

Whole House Combustion Appliance
Safety Test Procedure
for Pacific Gas and Electric Company
(PG&E) Whole House Rebate Program
August 27, 2012

Please be advised that this procedure is subject to revision
or modification by PG&E at any time.

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1. Combustion Appliance Safety (CAS) Test

This test procedure is intended for use in the Pacific Gas and Electric Company (PG&E) Whole House Rebate Program, a part of Energy Upgrade California.

These policies and procedures apply the most stringent testing components of the nationally recognized Building Performance Institute (BPI) Combustion Appliance Safety Testing Procedure as stated within the current *BPI Technical Standard for Building Analyst Professional* (version v1/4/12), Building Analyst Clarification of Combustion Zone Testing (July 2011) and the Statewide Low Income Program Natural Gas Appliance Testing (NGAT) PG&E *Low Income Program Weatherization Installation Standards*, (April 1, 2006). These procedures are to be applied by Program participants (collectively consisting of participating raters and participating contractors and any consultants or subcontractors that they employ to perform testing) both before and after the installation of infiltration measures. These procedures are also to be applied by PG&E Central Inspection Program (CIP) personnel, Third Party Verifiers, and Program participants (collectively “inspectors or Program participants”) when combustion appliance safety testing must be performed. If more stringent BPI or NGAT testing protocols are released, this procedure will be updated to accordingly. This testing procedure does not cover propane appliances. CAS testing should only be performed if it is safe to do so, and only with the proper equipment per worker safety guidelines.

These test procedures recognize that during the initial assessment, or test-in, the Program participant may be unable to make immediate repairs to correct conditions found in a home. The Program participant is expected to follow the Action Guidelines and if an issue persists, include any repairs in the scope of work for the upgrade. All appliance fails must be corrected prior to finishing the job and submitting for rebate approval.

1.1. Action Guidelines

In instances where an appliance fails the Combustion Appliance Safety (CAS), the Program participant should refer to the Whole House Action Guidelines for next steps. Document results on the Action Guidelines and Test Measurement forms.

1.2. Participating Contractor Repairs

Participating Contractor may attempt to repair, or contract a qualified technician to repair, any conditions that caused a Combustion Appliance Safety (CAS) test to fail provided they are properly licensed to do so (refer to the Whole House Action Guidelines). If the participating Contractor is unable to repair any conditions that caused a CAS test to fail, the Program participant (Contractor or Rater; whoever performed the CAS testing) must call a PG&E Gas Service Representative (GSR), as required by the Whole House Action Guidelines.

If a GSR call is required, contact the GSR immediately (before leaving the customer's home). To contact the GSR and schedule a visit, the Program participant must call PG&E Central Inspection Program (CIP) Dispatch at 1-800-813-1975 during normal business hours or the PG&E Customer Service Line at 1-800-743-5000 after 5:30 PM or on weekends. The Program participant must also notify the customer of the need for a GSR visit.

In instances where an appliance fails during the initial assessment, or test-in, the Program participant is required to call a PG&E Gas Service Representative (GSR), as required by the Whole House Action Guidelines. If a condition persists the participating Contractor must include repairs in the scope of work of the upgrade in order to qualify for the Whole House Program.

If an appliance fail occurs during the course of work or the final assessment and a GSR call is not required, the participating Contractor (if properly licensed) will make the appropriate repairs or contract a properly licensed technician to repair the hazards.

1.3. Non-Feasible CAS Test

A CAS test will not be performed when the appliance(s) do not meet the criteria listed in **2.1 Gas Appliance(s) Within the Living Space** or infiltration measures (air sealing measures) are not installed or scheduled to be installed.

1.4. CAS Test Components

The appliance or dwelling fails the CAS test if it does not pass the tests/inspections below:

1.4.1. Gas Leak and/or Soldered Flex Connector

The CAS test will fail when an inspector or Program participant detects a natural gas leak by sensory smell or electronic leak detector and it is verified by a soap test during the dwelling inspection (inside or outside). The CAS test fails if an inspector or Program participant finds a soldered flex connector or a flex connector clearly labeled prior to 1973 on any gas appliance.

1.4.2. Drafting

When an inspector or Program participant determines that drafting of the by-products of combustion is improper (using a smoke test and mechanical draft pressure test), the appliance will fail the CAS test.

