ANSI Z83.18-2004

American National Standard For **Recirculating Direct Gas-Fired Industrial Air Heaters**

Fourth Edition - 2004

This standard is a revised
edition of the former
standard for

Recirculating Direct
Gas-Fired Industrial
Air Heaters

Z83.18-2000
Z83.18a-2001
Z21.18b-2003

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AMERICAN NATIONAL
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History Of The Development Of The Standard For Recirculating Direct Gas-Fired Industrial Air Heaters

(This History is informative and is not part of the standard.)

At its March 1983 meeting, the Z83 Subcommittee on Standards for Gas-Fired Heavy Duty Forced Air Heaters considered the need to increase the discharge air temperature limit in the direct gas-fired make-up air heater standard (Z83.4), in light of the increased use of make-up air heaters as total space heating appliances. The heavy duty heater subcommittee appointed a working group of subcommittee members and interested individuals to gather information on the use of direct gas-fired make-up heaters for total space heating.

The working group's report to the subcommittee confirmed there were several local codes permitting the installation of gas-fired make-up air heaters as total space heating appliances in non-residential buildings. Consequently, the working group was requested to develop standards coverage for make-up air heaters installed as total space heating appliances for inclusion in Z83.4.

Although it was initially intended that the necessary coverage would be included in Z83.4, following review of the working group's suggested coverage of its July 1984 meeting, the subcommittee concluded that because of design and function differences (i.e., recirculation of inside air) a separate standard would better suit the needs of certification agencies and Code officials.

A draft standard for industrial air heaters, developed by the working group at a series of meetings, was adopted by the heavy duty heater subcommittee at its June 1985 meeting and distributed for industry review in December 1985. Following reconsideration of this draft standard in light of comments received at its February 1986 meeting, the heavy duty heater subcommittee recommended the draft standard to the Z83 Committee.

At its October 1986 meeting, the Z83 Committee approved the proposed standard for submittal the American National Standards Institute, Inc.

The first edition of the Standard for Direct Gas-Fired Industrial Air Heaters, was approved by the American National Standards Institute, Inc., in September 1987. The second edition was approved by the American National Standards Institute, Inc., on November 30, 1990. The third edition was approved by the American National Standards Institute, Inc., on June 22, 2000.

This, the fourth edition of the industrial heater standard was approved as American National Standard by the American National Standard Institute, Inc. on December 20, 2004.

Following procedures outlined above, further revisions to this standard were developed in line with industry developments.

Previous editions of the industrial air heater standard, and addenda thereto, approved by the American National Standards Institute, are as follows:

Z83.18-1987	Z83.18a-1989	Z83.18b-1989
Z83.18-1990	Z83.18a-1991	Z83.18b-1992
Z83.18-2000	Z83.18a-2001	Z21.18b-2003

The following identifies the designation and year of the fourth edition of the standard:
ANSI Z21.83-2004

NOTE: This 2004 edition incorporates changes to the 2000 edition of Z83.18 and addenda thereto. Changes other than editorial, are denoted by a vertical line in the margin.

2.9 Combustion

2.9.1 Combustion tests shall be conducted with the heater adjusted to operate at the following conditions. The combustion test results for each test shall be recorded and used in conjunction with 1.23.2-u.

a. Manufacturer's specified maximum rated air throughput, minimum external static 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), bypass damper(s), or return air 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), bypass damper(s) and return air 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 the 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 formula 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 Duct Derived from ANSI/ASHRAE 51 (ANSI/AMCA 210) or Figure 4, 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:

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

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

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

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 W) of gas based on dry standard conditions [60°F and 30 in. Hg (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, Test Gases:

ΔT = temperature rise

Test Gas	K Factor
Gas A (Natural)	1.04
Gas B (Manufactured)	0.893
Gas C (Mixed)	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 is to be taken at the outlet of the heater. The difference in readings, outdoor incoming to discharge air, shall 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.