U.S. CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

September 30, 2015

Mrs. Lorraine McCourt
Project Manager
Gas Appliances
CSA Group
8501 East Pleasant Valley Road
Cleveland, OH USA, 44131

Dear Mrs. McCourt,

Staff of the U.S. Consumer Product Safety Commission ("CPSC")[1] continues to explore ways to work with the ANZI Z21 Technical Committee ("TC") and its subordinate Technical Subcommittees ("TSC") to improve the safety of vented gas-fired heating appliances, particularly gas furnaces, boilers, wall furnaces and floor furnaces. Despite safety-related improvements to the ANSI Z21 standards for these appliances over the years, as a group, gas furnaces, boilers, and wall and floor furnaces continue to be the leading cause of carbon monoxide ("CO") deaths associated with heating systems. Based on our review of investigated CO incidents, our observation has been that many of these incidents are caused by failure modes or conditions that are not addressed in the respective standards for these appliances, including ANSI Z21.86, *Vented Gas-Fired Space Heating Appliances*. To address these risks, we request that the Z21.86 TSC adopt the following standards proposal. This proposal is an updated version of the proposal CPSC staff originally submitted to the Z21.47 Central Furnace TSC in 2000.[2] Staff believes that advances in CO sensors, exemplified by their use in gas water heaters in Japan (which meet JIS-S-2109) since 2001, makes a strong case that this proposal is feasible.

Action Requested:

CPSC staff requests that the Z21.86 vented space heater TSC adopt the following performance requirements into ANSI Z21.86, *Vented Gas-Fired Space Heating Appliances*, to protect consumers from CO exposure risks caused by combustion products with dangerous levels of CO entering the living space of a dwelling, instead of being safely exhausted to the outdoors through a vent or chimney:

[1] This letter was written by CPSC Staff, was not reviewed or approved by, and may not represent the views of the Commission.

[2] Letter from R. Jordan, CPSC to R. Stack, CSA International
http://www.cpsc.gov/PageFiles/106498/Letter_ANSI_Z21.47_COemissions_furnace2_to_5_CO_shutoff_proposal.pdf

1. Require a means to limit gas wall furnace and gas floor furnace:
    a. CO emissions to below 0.04 percent; or
    b. combustion conditions that result in CO emissions at or in excess of 0.04 percent; or

2. Require a means to shut-off a gas wall furnace and gas floor furnace in response to:
    a. CO emissions at or in excess of 0.04 percent; or
    b. combustion conditions that result in CO emissions at or in excess of 0.04 percent; or

3. Require a means to modulate gas wall furnace and gas floor furnace operation to reduce CO emissions in response to:
    a. CO emissions at or in excess of 0.04 percent; or
    b. combustion conditions that result in CO emissions at or in excess of 0.04 percent.

Proposed wording for Z21.86 is included in the attached Standards Proposal Form.

Rationale

The need to adopt the proposed performance requirements is demonstrated by CPSC's annual CO death estimates and CO incident data, weaknesses in the existing standard, and the existence of potential solutions in international standards. The proposed emission rate of 0.04 percent CO is based, in part, on the existing requirements in Section 6.3, Combustion, and Section 10.3, Combustion, of ANSI Z21.86 which specify that wall furnace and floor furnace CO emissions shall not be "… in excess of 0.04 percent in an air-free sample of the flue gases…" CPSC staff did not include the air-free CO stipulation in its proposal based on comments received from the American Gas Association ("AGA")[3] on CPSC's 2014 Carbon Monoxide/Combustion Sensor Forum. AGA reminded CPSC staff that an air-free CO measurement would require a sensor that measured either carbon dioxide or oxygen, in addition to CO and advised against it.

Annual CO death estimates and incident data

CPSC's annual death estimates indicate that from 2002 through 2011 there were 278 total estimated CO deaths associated with gas furnaces, boilers, wall furnaces and floor furnaces, or 45 percent (278 out of 616) of all heating system CO deaths and 16 percent (278 out of 1703) of CO deaths associated with all consumer products.[4] When staff reviews the data to determine the causes or contributing factors to these incidents, we continue to observe failure modes or mechanisms associated with gas furnaces, boilers, and wall and floor furnaces[5] that are not addressed in the governing standards for these products. Those failure modes include disconnected vents, partially blocked vents, over-fired appliances, and inadequate combustion air.