1.4.3. Carbon Monoxide (CO)

Per BPI, a personal CO monitor is required during inspections. Both Appliance Ambient and Flue Gas readings must be taken on all natural gas combustion appliances per the attached Addendum #1 (“NGAT Ambient and Flue CO Levels for GSR Calls”). A Room Ambient CO reading must be taken in the center of each dwelling unit, six (6) feet above the floor level. When CO levels are found to be equal to or greater than those found in the attached Addendum # 1, the appliance fails the CAS test.

1.4.4. Flue and/or Venting System Defects

Disconnection, holes, missing sections, gaps, double diverters, inappropriate materials or installation, or other defects in the flue or venting system will cause the appliance to fail the CAS test. When it is determined that improper terminations cause an appliance to fail the CAS test, Program participants must adhere to all California Mechanical Code requirements for vent terminations.

1.4.5. Inadequate Combustion/Ventilation Air (CVA)

The inspector or Program participant will verify that there is adequate combustion/ventilation air for all tested open burner or induced draft furnaces, room heaters, wall furnaces and water heaters located in a confined space (see Appendix #2 for a definition of confined space). Inadequate combustion/ventilation air will cause the appliance(s) to fail the CAS test. Inspectors and Program participants will refer to the California Mechanical Code and the attached Addendum #2 (“Combustion Ventilation Air Supplement”) for standards that define adequate combustion/ventilation air. Appliances other than natural draft design and Category I vented appliances must be excluded from the CVA calculation (e.g. listed direct vent appliances, enclosed furnaces, cooking appliances, gas refrigerators, and domestic clothes dryers).

1.4.6. Communication

The inspector or Program participant will conduct a visual inspection of the return duct system of a forced air system to determine if depressurization may cause by-products of combustion to be distributed throughout the living space of the house. Gaps discovered during visual inspection or missing sections of the return duct system will cause the appliance to fail the CAS test.

1.4.7. Unvented Combustion Space Heater in the Living Space

By observation and customer interviews, the inspector or Program participant will determine if an unvented gas appliance is used to heat the living space. When an unvented appliance including a

range, cook top, incinerator/heater as part of a range, or oven is used to heat the living space the dwelling will fail the CAS test.

1.4.8. Appliance Operating Characteristics

The inspector or Program participant will verify that the flame roll-out shield and doors to the appliance are in place, and that burner ignition is not delayed (indicated by an explosion, bang or boom at start up). Missing components, roll-out, delayed ignition, or other operating defects will cause the CAS test to fail.

1.4.9. Gas Clothes Dryer Located in the Living Space Not Exhausted to Outdoors

The inspector or Program participant will verify that a gas clothes dryer terminates outside of the building regardless of its location.

1.4.10. Whole House Fan(s) Located in a Ceiling with Open Combustion Gas Water Heater or Furnace with Standing Pilot Located within the Attic

If the inspector or Program participant finds that an open combustion furnace or water heater exists in an attic where a whole house fan is installed in the ceiling, the home will fail the CAS test. The inspector or Program participant *must not* operate an existing whole house fan to simulate a worst case depressurization condition.

1.4.11. Open Combustion Water Heater Located in a Sleeping Area

If the inspector or Program participant finds an open combustion water heater located within a sleeping area, the home fails the CAS test.

2. Appliances

All gas appliances meeting the criteria specified in **2.1 Gas Appliance(s) Within the Living Space**, will be subject to a CAS test performed in accordance with the procedures outlined within this document.

2.1 Gas Appliance(s) Within The Living Space

Combustion appliances in locations 1 through 4 below affecting the living space consist of (a) all combustion space heating appliances, and (b) other combustion appliances:

1. Partially or entirely within the living space (including closets located within the envelope but accessed from outdoors).
2. Attached garage, attic, basement or raised floor crawl space.

3. An outdoor location when any part of an open combustion appliance including its vent system or the vent termination of a sealed combustion appliance is within four (4) feet of an operable door or window leading to the living space.
4. A location where combustion products from the appliance could infiltrate a forced air duct system (e.g., in a garage or room containing supply or return plenum/ductwork).

Appliances in all other locations are considered to be appliances NOT affecting the living space. These appliances must be checked for gas leaks, combustion ventilation air requirements, potential fire hazards due to charring of framing members, burner intakes clogged with dust and/or lint and other hazards.

2.1.1 Primary Gas Appliances

Primary gas appliances include the main source of heating, water heating and cooking. If present, primary gas appliances must be operational. Primary gas appliances *will not* be abandoned or disconnected to allow installation of infiltration reducing weatherization or energy efficiency measures.

2.1.2 Non-Primary Gas Appliances

Non-primary gas appliances may be abandoned at the customer's request. Clothes dryers and/or secondary or back-up gas appliances may be abandoned (e.g. a second gas range is no longer used). The customer must be advised to call a GSR or qualified technician to disconnect the appliance.

