

Guidelines for Home Energy Professionals Project

Standard Work Specifications (SWS) Update to Align SWS with the Combustion Appliance Section of ANSI/BPI-1200-S-2015: *Standard Practice for Basic Analysis of Buildings*

The SWS define the minimum requirements to ensure that the work performed during home energy upgrades is effective, durable, and safe. The SWS can be used as an industry guide for workers, training instructors, homeowners, and program administrators involved in the home performance industry.

To ensure that the SWS are accurate and contain the most up to date information, comments are accepted on the SWS. These comments are adjudicated by several committees of experts, as detailed in the “2014 SWS Maintenance Report” on the SWS website.

In 2014, several of the comments received were on Section 2.02: Combustion Safety. At the same time, the Building Performance Institute was updating guidance on combustion safety testing. Rather than adjudicate these comments related to combustion safety, members of the SWS Health & Safety SWS Maintenance Committee decided to wait until BPI finalized their guidance, and then align the SWS with BPI’s guidance.

In 2015, BPI-1200 was updated to reflect industry consensus around, among other things, testing of combustion appliances. The “redline” document below details edits to the SWS Section 2.02: Combustion Safety, as well as Details 5.3003.14 & 15: Heating & Cooling – Forced Air. Blue underlined text is new, and red strikethrough has been deleted.

Major changes include:

1. Combined CAZ Testing Single-Family (2.0201.1) and Manufactured Housing (2.0201.3) into one detail
2. Aligned the Combustion Safety—Make-up air (2.0201.2) single-family and manufactured homes
3. Created Vented Combustion Appliance Safety Testing (2.0201.4) detail from specifications previously numbered: 2.0201.1f & 2.0201.3f, 2.0201.1g & 2.0201.3g, and 2.0201.3h; this splits out CAZ depressurization evaluation (i.e. determining "worst-case") from tests done in that condition
4. Combined Combustion Air for Natural Draft Appliances Single-family Housing (2.0203.1) and Manufactured Housing (previously 2.0203.4) into one detail; 2.0203.1 remains, 2.0203.4 has been deleted
5. Combined Combustion Flue Gas--Orphaned Water Heaters Single-family Housing (2.0203.2) and Manufactured Housing (previously 2.0203.5) into one detail; 2.0203.2 remains, 2.0203.5 has been deleted
6. Deleted Draft Regulation—Category I Appliance (2.0203.3 & 2.0203.6). Specifications related to occupant education added to new detail: Occupant Education (2.0203.8); draft regulators are really for oil-fired appliances and don't belong in the gas-fired sections
7. Created Occupant Education (2.0203.8) detail from specs originally numbered: 2.0203.2f & 2.0203.3d, 2.0203.5e, 2.0203.6d, and 2.0203.2g & 2.0203.e, 2.0203.5f, 2.0203.6e; this combines the occupant education on CO alarms and other maintenance issues

8. Deleted Combustion Appliance Depressurization Limits Table (2.0299.1); Worst-case depressurization limits are no longer required by BPI-1200 as the consensus is that actual spillage is the important metric

2.0201.1 Combustion Appliance Zone (CAZ) Testing		
Topic	Combustion Safety	
Subtopic	Combustion Safety Testing-General	
Desired Outcome	Accurate information about appliance safe operation is gathered	
Manufactured Housing, Single-Family Homes		
Title	Specification(s)	Objective(s)
2.0201.1a Assessment	Emergency problems (e.g., gas leak greater than 10% Lower Explosion Limit (LEL), ambient CO levels that exceed 70 ppm) will be communicated clearly and immediately to the customer, the home shall be evacuated, and appropriate emergency services shall be contacted	Ensure system does not have potentially fatal problems
	Significant problems (e.g., gas leak less than 10% LEL, ambient CO levels that exceed 35 ppm but less than 70 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested	
	Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance	
2.0201.1b Fuel leak detection	Inspect and test for gas or oil leakage at connections of natural gas, propane piping, or oil systems	Detect fuel gas leaks
	If leaks are found, immediate action will be taken to notify occupant to help ensure leaks are repaired	Determine and report need for repair
	The report will specify repair for leaks and replacement for hazardous or damaged gas or oil connectors and pipes	
2.0201.1c Venting	For oil systems, the presence and operability of a draft regulator will be verified and tested	Determine if a regulator is present and working
	Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards	Determine whether vent system is in good condition and installed properly