[3] AGA Comments on CPSC forum and RFI. July 2014, http://www.regulations.gov/#!documentDetail;D=CPSC-2014-0009-0003

[4] Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 2011 Annual Estimates: http://www.cpsc.gov//Global/Research-and-Statistics/Injury-Statistics/Carbon-Monoxide-Posioning/NonFireCarbonMonoxideDeathsAssociatedwiththeUseofConsumerProducts2011AnnualEstimatesSept2014.pdf

[5] *In-Depth Investigations Associated with Certain Vented Gas Appliances*, April 2002. http://www.cpsc.gov//PageFiles/103851/IDI_review_CO_and_vented_gas_appliances.pdf

Weaknesses in the existing standards

The current performance standard for gas wall furnaces and gas floor furnaces, ANSI Z21.86, does not include provisions that protect against certain conditions that can cause or contribute to the production of dangerous levels of CO or the leakage of CO into the living space of a dwelling. These conditions include, but are not limited to, disconnected and partially blocked vents, as well as over-fired appliances, and inadequate air for combustion.[6] CPSC staff believes that adoption of the proposed requirements would help to eliminate or reduce the occurrence of CO-related deaths, injuries, and exposures associated with gas wall furnaces and gas floor furnaces. This proposal addresses the CO risk at the source of production, before potentially deadly levels of CO can enter the living space, regardless of conditions that cause or contribute to the appliance's production and leakage of CO into the living space.

International standards

There are a number of international standards development organizations ("SDOs") that have developed, or have under development, performance provisions that require the use of CO or other combustion-sensing technology within the operating environment of domestic gas appliances. These SDOs represent Japan and the European Union. A list of the SDOs and relevant standards are provided in Table 1, below. The existence of these standards requirements suggests that these SDOs, particularly their appliance and sensor manufacturer members, have evaluated and addressed operational/reliability issues. CPSC staff believes that these issues would likely include the concerns raised by the ANSI Z21/83 TC in 2005 about the durability and longevity of sensors operating within the harsh environment of a gas appliance. Furthermore, the commercialization of appliances meeting JIS-S-2109 suggests that real-world application of this technology has occurred. CPSC staff believes that these standards and the experiences of the SDOs could be used to support the adoption of the CPSC staff's proposal for changes to ANSI Z21.86 and as benchmarks for the development of a U.S. performance requirement to be added to the existing version of ANSI Z21.86.

Table 1. List of international standards development organizations and relevant standards

Standards Development Organization	***Committee on European Standardization (CEN)***	***Japanese Standards Association (JSA)***
Title of Standard	*Combustion product sensing devices for gas burners and gas burning appliances*	*Gas burning water heaters for domestic use*
Standard No.	*EN 16340*[7]	*JIS-S-2109*
Type of Standard	*Component standard*	*Appliance standard*
Key provision of standard	*Use combustion product monitoring devices (CPSD) within the flue of gas appliances to ensure combustion efficiency*	*Shutdown appliance at ambient CO level = 300 ppm (based on the CO concentration in the combustion gas)*
Purpose of key provision	*Energy efficiency*	*CO safety*

[6] Ibid.

[7] The following CEN domestic heating appliance standards, EN 15502-1: 2012, Gas-fired heating boilers – Part 1: General requirements and tests; EN 15502-2-1: 2012, Gas-fired central heating boilers - Part 2-1: Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input not exceeding 1 000 kW, currently require electronic or pneumatic gas/air ratio controls to ensure proper combustion of fuel. Electronic gas/air ratio controls are required to comply with the provisions of EN 12067-2, Gas/air ratio controls for gas burners and gas burning appliances — Part 2: Electronic types. EN 15502-1 references EN 12067-2. EN 15502-1 and EN 12067-2 are both currently undergoing revisions by their respective technical committees. The revised EN 12067-2 will reference EN 16340.