A disconnected gas-fired appliance does not require a CAS test; however, appliances found disconnected without the gas line, line valve or gas valve sealed with an approved cap or plug will fail the CAS test. The inspector or Program participant will note the status of the appliance.

3. General Procedures

1. Look for signs of soot on combustion appliance vent caps terminating at the roof, or exterior walls of the house.
2. Note weather conditions (e.g. clear, mild winds, rain, strong wind, etc.)
3. Ask the customer how many gas appliances they have, where they are located, and if they are all operational. If appliances with standing pilots are present and pilots are not lit, continue the CAS test on all operable appliances and identify any additional problems. A Program participant or third party inspector who is properly licensed may choose to light the pilot(s) or schedule a GSR visit. If a PG&E inspector is conducting the CAS test and if the dwelling is served by PG&E-supplied natural gas, the PG&E inspector will light the pilot(s) and

perform the CAS test. If the customer is not served by PG&E-supplied natural gas, the customer must be advised that the pilot must be lit by a qualified technician before the test can be completed. (Note: If the range top pilots are not lit, the test will still be performed by match-lighting the burners. Assuming the burner CO reads are within standards, the range will pass. The pilots do not have to be operational. Match-lit ovens will also be tested by lighting with a match).

4. Ask the customer where the thermostat for the heating system(s) is located.

3.1 Initial Walk Through

The inspector or Program participant will perform a walk through inspection of the dwelling and preliminary inspection of the appliances and if issues are identified, consult the Whole House Action Guidelines for next steps.

3.1.1 Water Heater

1. Make sure the unit is operational and the pilot is on.
2. Using a pencil (or other available marking device), mark on the control knob the temperature setting as found. Turn the temperature knob all the way down.
3. Perform combustion/ventilation air calculations. Inadequate combustion air will cause the CAS test to fail. Inspectors and Program participants will refer to the California Mechanical Code and the attached Addendum #2 ("Combustion Ventilation Air").
4. Does the water heater share a common vent with another appliance? If it does, the two appliances must be operating simultaneously when mechanical draft pressure and smoke tests are performed under worst case Combustion Appliance Zone (CAZ) depressurization.
5. Is there soot at the flue termination, draft hood, vent pipe or burner access door?
 - **A "yes" answer to questions 6-14 below will cause the CAS test to fail. Continue the walk through and visual appliance inspection in order to report all problems to the customer.**
6. Is the water heater located within a sleeping area?
7. Is an open combustion water heater with a standing pilot located in an attic with a whole house fan?
8. Is there a soldered flex connector present or is the flex connector clearly labeled prior to 1973?
9. Are both access doors to the appliance missing? At least one must be present.
10. Are components missing (e.g. draft diverter, vent, or other components)?

11. Using soap test solution or an electronic leak detector, is there a gas leak near any of the fittings, or an odor in general at the unit? Leaks identified by an electronic leak detector must be verified with a soap test.
12. Is the vent pipe damaged? Is the draft hood out of alignment with the water heater flue or is spillage occurring? Are the sections of pipe adequately fastened?
13. Are there rust and/or weak spots due to corrosion?
14. Are there double draft diverters?

3.1.2 Gas Heaters

1. Make sure the unit is operational and the pilot is on.
2. Note the thermostat setting as found.
3. Turn the thermostat all the way down or to the off position.
4. Perform combustion/ventilation air calculations. Inadequate air openings will cause the CAS test to fail. Inspectors and Program participants will refer to the California Mechanical Code and the attached Addendum #2 ("Combustion Ventilation Air").
5. Inspect the heat exchanger for cracks.
6. Does the furnace share a common vent with another appliance? If it does, the two appliances must be operating simultaneously when mechanical draft pressure and smoke tests are performed under worst case CAZ depressurization.
7. Is there soot at the flue termination opening, draft hood or vent pipe?
 - **A "yes" answer to questions 8-13 below will cause the CAS test to fail. Continue the walk through and visual appliance inspection in order to report all problems to the customer.**
8. Is there a soldered flex connector present or is the flex connector clearly labeled prior to 1973?
9. Is an open combustion gas heater with a standing pilot located in an attic with a whole house fan?
10. Is the flame roll out shield or access door(s) to the appliance missing?
11. Are there components missing (e.g. access doors, draft diverter, vent, or other components)?
12. Using a soap test solution or an electronic gas detector, is there a gas leak near any of the fittings, or an odor in general at the unit? Leaks identified by an electronic leak detector must be verified with a soap test.
13. Is the vent pipe damaged? Are there rust and/or weak spots due to corrosion? Are the connections adequately fastened?