2.0201.1d Base pressure test	Baseline pressure will be measured in Combustion Appliance Zone (CAZ) with reference to outdoors	Measure pressure difference between combustion zone and the outside under natural conditions
2.0201.1e Depressurization test	CAZ depressurization testing will be administered for all equipment equipped with a draft hood. Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof; the test will be done to determine the largest negative pressure per BPI Standard 1200.	Determine worst-case depressurization in combustion zone due to mechanical system fans

2.0201.2	Combustion Safety – Make-up Air	
Topic	Combustion Safety	
Subtopic	Combustion Safety General	
Desired Outcome	Buildup of dangerous combustion byproducts in the living space prevented	
Note	The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.	
Single-Family Homes, Manufactured Housing		
Title	Specification(s)	Objective(s)
2.0201.2a Outside combustion make-up air	Where applicable, combustion air will be provided from the outside and installed in accordance with the 2012 IRC for the type of appliance installed	Prevent combustion byproducts from entering the house
2.0201.2b New appliances	If replacing appliances, a sealed-combustion, direct-vent appliance will be installed if possible. New appliances will be installed in accordance with manufacturer specifications, the 2012 IRC and additional applicable codes	Prevent combustion byproducts from entering the house
2.0201.2c CO detection and warning equipment	CO detection or warning equipment will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in accordance with ASHRAE 62.2 and authority having local jurisdiction Installation will be accomplished by a licensed electrician when required by local code	Alert occupant to CO exposure
2.0201.2d Gas ovens	Gas ovens will be tested for CO A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 225 ppm as measured	Ensure clean burn of gas ovens
2.0201.2e Gas range burners	Specify clean and tune if the flame has any discoloration, flame impingement, an irregular pattern, or if burners are visibly dirty, corroded, or bent	Ensure clean burn and operation of gas range burners
2.0201.2f Solid fuel burning appliances	If the solid fuel burning appliance is the primary heat source and has signs of structural failure replace solid fuel burning appliance with UL-listed and EPA - certified appliances if the existing appliance is not UL-listed	Ensure safe operations of solid fuel burning appliances

2.0201.4 Vented Combustion Appliance Safety Testing		
Topic	Combustion Safety	
Subtopic	Combustion Safety Testing-General	
Desired Outcome	Buildup of dangerous combustion byproducts in the living space prevented	
Manufactured Housing, Single-family		
Title	Specification(s)	Objective(s)
2.0201.4a Spillage test	<p>In conditions with largest negative pressure as determined from Detail 2.0201.1e:</p> <p>If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate.</p> <p>If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate.</p>	Detect excessive spillage of combustion gases
2.0201.4b Carbon monoxide (CO) test in appliance vent	<p>CO will be tested for in undiluted flue gases of combustion appliances</p> <hr/> <p>In conditions with largest negative pressure as determined from Detail 2.0201.3e:</p> <hr/> <p>If CO levels exceed 400 ppm air-free measurement in furnaces, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)</p> <hr/> <p>If CO levels exceed 200 ppm air-free measurement in water heaters or room heaters, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)</p>	Measure CO and report excessive levels
2.0201.4c Final test out	Final combustion testing will be conducted at project completion to ensure compliance with the above specifications	Ensure safe operation of combustion appliance within the whole house system after any repair project

2.0202.1 Unvented Space Heaters: Propane, Natural Gas, and Kerosene Heaters

Topic Combustion Safety
Subtopic Unvented Space Heaters
Desired Outcome Elimination of combustion byproducts

Single-Family Homes

Title	Specification(s)	Objective(s)
	With the occupant's permission, unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2	
2.0202.1a Removal	Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place	Eliminate sources of combustion byproduct within a living space
	Failure to remove unvented space heaters serving as primary heat sources has the potential to create hazardous conditions and thus any further weatherization services will be re-evaluated in the context of potential indoor air quality risks	
2.0202.1b Occupant education	Occupant will be educated on potential hazards of unvented combustion appliances (primary or secondary) within a living space	Inform occupant about possible hazards associated with combustion byproducts and moisture

Manufactured Housing

Title	Specification(s)	Objective(s)
	With the occupant's permission, unvented heaters will be removed except when used as a secondary heat source and when it can be confirmed that the unit is listed to ANSI Z21.11.2	
2.0202.1a Removal	Units that are not being operated in compliance with ANSI Z21.11.2 should be removed before the retrofit but may remain until a replacement heating system is in place	Eliminate sources of combustion byproduct within a living space
	Failure to remove unvented space heaters serving as primary heat sources has the potential to create hazardous conditions, and thus any further weatherization services will be reevaluated in the context of potential indoor air quality risks	
2.0202.1b Occupant education	Occupant will be educated on potential hazards of unvented combustion appliances (primary or secondary) within a living space	Inform occupant about possible hazards associated with combustion byproducts and moisture