Target Gas/es	*Multiple combustion gases, including CO*	*CO*
Sensor Location	*Combustion Chamber*	*Combustion chamber*
Country/ Trade Block	*European Union*	*Japan*
Effective Date of Standard	*May 2014*	*2001*

Background

This proposal is an update to a 2000 CO shutoff proposal made by CPSC staff to the Z21.47 furnace subcommittee.[8] In that submission, CPSC staff proposed that the subcommittee incorporate the following performance requirements to the furnace standard:

> "*(1) Require the furnace to shut off in the event the vent pipe becomes disconnected;*
> *(2) Require the furnace to shut off in the event the vent pipe becomes totally or partially blocked.*
>
> *In the event technology is not available to accomplish (1) and (2), CPSC staff recommends the following alternative performance requirements to address this risk:*
>
> *(3) Require a means to prevent furnace CO emissions from exceeding the standard limits once installed in the field, or*
> *(4) Require a means, once installed in the field, to shut down the furnace if CO emissions exceed the standard limits."*

The absence of a technological means to implement a standards proposal is sometimes cited as a barrier to implementing the proposal. However, CPSC staff conducted "proof-of-concept" testing of a gas furnace in 2001 with two different CO sensor technologies integrated into its vent pipe to show that the furnace could be effectively shut down in response to sensor voltages that corresponded to CO levels in excess 400 ppm in the vent pipe. CPSC staff successfully demonstrated the concept of using gas sensors for this purpose. The findings of this report were provided to the Z21.47 furnace TSC in 2001 in support of staff's 2000 "CO Shutoff" proposal.[9]

As a result of CPSC staff's 2000 proposal and 2001 "proof-of-concept" testing, the Z21/83 TC established the Z21/83 Ad Hoc Working Group ("AHWG") for Carbon Monoxide/Combustion Sensors in 2002 to develop a test criterion and work plan to evaluate the use of CO/combustion sensors for shutoff of vented gas heating appliances.[10] The AHWG worked on these tasks from 2002 through 2004, and submitted a test criterion and work plan to the Z21/83 TC in 2004 for approval.

The TC approved the test criterion and work plan and provided them to the Z21/83 Advisory Council for funding. Between late-2004 and early-2005, the Advisory Council solicited aid from gas

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[8] Letter to CSA International conveying furnace emissions test results and "CO Shutoff" proposal, October 2001. http://www.cpsc.gov//PageFiles/106465/Letter_ANSI_Z21.47_%20furnace_combustion_sensor_test_results_and_COshutoff_proposal.pdf

[9] *Furnace Combustion Sensor Test Results*, September 2001. http://www.cpsc.gov/PageFiles/98232/Furnace_combustion_sensor_test_results.pdf

[10] Minutes of the Z21/83 Committee and CSA Technical Committee, April 2002 .

appliance industry stakeholders, including CPSC, to help fund the CO/combustion sensor test and evaluation outlined in the test criterion and work plan. At its September 2005 meeting, the ANSI Z21/83 TC decided not to pursue this work, citing its belief that there were no available sensors that had the durability to survive within the harsh environment of a gas appliance for the life span of the appliance, which they consider to be approximately 20 years.[11] CPSC staff objected to the TC's decision, since issues such as durability and life span were among the factors that the sensor testing would have evaluated. Nevertheless, the TC voted not to pursue this matter further and dismissed the AHWG.

In order to explore the concerns raised by the TC in 2005, CPSC staff conducted a test program from 2007 through 2008 to evaluate the durability and longevity of sensors operating within the flue passageways of a gas furnace. A portion of this test program was based on the test criterion completed by the AHWG and approved by the TC in 2004. Staff found that the performance of the sensors involved in the test program demonstrated that the sensors were capable of withstanding the harsh operating environment of a furnace and potentially surviving throughout the lifespan of the furnace. A report on our findings[12] was provided to the TC and the Z21.47 and Z21.13 TSCs in 2012. In 2014 CPSC staff hosted a Carbon Monoxide/Combustion Sensor Forum and published a Request for Information (RFI) in the Federal Register. The goal of the forum and the RFI was to help CPSC staff obtain a broader understanding of the sensor technologies currently available and under development, as well as any barriers to using these technologies in vented gas heating appliances as shutoff devices in scenarios in which the appliance produces excessive levels of CO.
A report on our findings[13] on the activities was also provided to the TC and the Z21.47 and Z21.13 TSCs in 2015.