3.1.3 Central Forced Air

In addition to 3.1.2 Gas Heaters questions 1-13 above, a “yes” answer to question 1 below will cause the CAS test to fail.

Continue the walk through and visual appliance inspection in order to report all problems to the customer.

1. Are the return air ducts damaged?

Look for communication. Check for openings that allow the return system of the furnace to draw by-products of combustion into the return duct systems and distribute them throughout the living space. (e.g. Furnace cabinet is misaligned with return plenum, blower compartment door is severely damaged and cannot be reinstalled or is not present, platform return has large holes and/or missing sections of sheetrock.) Make sure the return duct is sealed to the forced air unit. Make sure the filter compartment door is in place prior to operating the unit.

3.1.4 Gas Cook Tops, Ovens and Broilers

1. Make sure the unit is operational and the pilot(s) is lit. (Note: if the range top pilots are not lit, the test can still be performed by match-lighting the burners. Individual burners that are found non-operational and cannot be lit with a match must not be tested and must be noted. Cook stoves are never reported to CIP Dispatch or the PG&E Customer Service Line unless none of the burners operate *and* the customer has no means of cooking food (e.g. electric hot plate, microwave not present).
2. Is there an exhaust fan to outdoors? If so, it must be operated during the CO testing.
3. Is there burned food (carbon deposits) inside the oven? If so, operate the oven for up to 15 minutes and note where reading stabilizes. Consult Addendum #1 to determine action.
 - **A “yes” answer to questions 4-5 below will cause the CAS test to fail. Continue the walk through and visual appliance inspection in order to report all problems to the customer.**
4. Using a soap test solution, is there a gas leak near any of the fittings, or a strong odor in general at the unit? Leaks identified by an electronic leak detector must be verified with a soap test.
5. Is there a soldered flex connector present or is the flex connector clearly labeled prior to 1973?

3.1.5 Gas Clothes Dryer

1. Make sure the unit is operational and if it is standard ignition, that the pilot is on.
 - **A “yes” answer to questions 2-6 below will cause the CAS test to fail. Continue the walk through and visual appliance inspection in order to report all problems to the customer.**

2. Using soap test solution or an electronic leak detector, is there a gas leak near any of the fittings, or an odor in general at the unit? Leaks identified by an electronic leak detector must be verified with a soap test.
3. Is dryer not being properly exhausted outside the building regardless of its location?
4. Does the dryer exhaust into another gas appliance's vent system?
5. Does the dwelling have a floor furnace *and* is the dryer exhausted under the house?
6. Is there a soldered flex connector present or is the flex connector clearly labeled prior to 1973?

4. Room Ambient CO Reading and Outside Temperature Measurement

Alert the customer that testing is in progress and will require their cooperation. Close all doors and windows to the exterior, and open all interior doors. Advise the customer not to open or close any doors or windows, or operate any gas appliances, exhaust fans, run hot water, or other interfering activity. The following procedure will produce the Room Ambient CO reading and temperature measurement for the mechanical draft pressure test of natural draft and induced draft combustion appliances.

1. Place thermometer outside, in the shade, and record ambient temperature.
2. Turn on and zero the CO meter outside, away from car exhaust, smokers, fireplace or woodstove exhaust, or any other potential source of CO.
3. Turn off all gas appliances at the thermostat so as to allow only pilot burner operation.
4. Ask the customer if they have used an unvented appliance within the last ½ hour. If they have and the initial test fails, ventilate the dwelling for 15 minutes, then retest.
5. Close all egress doors and windows.
6. Close all doors and windows to gas appliance rooms.
7. Go to a central location within the house, at least ten (10) feet away from any combustion appliance. With all gas appliances in the home turned off at the thermostat, measure the Room Ambient CO at six (6) feet above the floor. If the Room Ambient CO level is 10 parts per million (ppm) or higher, follow the procedure outlined in # 4 above. If this reading is still 10 ppm or more, the dwelling fails the CAS test.
8. The Room Ambient CO must be used to determine whether the CO Appliance Ambient readings for space heaters cause the CAS Test to Fail in Step 6.2 below.

5. Combustion Appliance Zone (CAZ) Test

Combustion Appliance Zone (CAZ) depressurization testing must be performed on all natural gas combustion appliances to determine the worst case

depressurization. See Addendum #3 (“CAZ (Combustion Appliance Zone) Worst Case Depressurization”) to determine whether the zone exceeds the Program limit. Identify and establish worst case CAZ condition prior to individual appliance-on testing.

