Les normes CSA reflètent le consensus de producteurs et d'usagers de partout au pays, au nombre desquels se trouvent des fabricants, des consommateurs, des détaillants et des représentants de syndicats, de corps professionnels et d'agences gouvernementales. L'utilisation des normes CSA est très répandue dans l'industrie et le commerce, et leur adoption à divers ordres de législation, tant municipal et provincial que fédéral, est chose courante, particulièrement dans les domaines de la santé, de la sécurité, du bâtiment, de la construction et de l'environnement.

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Pour plus amples renseignements sur les services de la CSA, s'adresser à

Canadian Standards Association
5060 Spectrum Way, Suite 100

Association canadienne de normalisation
5060, rue Spectrum, bureau 100

Mississauga, Ontario, Canada L4W 5N6

American National Standards Institute

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ANSI provides that the interests of the public may have appropriate participation and representation in standardization activity, and cooperates with departments and agencies of U.S. Federal, state and local governments in achieving compatibility between government codes and standards and the voluntary standards of industry and commerce.

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11 West 42nd Street
New York, NY
10036

After the heater has been cooled, the heater shall be placed in operation with the outlet air temperature monitored. The heater shall be allowed to operate (constant on or cyclic, as applicable) until equilibrium is attained.

The air inlet to the heater shall be gradually restricted until the air flow sensing system acts to shut off the main burner gas. The high temperature limit control system shall not function to shut off the gas during this test. The operating temperature control system shall shut off or modulate the main burner gas so the outlet air temperature does not exceed 160°F (71°C) or the activation point of the high temperature limit control system, whichever is less.

If the heater is equipped with variable or adjustable profile plates, the above test shall be repeated at the manufacturer's specified minimum rated air throughput.

2.9 Combustion

2.9.1 Combustion tests shall be conducted with the heater adjusted to operate at the following conditions:

a. Manufacturer's specified maximum rated air throughput, minimum externalstatic pressure and maximum temperature rise.
The air velocity or pressure drop across the burner shall be maintained at the air flow sensing system trip points, including the worst-case tolerance, of 2.7.1 and 2.7.2 (or maximum possible throughput for designs which do not incorporate a high air flow sensing system) for each temperature rise specified in 2.9.2 by adjusting the fan speed or changing the profile plate opening, as applicable.

b. Manufacturer's specified minimum rated air throughput, maintaining the air flow sensing system trip point including the worst-case tolerance of 2.7.1, minimum external static pressure for each temperature rise specified in 2.9.2 by adjusting the fan speed or changing the profile plate opening, as applicable.

c. On heaters furnished with profile plate(s) or bypass damper(s), the manufacturer's specified minimum rated air throughput and minimum external static pressure. The air velocity or pressure drop across the burner shall be maintained at the air flow sensing system trip point including the worst-case tolerance of 2.7.2 for each temperature rise specified in 2.9.2 by adjusting the fan speed or changing the profile plate opening, as applicable.

d. The resulting air throughput starting with the manufacturer's specified maximum rated air throughput and minimum external static pressure for each of the damper positions identified in 2.7.3. The air velocity or pressure drop across the burner shall be maintained at the air flow sensing system point obtained during the conduct of 2.7.3 for each temperature rise specified in 2.9.2 by adjusting the fan speed or changing the profile plate opening, as applicable.

e. On heaters equipped with profile plate damper(s) or bypass damper(s), the test conditions of 2.9.1-a shall be re-established at the temperature rise point(s) where the CO results were found to be the highest.

The control system(s) that controls the movement of the profile plate damper(s) and bypass damper(s) shall be adjusted in four approximately equal increments over their full range of operation. The temperature rise shall be maintained for each point.

f. On heaters furnished with separate combustion air fans, the heater shall be adjusted to the test conditions of 2.9.1-a and the air to the combustion air fan reduced to the trip point of the combustion air fan airflow sensing system specified by the manufacturer (See 2.7.4) for each temperature rise specified in 2.9.2.

g. On heaters equipped with a means to reduce air throughput and without a means to limit the maximum temperature rise to that achieved at the maximum air throughput, determine the theoretical maximum temperature rise at the minimum airflow from the following conditions:

1. Maximum air throughput times maximum temperature rise divided by the minimum air throughput.

2. Maximum discharge temperature minus minimum inlet temperature.

Combustion tests shall be conducted with the heater adjusted to the minimum air throughput with he air velocity or pressure drop across the burner maintained at the airflow sensing trip point, including the worst-case tolerance of 2.7.1 and 2.7.2 for the maximum theoretical temperature rise derived from the lesser of -a and -b above.