As you know, CPSC hosted a Carbon Monoxide/Combustion Sensor Forum in 2014 to gain a broader understanding of sensor technologies that were available or under development, and any barriers to using sensors as shutoff devices in response to excessive levels of CO or conditions that lead to excessive CO levels within a gas appliance. The most important new information shared at the forum was a summary of long term testing of combustion sensors operated within the heat exchangers of gas boilers. The summary demonstrated sensor lifespans that approached the 15 to 20-year threshold considered by the Z21/83 Technical Committee to be a barrier to using sensors in gas heating appliances as CO shutoff devices. This reinforces the continued importance of seeking information on the capabilities of sensors to operate within the harsh environment of gas appliance heat exchangers, as well as continuing the dialog on this topic with U.S. and international standards developers.

To date, other than the requirements for totally blocked vents that became effective in the late 1980's and early 1990s, CPSC staff is not aware of any new requirements in ANSI Z21.86 that address CO risks associated with disconnected or partially blocked vents, over-firing of the boiler, inadequate combustion air, or any other failure conditions or mechanisms that are known to have caused or contributed to CO exposures and fatalities. CPSC staff firmly believes that a requirement for CO shut-off or to pre-empt production of CO levels in excess of 400 ppm would help prevent or reduce the occurrence of these CO exposure risks and the fatalities and injuries that result from them.

[11] Minutes of the Z21/83 Committee and CSA Technical Committee, September 2005.
[12] Evaluation of the Durability and Longevity of Chemicals Sensors Used In-Situ for Carbon Monoxide Safety Shutdown of Gas Furnaces, September 2012.
[13] Findings from CPSC's 2014 Carbon Monoxide/Combustion Sensor Forum and Request for Information, March 2015.

I look forward to working with the Z21.86 TSC and the Z21/83 TC to address these issues. Please feel free to contact me at rjordan@cpsc.gov or 301-987-2219 if you have any questions about this proposal.

Best regards,

RONALD JORDAN

Digitally signed by RONALD JORDAN
DN: c=US, o=U.S. Government, ou=Consumer Product Safety Commission, cn=RONALD JORDAN, 0.9.2342.19200300.100.1.1=61001001710382
Date: 2015.09.30 10:31:42 -04'00'

Ronald A. Jordan
Mechanical Engineer
Division of Combustion and Fire Science
Directorate for Engineering Sciences
U.S. Consumer Product Safety Commission

cc.
ANSI Z21/83 Technical Committee members

Frank Stanonik	Air Conditioning, Heating, and Refrigeration Institute
Ted Williams	American Gas Association
Marvan Evans	Technical Standards and Safety Authority
Colin Church	Voluntary Standards Coordinator, U.S. CPSC

ATTACHMENT

STANDARDS PROPOSAL FORM

PLEASE USE SEPARATE FORM FOR EACH PROPOSAL.

E-MAIL, FAX OR MAIL FORM TO:

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REPRESENTING (Please indicate organization, company or self): U.S. Consumer Product Safety Commission

1. Title of Standard: Standard for Vented Gas-Fired Space Heating Appliances

   Standard Designation: ANSI Z21.86

2. Proposed Changes and Rationale (please enter each proposal on a separate line). Use separate form if the number of proposals exceeds ten (10).