6. Individual Appliance-On Testing

CO reading(s) in excess of standards per attached Addendum #1 (“NGAT Ambient and Flue CO Action Levels for GSR Calls”), or gas leaks identified by a gas odor, soap test or electronic leak detector will cause the CAS test to fail. Leaks identified by an electronic leak detector must be verified with a soap test. Per Section 1.1, a GSR or a properly licensed qualified technician must be called immediately (before leaving the customer’s home) to schedule a visit. If the appliance fails and cannot be put into a safe operating condition, the appliance must be capped by a GSR, or capped or replaced by a properly licensed participating Contractor or properly licensed qualified technician contracted by the participating Contractor.

Always test the appliance with the smallest BTU_h input rate first after establishing the worst case depressurization per Part 5, Combustion Appliance Zone Test. When the smallest input appliance is a water heater that shares a common vent, test the water heater by itself under worst case condition first. Second, test the other appliance which is commonly vented with the water heater by itself under worst case condition. Third, perform mechanical draft and spillage tests with both appliances operating simultaneously under worst case condition.

6.1. Water Heater

1. Drill a hole 12” to 24” from the top of the draft hood in a straight section of the vent pipe. Do not drill into asbestos, elbows, double wall, loose, or improperly secured vent pipe. Determine the worst case depressurization by using the attached Addendum #3 (“CAZ (Combustion Appliance Zone) Worst Case Depressurization”) to determine whether the zone exceeds the Program limit.
2. Turn the water heater thermostat to high, running water if necessary to cause continuous main burner operation, and note the time.
3. Verify that burner ignition is not delayed and check for flames more than 50% yellow. Roll-out, delayed (explosion, bang or boom at start up) ignition, or other operating defects will cause the CAS test to fail.
4. Test for CO at the flue at steady-state. If steady-state is not achieved within 10 minutes, take CO readings at the 10 minute mark. Place the CO meter probe inside the draft hood into the flue of the appliance. The CO sampling must be taken before dilution air in the flue. Record the CO Appliance Ambient level, Air Free Flue Gas CO level, and draft reading under the worst case CAZ depressurization. CO Appliance Ambient and Flue measurements in excess of attached Addendum # 1 (“NGAT Ambient and Flue CO Action Levels for GSR Calls”) will cause the CAS test to fail.

5. Perform the mechanical draft pressure test five (5) to fifteen (15) minutes after the burner “on” time. Insert the static pressure probe into the center of the vent and observe the reading in Pascals on the digital manometer. Compare draft pressure test result to attached Addendum #4 (“BPI Minimum Draft Table”). If the draft pressure reading is not equal to or more negative than the minimum draft pressure, the water heater fails the CAS test. Record the reading in Pascals. Seal the hole with a metal vent plug button. When B-Vent drilling is allowed by local code, use high temperature caulk and a stainless steel log bolt on all B-Vent holes drilled for the draft test.
6. Perform smoke and tactile test to check for excessive spillage. A mirror may be also be used to verify spillage. If excessive spillage of smoke is indicated, the water heater fails the CAS test. Be cautious of wind induced changes in smoke direction as applicable.
7. Return the thermostat to the customer’s original temperature setting as found.
8. If CO flue gas testing is not safe and accessible, then the CO test will be limited to checking for CO in the ambient air above the unit. This is the CO Appliance Ambient reading. A CO Appliance Ambient reading of 10 ppm or more will cause the appliance to fail the CAS test. See attached Addendum # 1 (“NGAT Ambient and Flue CO Action Levels for GSR Calls”).

6.1.1 Sealed Combustion Water Heaters

It is not possible to perform mechanical draft pressure and smoke tests on these types of water heaters because they do not have natural draft (e.g. draft diverters, vent pipes). The CO test point is typically located at the rain cap on the roof or side wall of the structure. CO testing at these terminations should only be performed if it is safe to do so and only with proper ladders and other safety gear.

6.2. Heating Appliances

1. Drill a hole 12” to 24” from the top of the draft hood in a straight section of the vent pipe. Do not drill into asbestos, elbows, double wall, loose, or improperly secured vent pipe. Determine the worst case depressurization by using the attached Addendum #3 (“CAZ (Combustion Appliance Zone) Worst Case Depressurization”) to determine whether the zone exceeds the Program limit.
2. Turn the heater thermostat to high and note the time.
3. Verify that burner ignition is not delayed and check for flames more than 50% yellow. Flame interference, roll-out, delayed ignition, or other operating defects will cause the CAS test to fail.