2.0203.1	Combustion Air for Natural Draft Appliances
Topic	Combustion Safety
Subtopic	Vented Gas Appliances
Desired Outcome	Sufficient air provided in the Combustion Appliance Zone (CAZ)

Single-Family Homes

Title	Specification(s)	Objective(s)
2.0203.1a Required combustion air	The required volume of indoor air will be determined in accordance with 2012 IRC Section G2407.5.1 or G2407.5.2 and authority having jurisdiction, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), 2012 IRC Section G2407.5.2 will be used	Determine if existing conditions meet the combustion air calculation
2.0203.1b Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with 2012 IRC G2407 and authority having jurisdiction when necessary to solve spillage problems	Ensure adequate combustion air for operation of the appliance
2.0203.1c Spillage testing	If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate. If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate.	Detect excessive spillage of combustion gases.

2.0203.2	Combustion Flue Gas—Orphaned Water Heaters	
Topic	Combustion Safety	
Subtopic	Vented Gas Appliances	
Desired Outcome	Flue gases successfully removed from the house	
Single-Family Homes		
Title	Specification(s)	Objective(s)
2.0203.2a Spillage testing	If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate	Detect excessive spillage of combustion gases
2.0203.2b Flue gas removal (chimney liner or approved methods)	A chimney liner will be installed in accordance with the 2012 IRC or applicable NFPA standard	Allow water heater to vent properly Prevent damage to the chimney
2.0203.2c Retesting spillage	If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate	Ensure appliance is not spilling longer than two minutes with a warm vent
2.0203.2d Required combustion air	The minimum required volume will be 50 cubic feet per 1,000 Btu/h in accordance with 2012 IRC G2407.5.1 and authority having jurisdiction	Determine if existing conditions meet the combustion air calculation
2.0203.2e Additional combustion air (if action is required)	Additional combustion air will be provided in accordance with 2012 IRC G2407 or other authority having jurisdiction	Ensure adequate combustion air for operation of the appliance

2.0203.7	Combustion Air—Boilers	
Topic	Combustion Safety	
Subtopic	Vented Gas Appliances	
Desired Outcome	Amount and quality of combustion air allows for safe and efficient operation of equipment	
Multifamily Homes		
Title	Specification(s)	Objective(s)
2.0203.7a Combustion air	Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction and manufacturer requirements. In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply (i.e., more air rather than less) In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31	Meet burner combustion air requirements
2.0203.7b Education	Property manager/occupant will be educated on proper operation of combustion air systems	Ensure occupant safety Ensure optimal operation of equipment

2.0203.8	Occupant Education	
Topic	Combustion Safety	
Subtopic	Occupant Education	
Desired Outcome	Ensure persistence of resident safety	
Single-Family Homes, Manufactured Housing		
Title	Specification(s)	Objective(s)
2.0203.8a Occupant health and safety	<p>All homes will have a functioning CO alarm</p> <p>If CO levels in interior living spaces exceed outdoor levels, potential sources will be investigated and appropriate action taken to reduce them (e.g., have a qualified professional tune, repair, or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)</p>	<p>Ensure occupant health and safety</p> <p>Ensure indoor CO levels do not exceed outdoor CO levels</p>
2.0203.8b Occupant education	<p>Occupants will be educated on the operation and maintenance of the CO alarm</p> <p>Completed work on combustion appliances and recommended maintenance will be reviewed with occupant</p> <p>Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA provides possible expanded actions and offers client education information in an appendix to the protocols</p>	<p>Ensure occupant can operate and maintain installations</p> <p>Inform occupant regarding possible CO hazards</p>

2.0204.1	Isolating Combustion Water Heater Closet	
Topic	Combustion Safety	
Subtopic	Isolation	
Desired Outcome	Isolate combustion water heater closet from conditioned space	
Manufactured Housing		
Title	Specification(s)	Objective(s)
2.0204.1a Work assessment	Installer prework assessment will be conducted to determine: Combustion safety Proper venting Structural integrity Roof leaks Insect infestation Accessibility Number, type, size, and location of penetrations	Ensure combustion appliance is functioning safely Ensure work space is safe and ready for air sealing Verify scope of work
2.0204.1b Air seal closet	When the water heater closet contains a heater that is not sealed combustion or power vented, the closet will be isolated/separated from the rest of the home through air sealing with fire-rated materials, if feasible Avoiding frozen pipes must be considered without creating an additional utility burden (e.g., heat tape)	Prevent combustion gases from entering living area and minimize extension of interior pressures caused by exhaust fan, dryers, and interior door closure into the water heater closet
2.0204.1c Materials	Only noncombustible materials will be used in contact with chimneys, vents, and flues	Prevent a fire hazard
2.0204.1d Post-work testing/verification	Blower door assisted zonal pressure diagnostics will be used to verify isolation has been achieved	Prevent combustion gases from entering living area