Section Number	Proposed Revision	Rationale Statement	This proposal is original material
		Efforts have been made by CPSC staff to use the language of the existing standard, as this is the language expected by the committee. Additionally, several sections are very similar to one another, but apply to different types or installations of boilers, again in keeping with the norms of the existing standard.	
(New) 6.3.2	A wall furnace shall not produce a concentration of carbon monoxide in excess of 0.04 percent in an air-free sample of the flue gases when the appliance is tested in a room having approximately a normal oxygen supply. **Method of Test** During combustion tests, the appliance	The performance standard that covers gas wall furnaces and gas floor furnaces, ANSI Z21.86, does not include provisions that protect against certain conditions that can cause or contribute to the production of dangerous levels of CO or the leakage of combustion products, including potentially dangerous levels of CO, into the living space of a dwelling.	☒

	shall depend for venting of the flue gases solely on the provisions for venting incorporated within it. Burner and primary air adjustments shall be made in accordance with 2.3.4. After adjustment, and with all parts of the appliance at room temperature, the pilot(s), if provided, shall be placed in operation and allowed to operate for a period of 5 minutes, at which time the main burner(s) shall be placed in operation. The appliance shall then be operated for 3 minutes 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 (see 2.3.1) shall be applied, and following a purge period of at least 2 minutes, another sample of the flue gases shall be secured. The appliance pressure regulator shall then be adjusted to provide the increased input rate (see 2.3.3). The appliance shall be allowed to continue in operation for 15 minutes after it is initially placed in operation, at which time another sample of the flue gases shall be secured. On an appliance provided with a power burner or induced draft, an additional combustion sample shall be secured with the appliance operating at normal inlet test pressure and the supply voltage reduced to 85 percent of the rated voltage of the appliance. Samples shall be secured between the appliance and the vent terminal at a point where uniform samples can be obtained. When this method of sampling is not practical, testing laboratory shall use sound engineering judgment to make a knowledge-based adjustment to the procedure in order to	These conditions include, but are not limited to; disconnected vents, snow blockage of side wall vented wall furnace installations, and partially blocked vents, as well as over-fired or oxygen-starved burners. CPSC staff believes that adoption of these proposed requirements should help to eliminate or reduce the occurrence of CO-related deaths, injuries, and exposures associated with gas wall furnaces. This proposal addresses the CO risk at the source of production, before harmful levels of CO can reach the living space across the range of conditions that cause or contribute to the appliance's production and leakage of harmful levels of CO into the living space.	

	obtain a reasonably uniform and representative sample. The flue gas sample shall be analyzed for carbon dioxide and carbon monoxide. The wall furnace shall then be tested after each of the following separate adjustments (a. through e.) have been made. After the adjustment for a. below has been made, the wall furnace shall then be allowed to operate for 15 minutes or until equilibrium temperature has been achieved, whichever occurs first. After equilibrium has been achieved, flue gases shall then be sampled for 15 minutes. If the average concentration of carbon monoxide in the sample of flue gases over the 15 minute period does not exceed 0.04 percent, then this provision will be deemed to have been met for that individual adjustment. After sampling of the flue gases has been completed, the adjustment parameter shall be restored back to normal and the wall furnace operated until normal flue CO levels are achieved again. Repeat for adjustments b. through e. as described below. A sample of flue gases shall be secured and tested after each incremental adjustment for a. through f.: a. Increase regulator pressure in increments of 0.25 in. w.c. until maximum pressure is achieved. If the outlet pressure of the manifold valve cannot be readily adjusted to obtain the maximum outlet pressure, the regulator may be removed or blocked in the open position or the inlet test pressure may be increased as necessary. b. Decrease regulator pressure in increments of 0.25 in. w.c. until minimum pressure is achieved. c. Decrease the combustion air supply to the burner as follows: i. For direct vent wall furnaces: block the cross-sectional area of the combustion air inlet pipe in		

	increments of ¼ of the combustion air opening up to and including complete blockage. ii. For non-direct vent wall furnaces: block the area of the combustion air openings, on the wall furnace cabinet adjacent to the burner vestibule, in increments of ¼ of the combustion air opening up to and including complete blockage. d. Reduce the line voltage supplied to the wall furnace to 85 percent of the appliance rating plate voltage or the lowest voltage that still allows wall furnace operation to be achieved, e. Incrementally block the vent pipe up to, but not including complete closure or any other point that would cause the wall furnace to shut off. For direct vent systems, the combustion air inlet piping may also be blocked incrementally up to, but not including complete closure or any other point that would cause the wall furnace to shut off. e. Repeat testing with adjustments a, c, and d made concurrently. Then repeat testing with adjustments b, c, and d. made concurrently. This provision will be deemed completely met when after being subjected to each of adjustments described in a-e, the average concentration of carbon monoxide in a sample of flue gases produced by the wall furnace over a 15 minute period does not exceed 0.04 percent.		
(New) 6.3.3	Add a provision that "When tested in an atmosphere having a normal oxygen supply, if the average concentration of carbon monoxide exceeds 0.04 percent in a sample of its flue gases for 15 minutes, or when combustion conditions exists that result in the average concentration	−Same Rationale Statement as used in Proposed Revision for Section Number 6.3.2 (New) above−	☒