4. Test for CO at the flue at steady-state. If steady-state is not achieved within 10 minutes, take CO readings at the 10 minute mark. Place the CO meter probe inside the draft hood into the exhaust ports of the appliance for natural draft heaters, and into the flue for sealed combustion and induced draft heaters. The CO sampling must be taken before dilution air in the flue. Place the meter probe inside the first supply register closest to the heater for the CO Appliance Ambient Reading. Record the CO Appliance Ambient level, air free Flue Gas CO level, and draft reading under the worst case CAZ depressurization. CO Appliance Ambient and Flue measurements in excess of attached Addendum #1 (“NGAT Ambient and Flue CO Action Levels for GSR Calls”) will cause the CAS test to fail.
5. Perform the mechanical draft pressure test five (5) to fifteen (15) minutes after the burner “on” time. Insert the static pressure probe into the center of the vent and observe the reading in Pascals on the digital manometer. Compare draft pressure test result to attached Addendum #4 (“BPI Minimum Draft Table”). If the draft pressure reading is not equal to or more negative than the minimum draft pressure the water heater fails the CAS test. Record the reading in Pascals. Seal the hole with a metal vent plug button. When B-Vent drilling is allowed by local code, use high temperature caulk and a stainless steel log bolt on all B-Vent holes drilled for the draft test.
6. Perform smoke and tactile test to check for excessive spillage. If excessive spillage of smoke is indicated, the water heater fails the CAS test. Be cautious of wind induced changes in smoke direction as applicable.
7. Return the thermostat to the customer’s original temperature setting as found.

6.2.1 Sealed Combustion Heaters

It is not possible to perform mechanical draft pressure and smoke tests on these types of heaters because they do not have natural draft (e.g. draft diverters, vent pipes). The CO test point is typically located at the rain cap on the roof or wall. If CO Flue Gas testing is not feasible, the CO test will be limited to checking for CO in the ambient air above the unit. This is the CO Appliance Ambient reading. For central forced air sealed combustion heaters, the CO Appliance Ambient reading must be taken inside the first supply register closest to the furnace. CO Appliance Ambient read of 2 ppm or greater than the CO Room Ambient reading will cause the appliance to fail the CAS test. See attached Addendum # 1 (“NGAT Ambient and Flue CO Action Levels for GSR Calls”).

6.3. Gas Dryer

Gas Dryers must be checked for gas leaks (by sensory smell or electronic leak detector and verified by a soap test) and must exhaust to the outside of the building as stated in 3.1.5 above. Measure the CO in the dryer exhaust. Measurements of 101 ppm or greater fail.

6.4 Gas Cook Tops, Ranges, Ovens, Broilers

1. Locate the flue gas termination for all existing oven and broiler burners.
2. With exhaust fans on, turn on all the cook top burners including any griddle burner present. Measure and record Appliance Ambient CO read in the middle of the kitchen and 6 feet above the floor after 1 minute of burner operation. If this reading is 10 ppm or more, the cook tops fail the Appliance Ambient CO test.
3. Turn off all cook top and griddle burners except the one in the upper left hand corner facing the appliance (left rear burner). Measure and record CO Flue as measured readings for each cook top burner separately 12 inches above the visible part of the flame. If any burner measures 26 ppm or greater, the burner fails the CO as measured flue test.
4. Test each oven or broiler burner separately, recording an Appliance Ambient CO read and an as measured Flue CO read for each burner.
5. Run each oven or broiler burner at its highest setting for a minimum of 5 minutes before taking Appliance Ambient CO and as measured Flue CO readings.
6. Measure the Appliance Ambient CO read for each oven or broiler burner separately (after each has been operating for 5 minutes) in the middle of the kitchen and 6 feet above the floor. If the Appliance Ambient reading is 10 ppm or greater, the oven or broiler burner fails the test.
7. After each Appliance Ambient CO read is taken for an oven burner or a broiler burner, immediately take the Flue CO as measured reading for that same burner inside the flue. Each burner should be operating separately for 5 minutes. If the Flue CO as measured reading for any oven or broiler burner is 226 ppm or more, that burner fails the test. See Addendum #1("NGAT Ambient and Flue CO Action Levels for GSR Calls").
8. If one burner provides both broiling and baking, read a record the one burner as an OVEN burner.