2.0204.2 Isolating Combustion Appliance Rooms (e.g., Boiler Room, Furnace Room, and Generator Room)		
Topic	Combustion Safety	
Subtopic	Isolation	
Desired Outcome	Effective air barrier between the combustion appliance room and all other spaces of the building	
Multifamily Homes		
Title	Specification(s)	Objective(s)
2.0204.2a Pre-inspection	<p>Hazardous materials stored in mechanical rooms with air handlers or combustion appliances (e.g., boilers, furnaces) will be identified and removed; operators will be educated on the dangers of storing hazardous materials in these areas</p> <p>Repairs necessary to stabilize work areas and protect or preserve integrity of energy improvement will be completed before subject work begins</p> <p>Mechanical room doors in a fire-rated wall will be closed; problems that cause doors to be blocked open will be determined and resolved</p>	<p>Eliminate existing storage hazards and prevent future dangerous storage occurrences</p> <p>Repair or address moisture, pest, and structure-related issues</p> <p>Provide a safe and stable work environment</p>
2.0204.2b Identification of penetrations	Penetrations will be identified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 (2009)]	Locate air leakage pathways to repair
2.0204.2c Preparation	<p>Health and safety concerns will be addressed for occupants, workers, and repair materials in accordance with OSHA standards (OSHA 1926, 1910)</p> <p>The area will be prepared and isolated in accordance with health and safety standards for the application and materials (e.g., extreme temperatures, lead, asbestos, carbon monoxide)</p> <p>Work lighting, work platform, and adequate ventilation will be provided</p>	<p>Provide a safe work environment</p> <p>Provide a safe indoor environmental quality (IEQ) work environment</p> <p>Provide effective repair access</p>
2.0204.2d Sealant and materials selection	<p>Sealants and materials will be compatible with their intended surfaces and applied in accordance with manufacturer specifications</p> <p>Selection will be durable, pest resistant, and have a weather-appropriate seal</p> <p>Indoor sealants will be low VOC products that meet independent testing and verification protocols, such as Green Seal GS-36, "GREENGUARD Children and Schools," or comparable certifications</p> <p>Fire-rated assemblies will be sealed by qualified workers, using materials and sealants permitted by the authority having jurisdiction, and in accordance with adopted building codes</p>	<p>Ensure sealants and materials meet or exceed the performance characteristics required of the assembly (e.g., fire rating)</p> <p>Prevent intrusion of moisture and pests into the sealed assembly</p> <p>Prevent exposing workers or occupants to excessive VOC levels</p> <p>Provide a durable and effective isolation of the identified compartmentalized space</p>

Mechanical and boiler room enclosures may need to be fire-rated assemblies. Materials will be rated for application in approved details; for example, the annular space around a pipe penetration through a fire-rated wall can usually be sealed using mineral wool fire safing sealed with a coating of flexible fire dam material Sealants and materials will be continuous and meet fire resistance rated assembly specifications

2.0204.2e
Verification

Repairs will be verified using visual inspections, infrared thermography, smoke, and/or pressure tests [ASTM E1186-03 (2009)]

Ensure quality and effectiveness of air sealing

2.0205.1	Gas and Oil-Fired Equipment	
Topic	Combustion Safety	
Subtopic	Gas and Oil-Fired Equipment	
Desired Outcome	Combustion products are properly vented to the outdoors	
Multifamily Homes		
Title	Specification(s)	Objective(s)
2.0205.1a Combustion air	<p>Combustion air shall be calculated and provided in conformance with the applicable code adopted by the jurisdiction, and manufacturer installation requirements</p> <p>In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply</p> <p>In absence of a local code, combustion air shall be calculated and provided in conformance with any of the following: NFPA 54, IFGC, or NFPA 31</p>	<p>Do not damage building</p> <p>Protect workers and occupants from injury</p>
2.0205.1b Installation	<p>Venting systems will be installed considering proper material, pitch, common venting, chimney liner, clearance, total equivalent length, and termination in accordance with the applicable code adopted by the jurisdiction and manufacturer installation requirements</p> <p>In instances where conflicts occur between the code and the manufacturer's installation instructions, the more restrictive provisions shall apply</p> <p>In absence of local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31</p>	<p>Exhaust combustion products to the outdoors</p> <p>Protect building from damage</p> <p>Protect workers and occupants from injury</p>
2.0205.1c Orphaned equipment	<p>Existing vent system or chimney will be resized or relined in accordance with the applicable code adopted by the jurisdiction when one or more common vented appliances are removed</p> <p>In absence of local code, combustion byproducts shall be removed in accordance with any of the following: NFPA 54, IFGC, or NFPA 31</p>	<p>Exhaust combustion products to the outdoors</p> <p>Protect building from damage</p> <p>Protect workers and occupants from injury</p>