	of carbon monoxide exceeding 0.04 percent in a sample of the flue gases for 15 minutes, a wall furnace shall either: **1.** Shut off; or **2.** Modulate its gas manifold pressure, inducer or power blower volumetric air flow, combustion air flow to the burner, or other combustion/control component parameters to reduce carbon monoxide concentrations to below 0.04 percent within 15 minutes. **Method of Test** Samples shall be secured at a point preceding the inlet to the draft hood where uniform samples can be obtained. When this method of sampling is not practical, testing laboratory shall use sound engineering judgment to make a knowledge-based adjustment to the procedure in order to obtain a reasonably uniform and representative sample. The flue gas sample shall be analyzed for carbon dioxide and carbon monoxide." A wall furnace shall be equipped with a duct, as specified in 2.3.2, the outlet end of which shall be symmetrically restricted until the wall furnace is operating against an external static pressure as specified in 2.6.1. Under the conditions of holding static pressure constant, the normal temperature rise can be allowed to vary slightly. Burner and primary air adjustments shall be made in accordance with 2.5.4. After adjustment and with all parts of the wall furnace at room temperature, the pilot(s), if provided, shall be placed in operation and allowed to operate for a period of 5 minutes. The main burner(s) shall then be placed in operation and the wall furnace operated for 3 minutes 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 (see 2.5.1) shall be applied and, following a purge period of at least 2 minutes, another sample of the flue gases shall be secured. Adjustments shall then be made to either the gas manifold supply pressure, the combustion air supply to the burner, or the combustion blower fan speed, the line voltage supplied to the wall furnace or a combination of these or other combustion/operational parameters until the average concentration of carbon monoxide of the wall furnace reaches or exceeds 0.04 percent in a sample of the flue gases. If the regulator outlet pressure cannot be readily adjusted to obtain the target carbon monoxide concentration, the regulator may be removed or blocked in the open position or the inlet test pressure may be increased as necessary. If after making these additional adjustments, the target carbon monoxide concentration still has not been attained, then begin incrementally blocking the vent pipe up to, but not including complete closure or any other point that would cause the wall furnace to shut off. For direct vent systems, the combustion air inlet piping may also be blocked incrementally up to, but not including complete closure or any other point that would cause the wall furnace to shut off. Once the carbon monoxide concentration exceeds 0.04 percent, the wall furnace shall then be allowed to operate for 15 minutes, at which time another sample of the flue gas shall be secured. On a wall furnace provided with a power burner or induced draft, an additional combustion sample shall be secured with the wall furnace operating at		

	normal inlet test pressure and with the supply voltage reduced to 85 percent of the appliance rating plate voltage. This sample shall be secured 15 minutes after the wall furnace has operated at the reduced voltage. The input rating may vary from normal as a result of the voltage reduction. Under these operating conditions for a draft hood-equipped, power, or induced draft wall furnace, when the average carbon monoxide concentration has equaled or exceeded 0.04 percent for 15 minutes, the wall furnace shall either: 1. Shut off; or 2. Modulate gas manifold pressure, inducer or power blower volumetric air flow, or other control component parameters to reduce the average carbon monoxide concentration to below 0.04 percent within 15 minutes. If the carbon monoxide concentration is not reduced or maintained below 0.04 percent, then the wall furnace shall shutoff. Samples shall be secured at a point preceding the inlet to the draft hood where uniform samples can be obtained. When this method of sampling is not practical, testing laboratory shall use sound engineering judgment to make a knowledge-based adjustment to the procedure in order to obtain a reasonably uniform and representative sample. The flue gas sample shall be analyzed for carbon dioxide and carbon monoxide."		
(New)10.3.2	A floor furnace shall not produce a concentration of carbon monoxide in excess of 0.04 percent in an air-free sample of the flue gases when the appliance is tested in a room having approximately a normal oxygen supply.	−Same Rationale Statement as used in Proposed Revision for Section Number 6.3.2 (New) above−	☒