6.5 Gas Log Fireplaces

Natural gas log fireplace heaters will be inspected and a CO test performed to determine CO levels during normal operation. The CO meter probe will be placed at least 12" above the flame. A CO reading of

26 ppm or higher will cause the CAS test to fail. Ceramic logs must be allowed to heat for at least ten (10) minutes before the test is taken. A smoke test will be performed to ensure that the appliance is operating correctly. Continuous spilling will cause the CAS test to fail. Dampers must be open during this test.

6.6 Gas Log Lighters

Gas log lighters will be inspected for gas leaks only, and do not require appliance-on CO and draft testing.

List of Addenda

Addendum #1: NGAT Ambient and Flue CO Action Levels for GSR Calls --
Energy Partners Program 11/05/2009

Addendum #2: Combustion Ventilation Air Supplement

Addendum #3: CAZ (Combustion Appliance Zone) Worst Case Depressurization

Addendum #4: BPI Minimum Draft Table

Addendum #1: NGAT Ambient and Flue CO Action Levels for GSR Calls (Energy Partners Program, 11-05-09)

Appliance/Room	Ambient CO ppm	Ambient Measurement Location	Flue CO ppm As Measured	Flue CO ppm * Air Free	Flue Measurement Location *
Room Ambient	10 ppm or greater	Center of home 6 ft above floor	-----	-----	-----
Floor Furnace	2 ppm or greater above room ambient	Above top of unit	-----	101 ppm or greater	Inside each exhaust port separately Record left to right if more than one
Forced Air Furnace (Includes Dual Pack)	2 ppm or greater above room ambient	Inside supply register nearest to furnace	-----	101 ppm or greater	Inside each exhaust port separately Record left to right if more than one No flue read required for RTFAF *
Gas Log Heater- Freestanding/Insert/ Direct Vent	2 ppm or greater above room ambient	Above unit	-----	101 ppm or greater	Inside the flue
Gravity Furnace	2 ppm or greater above room ambient	Inside supply register nearest to furnace	-----	101 ppm or greater	Inside each exhaust port separately Record left to right if more than one
Vented Room Heater	2 ppm or greater above room ambient	Above top of unit and draft diverter	-----	101 ppm or greater	Inside each exhaust port separately Record left to right if more than one
Wall furnace	2 ppm or greater above room ambient	Above top of unit and draft diverter	-----	101 ppm or greater	Inside of flue on each side of baffle Record the highest read
Wall Furnace Direct Vent	2 ppm or greater above room ambient	Above top of unit	-----	101 ppm or greater	Flue gas CO is measured at the flue termination when it is accessible from the ground
Water Heater	10 ppm or greater	Above and around top of tank and draft diverter	-----	101 ppm or greater	Inside flue on each side of baffle Record the highest read
Gas Dryer**	10 ppm or greater	Above top of unit	-----		
Range Top Burners and Griddle	10 ppm or greater	Center of kitchen	26 ppm or greater (per Burner)	-----	Burner: 12 inches above flame Griddle: Inside port opening U or W pattern left to right
Oven/Broiler	10 ppm or greater	Center of kitchen	226 ppm or greater	-----	Inside exhaust port
Gas Log Fireplace	-----	-----	26 ppm or greater	-----	Inside top edge of fireplace opening 12" above flame

* If flue is not accessible and no flue read is possible, appliance ambient determines action. Include valid reason for no flue read in Comments on NGAT Results.

** Required by BPI test procedure.

Addendum # 2: Combustion Ventilation Air (CVA)

CVA requirements only apply to open combustion furnaces and water heaters. Abandoned appliances (capped off or disconnected only) must be included in CVA or room volume calculations. Heating appliances with flex gas connector removed, the gas line shut off valve capped or valve removed and pipe capped are considered abandoned.

Confined Space - Is an area designed for the operation of combustion appliances which has a total volume **less than 50 cubic ft. per 1000 BTUs input** of all open combustion furnaces/heaters and water heaters within the space.

Procedure for Determining if an Open Combustion Appliance is Located in a Confined Space

1. Measure enclosure or room: **L (length) X W (width) X H (height)** = Existing Area in Cubic Feet.
2. Total BTU's divided by 1000 X 50 cubic = Required Cubic Feet. Here is an easier method: Divide the total BTU input by 2, and then drop the last zero. Example: 44,000 total BTU input divided by 2 = 22,000. Drop the last zero = 2,200 cu. Ft.
3. If the result of 1 is less than 2, CVA **is** required.
4. If the result of 1 is equal to or greater than 2, CVA is **not** required.