2.9.2 Combustion tests shall be conducted at maximum temperature rise, at 75 percent, 50 percent, 25 percent, and at the manufacturer's minimum temperature rise for the test conditions specified under 2.9.1-a, -b, -c, -d, and -f, as applicable.

These tests are intended to be performed at input rates that correspond to the theoretical point of rating for each temperature rise for the conditions specified by using the formulae shown in 2.15 (Burner and Heater Input Rating Determination).

2.9.3 Samples of the outlet air shall be taken at plane 4 in Figure 2 (Test Set-Up), at each of the points in Figure 3 (Distribution of Traverse Points for Round Ducts) or Figure 4 (Distribution of Traverse Points for Rectangular Ducts), as applicable.

2.9.4 The heater shall not produce carbon dioxide, carbon monoxide, aldehydes or nitrogen dioxide in excess of the values given below, when operated in an atmosphere having a normal oxygen content:

CARBON DIOXIDE: 4000 ppm Maximum Average Concentration added. No test required for carbon dioxide, as the quantity formed varies only with the type of fuel gas and only in direct proportion to the input of the particular fuel gas being used. With -30°F (-34.5°C) incoming air temperature and 160°F (71°C) discharge air temperature, carbon dioxide concentration will approximate 3900 ppm with natural gas. A heater for use with other than natural, manufactured or mixed gas shall be required to operate at less than 190°F (88°C) temperature rise since the calculated carbon dioxide concentration exceeds the 4000 ppm maximum average concentration (calculated 4550 ppm with propane).

Carbon dioxide concentration shall be calculated from the following:

$$CO_2\,(ppm) = \frac{K \times I \times 10^3)}{(CFM \times 60)}$$

$$= 19.63 \times K \times \triangle T\ °F$$

(SI: $= 35.33 \times K \times \triangle T\ °C$)

where

I = input rate in Btu per hr.

CFM = total air throughput in cu ft per minute (m^3/s),

K = the amount of CO_2 formed by combustion of 1000 Btu (293 Wh) of gas based on dry standard conditions [60°F and 30 in. Mercury Column (15.5°C and 101.3 kPa)] and the ultimate CO_2 of the particular test gas. The following are the K factors for the test gases specified in 2.2:

T = temperature rise

Test Gas	K Factor
Gas A (Natural)	1.04
Gas B (Manufactured)	0.893
Gas C (Mix)	0.982
Gas D (n-Butane)	1.24
Gas E (Propane HD-5)	1.206
Gas F (Propane-Air)	1.206
Gas G (Butane-air)	1.24
Gas H (Propane-Air)	1.206

CARBON MONOXIDE: 5 ppm Maximum Average Concentration added. Carbon Monoxide (CO) determination shall be made with a long-path infrared spectrophotometer which has been properly compensated for moisture (Beckman 315L or equal) capable of being set to a 0 to 50 ppm full-scale CO range with an accuracy of ± 1 percent of scale; and connected to a strip-chart recorder set to read 10 ppm on a span of 1 inch (25.4 mm). The instrument shall be zeroed before test with CO-free air. The instrument shall be calibrated before and after each test with CO Standard Test Gas. Before each reading of heated discharge air, a reading of the outside incoming air shall be taken at the outlet of the heater. The difference in readings, outdoor incoming to discharge air, is to be considered to be the parts per million of carbon monoxide added by the burner.

ALIPHATIC ALDEHYDES: 1.0 ppm Maximum Average Concentration added. Aldehyde determination shall be made with natural gas only, in which case only formaldehyde will be sought. The basic test shall be the organoleptic technique, as most people can sense 0.5 to 1.0 ppm by this method. At least two persons shall independently check the heated discharge air for aldehydic odor.

Final testing, if deemed necessary by either the heater manufacturer or the testing agency, shall consist of collecting and analyzing samples in accordance with the MBTH method outlined in Public Health Service *Publication No. 999-AP-11, Selected Methods for the Measurement of Air Pollutants.*

NITROGEN DIOXIDE: 0.50 ppm Maximum Average Concentration added. Nitrogen dioxide determination of the heated airstream shall be made using a chemiluminescent analyzer or equivalent.

2.10 Burner Operating Characteristics

2.10.1 Burner flame shall not flash back when turned on and off at any firing rate or air throughput specified in 2.9 (Combustion).

Tests shall be conducted with the burner(s) both hot and cold.

2.10.2 The arrangement of main burners, burner valves and pilot burners shall be such that the gas from any burner or combination of burners will be effectively ignited without delayed ignition, flash back or damage to the heater under the test conditions specified in 2.9 (Combustion).

These tests shall be conducted with the burner(s) both hot and cold.