	Method of Test During combustion tests, the appliance shall depend for venting of the flue gases solely on the provisions for venting incorporated within it. Burner and primary air adjustments shall be made in accordance with 2.3.4. After adjustment, and with all parts of the appliance at room temperature, the pilot(s), if provided, shall be placed in operation and allowed to operate for a period of 5 minutes, at which time the main burner(s) shall be placed in operation. The appliance shall then be operated for 3 minutes 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 (see 2.3.1) shall be applied, and following a purge period of at least 2 minutes, another sample of the flue gases shall be secured. The appliance pressure regulator shall then be adjusted to provide the increased input rate (see 2.3.3). The appliance shall be allowed to continue in operation for 15 minutes after it is initially placed in operation, at which time another sample of the flue gases shall be secured. On an appliance provided with a power burner or induced draft, an additional combustion sample shall be secured with the appliance operating at normal inlet test pressure and the supply voltage reduced to 85 percent of the rated voltage of the appliance. Samples shall be secured between the appliance and the vent terminal at a point where uniform samples can be obtained. When this method of sampling is not practical, testing laboratory shall use sound engineering judgment to make a knowledge-based adjustment to the procedure in order to		

	obtain a reasonably uniform and representative sample. The flue gas sample shall be analyzed for carbon dioxide and carbon monoxide. The wall furnace shall then be tested after each of the following separate adjustments (a. through e.) have been made. After the adjustment for a. below has been made, the wall furnace shall then be allowed to operate for 15 minutes or until equilibrium temperature has been achieved, whichever occurs first. After equilibrium has been achieved, flue gases shall then be sampled for 15 minutes. If the average concentration of carbon monoxide in the sample of flue gases over the 15 minute period does not exceed 0.04 percent, then this provision will be deemed to have been met for that individual adjustment. After sampling of the flue gases has been completed, the adjustment parameter shall be restored back to normal and the wall furnace operated until normal flue CO levels are achieved again. Repeat for adjustments b. through e. as described below. A sample of flue gases shall be secured and tested after each incremental adjustment for a. through e.: a. Increase regulator pressure in increments of 0.25 in. w.c. until maximum pressure is achieved. If the outlet pressure of the manifold valve cannot be readily adjusted to obtain the maximum outlet pressure, the regulator may be removed or blocked in the open position or the inlet test pressure may be increased as necessary. b. Decrease regulator pressure in increments of 0.25 in. w.c. until minimum pressure is achieved. c. Decrease the combustion air supply to the burner as follows: i. For direct vent boilers: block the cross-sectional area of the combustion air inlet pipe in		

	increments of ¼ of the combustion air opening up to and including complete blockage. ii. For non-direct vent floor furnaces: block the area of the combustion air openings, on the floor furnace cabinet adjacent to the burner vestibule, in increments of ¼ of the combustion air opening up to and including complete blockage. d. Reduce the line voltage supplied to the floor furnace to 85 percent of the appliance rating plate voltage or the lowest voltage that still allows floor furnace operation to be achieved, e. Incrementally block the vent pipe up to, but not including complete closure or any other point that would cause the floor furnace to shut off. For direct vent systems, the combustion air inlet piping may also be blocked incrementally up to, but not including complete closure or any other point that would cause the floor furnace to shut off. f. Repeat testing with adjustments a, c, and d made concurrently. Then repeat testing with adjustments b, c, d, and e. made concurrently. This provision will be deemed completely met when after being subjected to each of adjustments described in a-f, the average concentration of carbon monoxide in a sample of flue gases produced by the floor furnace over a 15 minute period does not exceed 0.04 percent.		
(New)10.3.3	Add a provision that "When tested in An atmosphere having a normal oxygen supply, if the average concentration of carbon monoxide exceeds 0.04 percent in a sample of its flue gases for 15 minutes, or when combustion conditions exists that result in the average concentration of carbon monoxide exceeding 0.04 percent in a sample of the flue gases for 15 minutes, a floor furnace shall either:	−Same Rationale Statement as used in Proposed Revision for Section Number 6.3.2 (New) above−	☒