CVA Calculation Rules

Determine the required Net Free Vent (NFV) area, **per opening(s)**, by taking the total BTU input and divide by 1000. Take the results and divide by the CVA Rule you have chosen to use. Example: The total BTU input is 80,000 BTUs. You have chosen rule 4. 80,000 divided by 1000 = 80. 80 divided by rule 4 = 20 sq. in required NFV area.

Rule 1: Requires two openings. CVA from **conditioned space** requires that each opening shall have a NFV area of at least **1 sq. in. for every 1000 BTUs** input. 1 upper vent within 12" of ceiling and 1 lower vent within 12" of floor venting to unconfined space. Each opening, **minimum 100 sq. in.**

Rule 2: Requires two openings. CVA supplied by **horizontal ducts** to the outside (**unconditioned space**). 1 upper duct and 1 lower duct. Each opening requires a NFV area of at least **1 sq. in. for every 2000 BTUs** input.

Rule 3: Requires one opening. CVA to outside (**unconditioned space**). 1 upper opening (or vertical or horizontal duct) may be used to provide the combustion air. The vent/duct must provide **1 sq. in. NFV area per 3,000 BTUs** input

Rule 4: Requires two openings. CVA to the outside (**unconditioned space**). 1 upper and 1 lower vent or vertical duct opening is required. Each opening shall have a NFV area of a least **1 sq. in. for every 4000 BTUs** input.

Note: With Rule 3, appliance must have clearances of 1 inch on sides and back and 6 inches in front from appliance to wall/door.

Note: In an unconditioned garage when it is considered a confined space, 1 vent either upper and/or lower, equal to 1 sq. in. per 4,000 BTU input for all applicable appliances is OK. The CVA opening can either be already installed, or installed by the participating Contractor. Must be designed CVA.

Note: If an water heater or furnace is in an enclosure that has non-standard doors (pocket, accordion, etc.) which cannot be weatherstripped, it is OK to not weatherstrip the doors, and in addition install or increase CVA to outside if necessary.

CALCULATIONS

Area of a Circle (sq. in.)

Area of a Circle = Radius X Radius X 3.14 Radius = Half the diameter

3" diameter circle = 7.1 sq. in. 4" = 12.6 5" = 19.6 6" = 28.3 7"=38.5 8" = 50.3 9"=63.6 10" = 78.5 12" = 113

Vent Opening Multipliers

*Note: Use **only one** of the following multipliers to calculate NFV area. Use the multiplier that will reduce the overall NFV area to the lowest term.*

Mesh, ¼ in. or Larger = 90% of the actual vent opening. **METAL LOUVERS = 75%** of the actual vent opening.
MESH, LESS THAN ¼ in. = 50% of the actual vent opening. **WOODEN LOUVERS = 25%** of the actual vent opening.

Estimated BTUh Input Ratings of Unmarked Open Combustion Furnaces/Heaters and Water Heaters

Wall Furnaces

Single sided: 25,000 BTUh
Double sided: 50,000 BTUh

Floor Furnaces:

Standard (usually 22" wide): 30,000 BTUh
Large (usually larger than 1 floor-joist bay): 60,000 BTUh

Forced Air Furnace:

25,000 BTUh per burner

Free-Standing Heaters:

Small: 25,000 BTUh
Standard (24" + 12" deep): 50,000 BTUh

Water Heaters:

Standard: 1000 BTUh per gallon
Tankless / Instantaneous: 200,000 BTUh

Addendum #3: CAZ (Combustion Appliance Zone) Worst Case Depressurization

Program participants will be responsible for setting up each combustion appliance zone in a worst case condition in order to compare the pressure in Pascals to the table below.

BPI CAZ Depressurization Limits

CAZ Depressurization Limits

Venting Condition	Limit (Pascals)
Orphan natural draft water heater (including outside chimneys)	-2
Natural draft boiler or furnace commonly vented with water heater	-3
Natural draft boiler or furnace with vent damper commonly vented with water heater	-5
Individual natural draft boiler, furnace or domestic hot water heater	-5
Mechanically-assisted draft boiler or furnace commonly vented with water heater	-5
Mechanically-assisted draft boiler or furnace alone, or fan-assisted DHW alone	-15
Chimney-top draft inducer (Exhausto-type or equivalent); High static pressure flame retention head oil burner; Direct-vented appliances/Sealed combustion appliances	-50

Addendum # 4: BPI Minimum Draft Table

Acceptable Draft Test Ranges

Outside Temperature (degree F)	Minimum Draft Pressure Standard (Pa)
<10	-2.5
10-90	$(T_{out} \div 40) - 2.75$
>90	-0.5