5.3003.14 Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)

Topic	Forced Air
Subtopic	System Assessment and Maintenance
Desired Outcome	Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

Single-Family Homes, Manufactured Housing

Title	Specification(s)	Objective(s)
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		Ensure equipment:
		Operates as designed
5.3003.14a Place appliance in operation	Heating equipment will be placed in operation in accordance with applicable NFPA standards and manufacturer specifications when available	Operates safely
		Operates efficiently
		Is durable

		Ensure equipment:
		Operates as designed
5.3003.14b Gas pressure	Measurement will be verified by a certified professional in accordance with fuel type and manufacturer specifications	Operates safely
		Operates efficiently
		Is durable

		Ensure equipment:
		Operates as designed
5.3003.14c Carbon dioxide (CO ₂) and oxygen (O ₂)	Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)	Operates safely
		Operates efficiently
		Is durable

		Ensure equipment:
		Operates as designed
5.3003.14d Excess combustion air	Excess combustion air will be calculated and verified in accordance with industry manuals (e.g., Testo, Bacharach)	Operates safely
		Operates efficiently
		Is durable

		Ensure equipment:
		Operates as designed
5.3003.14e Carbon monoxide (CO) in flue gas	CO in the undiluted flue gas will be less than 400 ppm air-free	Operates safely
		Operates efficiently

Is durable

Ensure equipment:

Operates as designed

5.3003.14f
Testing/inspection
holes

All testing and inspection holes will be sealed with
manufacturer approved materials

Operates safely

Operates efficiently

Is durable

5.3003.15 Combustion Analysis of Oil-Fired Appliances

Topic	Forced Air
Subtopic	System Assessment and Maintenance
Desired Outcome	Analysis of critical components and operations completed to industry and manufacturer specifications

Manufactured Housing

Title	Specification(s)	Objective(s)
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	Smoke test will be conducted before any combustion testing is completed	Ensure equipment:
5.3003.15a Oil system: smoke test	Smoke spot reading will be in accordance with burner manufacturer specifications	Operates as designed Operates safely Operates efficiently Is durable
		Ensure equipment:
5.3003.15b Oil system: nozzle	Nozzle size, angle, and spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer	Operates as designed Operates safely Operates efficiently Is durable
		Ensure equipment:
5.3003.15c Oil filter	Filter will be present, clean, and leak free	Operates as designed Operates safely Operates efficiently Is durable
		Ensure equipment:
5.3003.15d Fuel pressure	Measurement will be verified in accordance with manufacturer specifications	Operates as designed Operates safely Operates efficiently Is durable
		Ensure equipment:
5.3003.15e Oil system: steady state efficiency	Measurement will be verified in accordance with manufacturer specifications	Operates as designed

(SSE)		Operates safely Operates efficiently Is durable
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Ensure equipment:

5.3003.15f Net stack temperature	Net stack temperature will be measured and verified in accordance with manufacturer specifications	Operates as designed Operates safely Operates efficiently Is durable
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Ensure equipment:

5.3003.15g Carbon dioxide (CO2) and oxygen (O2)	Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)	Operates as designed Operates safely Operates efficiently Is durable
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Ensure equipment:

5.3003.15h Excess combustion air	Excess combustion air will be calculated and shown to be in accordance with industry manuals (e.g., Testo, Bacharach)	Operates as designed Operates safely Operates efficiently Is durable
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Ensure equipment:

5.3003.15i CO in flue gas	CO in the undiluted flue gas will be less than 400 ppm air-free	Operates as designed Operates safely Operates efficiently Is durable
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Ensure equipment:

5.3003.15j Testing/inspection holes	All testing and inspection holes will be sealed with approved materials	Operates as designed Operates safely Operates efficiently Is durable
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