	1. Shut off; or 2. Modulate its gas manifold pressure, inducer or power blower volumetric air flow, combustion air flow to the burner, or other combustion/control component parameters to reduce carbon monoxide concentrations to below 0.04 percent within 15 minutes. **Method of Test** Samples shall be secured at a point preceding the inlet to the draft hood where uniform samples can be obtained. When this method of sampling is not practical, testing laboratory shall use sound engineering judgment to make a knowledge-based adjustment to the procedure in order to obtain a reasonably uniform and representative sample. The flue gas sample shall be analyzed for carbon dioxide and carbon monoxide." A floor furnace shall be equipped with a duct, as specified in 2.3.2, the outlet end of which shall be symmetrically restricted until the furnace is operating against an external static pressure as specified in 2.6.1. Under the conditions of holding static pressure constant, the normal temperature rise can be allowed to vary slightly. Burner and primary air adjustments shall be made in accordance with 2.5.4. After adjustment and with all parts of the furnace at room temperature, the pilot(s), if provided, shall be placed in operation and allowed to operate for a period of 5 minutes. The main burner(s) shall then be placed in operation and the furnace operated for 3 minutes 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 (see 2.5.1)		

	shall be applied and, following a purge period of at least 2 minutes, another sample of the flue gases shall be secured. Adjustments shall then be made to either the gas manifold supply pressure, the combustion air supply to the burner, or the combustion blower fan speed, the line voltage supplied to the furnace or a combination of these or other combustion/operational parameters until the average concentration of carbon monoxide of the furnace reaches or exceeds 0.04 percent in a sample of the flue gases. If the regulator outlet pressure cannot be readily adjusted to obtain the target carbon monoxide concentration, the regulator may be removed or blocked in the open position or the inlet test pressure may be increased as necessary. If after making these additional adjustments, the target carbon monoxide concentration still has not been attained, then begin incrementally blocking the vent pipe up to, but not including complete closure or any other point that would cause the furnace to shut off. For direct vent systems, the combustion air inlet piping may also be blocked incrementally up to, but not including complete closure or any other point that would cause the furnace to shut off. Once the carbon monoxide concentration exceeds 0.04 percent, the floor furnace shall then be allowed to operate for 15 minutes, at which time another sample of the flue gas shall be secured. On a floor furnace provided with a power burner or induced draft, an additional combustion sample shall be secured with the furnace operating at normal inlet test pressure and with the supply voltage reduced to 85 percent of the appliance rating plate voltage. This sample shall be secured 15 minutes		

	after the furnace has operated at the reduced voltage. The input rating may vary from normal as a result of the voltage reduction. Under these operating conditions for a draft hood-equipped, power, or induced draft floor furnace, when the average carbon monoxide concentration has equaled or exceeded 0.04 percent for 15 minutes, the floor furnace shall either: 1. Shut off; or 2. Modulate gas manifold pressure, inducer or power blower volumetric air flow, or other control component parameters to reduce the average carbon monoxide concentration to below 0.04 percent within 15 minutes. If the carbon monoxide concentration is not reduced or maintained below 0.04 percent, then the floor furnace shall shutoff. Samples shall be secured at a point preceding the inlet to the draft hood where uniform samples can be obtained. When this method of sampling is not practical, testing laboratory shall use sound engineering judgment to make a knowledge-based adjustment to the procedure in order to obtain a reasonably uniform and representative sample. The flue gas sample shall be analyzed for carbon dioxide and carbon monoxide."		

3. If the proposal is not original material, the source (if known) is as follows: Z21.86

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* (Note: Proposed wording and original material is considered to be the submitter's own idea based on, or as a result of, his/her own experience, thought or research, and to the best of his/her knowledge is not copied from another source.)

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