SAN DIEGO GAS AND ELECTRIC AND SOCALGAS®
ENERGY UPGRADE CALIFORNIA® HOME UPGRADE

QUALITY CONTROL INSPECTION GUIDELINES
V7.0

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Home Upgrade
Energy Upgrade California®

Note: As a participating contractor in Home Upgrade, it is the contractor's responsibility to adhere to all federal, state and local ordinances and regulations. Applicable regulations include (but are not limited to) those issued by the following organizations and publications: Environmental Protection Agency (EPA), Federal Occupational Safety and Health Administration (OSHA), Division of Occupational Safety and Health (Cal/OSHA), California Energy Commission (CEC), California Public Utilities Commission (CPUC), Department of Energy (DOE), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Natural Gas Appliance Testing (NGAT), California Energy Efficiency Standards (Title-24) and California Residential Code (CRC).

In addition, all participating contractors must adhere to the requirements set forth by the program per the participating contractor agreement, customer application, Inspection Guidelines, Processing Guidelines, and any other program documents and notifications related to program guidelines and requirements.

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Chapter 1
Document Purpose and Application

The procedures and specifications presented in this document are intended as a guide to quality control (QC) inspectors and contractors for completing a thorough site inspection of these projects:

a. Single Family Energy Upgrade California® Home Upgrade

b. Single Family Energy Upgrade California Advanced Home Upgrade

1.

The procedures are at times interrelated—as with Combustion Appliance Zone (CAZ) set-up and Combustion Appliance Safety (CAS) testing.

2. Participating contractors are required to follow the order of inspection procedures as described in Chapter 2.

3. All 2-4-unit buildings will be inspected in accordance with the Energy Upgrade California Advanced Home Upgrade Single Family Inspection Guidelines.

4. Acronyms and definitions are in Inspection Guidelines Appendix S.

5.

Chapter 2
Order of Inspection Procedures

A. Order of Inspection Procedures - Summary

Participating Contractors are required to follow the order of inspection procedures as described below:

1) Gas leak testing – **see Section B below**
2) Inspect for presence of hazardous materials – **see Section C below**
3) Visual Safety Inspection of all appliances – **see Chapter 3**
4) Evaluate Combustion Ventilation Air (CVA) for all appliances – **see Chapter 4**
5) Set-up CAZ depressurization – **see Chapter 5**
6) Conduct Combustion Appliance Safety (CAS) testing – **see Chapter 5**
7) Conduct pressure diagnostics – **see Chapters 6 and 7**
8) Collect remaining field data – **see Chapters 8 - 12**

Where applicable, utilize Test-by-Measure (TBM) protocol – **see Appendix R**

C. Gas Leak Testing

1. All appliances that are part of the scope of work (SOW) and their associated piping, appliances located in an area that may have a direct effect on the living space and their associated piping and all confined meter sets and their associated piping must be checked for gas leaks prior to performing Combustion Appliance Safety (CAS) or diagnostic testing.

   a. Closely examine the following: gas meter sets, line valves, gas control valves, pilot lines, joints, fittings and any accessible gas lines.

   b. Testing will be conducted using an electronic leak detector at 1" per one second. If a potential leak is identified, it will be confirmed with micro leak detector solution.

2. For unconfined gas meter sets, outdoor appliances and associated piping that are not part of the SOW, and appliances having no direct effect on the living space, olfactory testing (smell test) will be used.

   a. Persons not sensitive to the odorant in natural gas must use an electronic detector.

   b. If gas odor is present or homeowner or designated representative has reported a gas odor, use an electronic leak detector.

3. c. If electronic leak detector identifies a potential leak, use a leak detection solution to confirm the leak.

4. Gas lines and connections that are part of the SOW and are within an area that may have a direct affect to the living space but are inaccessible to electronic leak detectors and micro leak detector solution will be subjected to olfactory testing. If odors consistent with gas leaks are detected by the inspector, a gas leak will be deemed to be present.

5. If a gas leak is found advise the customer to notify the gas company immediately. Do not perform any combustion appliance safety tests or diagnostic testing until the leak is repaired or isolated.

   Do not turn on a combustion appliance that has a gas leak.

If a catastrophic gas leak is present, immediately evacuate the home and call the gas company from outside.

For leaks on the customer's side of the meter, a C-4, C-20, or C-36 license is required to complete repairs.

If a gas leak is found and can be isolated:

a. Close the line valve, and retest in same place where the gas leak was found with micro leak detector solution.

b. If leak is no longer present, proceed with combustion safety and diagnostic testing.

If a gas leak cannot be isolated, mark the location of the gas leak by tying a brightly colored string around the pipe at the leak site.

After a gas leak has been repaired:

a. Conduct an additional gas leak test to verify that the leak has been repaired and that no other leaks are present.

b. If gas leaks are no longer present, proceed with combustion safety and diagnostic testing.

D. Hazardous Materials

Assess for presence of hazardous materials or any other health and safety concerns.

a. Check in the attic, crawl space, basement, interior and exterior of home.

Safety concerns to look for include, but are not limited to, the following:

a. Possible asbestos containing materials (PACM)

b. Black organic matter

c. Knob-and-tube wiring

d. Rodent feces

e. Any other hazardous materials or conditions

E. CAS/CAZ Testing

1. Perform visual inspection of all appliances.
2. Evaluate Combustion Ventilation Air (CVA) for each CAZ.
3. Set-up CAZ depressurization when feasible.
4. Conduct CAS testing when feasible.

F. Diagnostics and Data Collection

1. Conduct pressure diagnostic testing (i.e., blower door and duct testing, as applicable).
2. Collect all remaining field data as require

Chapter 3
Visual Safety Inspection

A. Safety Issues

1. When a safety issue is identified, the data must be recorded and the homeowner must be informed.
2. A Notice of Unsatisfactory Condition (NOUC) must be filled out and signed by the homeowner. A copy will be given to the homeowner, and the file will be uploaded into EECP.

B. Prohibited Appliance Installations

A Forced Air Unit (FAU) or water heater must not be located in a sleeping area, unless it is:

a. A direct vent appliance, or

1.

b. An open combustion appliance that:
   1) draws combustion air from outdoors, and
   2) is inside an enclosure with self-closing weather-stripped door.

2. An FAU may not draw CVA from the living space. That condition renders infiltration-reduction measures unfeasible.

3. The following appliances are not allowed in the residence:

a. Unvented combustion space heater within the living space.

b. Unvented fireplace (illegal in California).

c. Recalled appliances, such as NOx rod FAU. (See Appendix G, “NOx Rod Furnace Identification and

4. Inspection Procedure.”)

Appliances in the Attic

a. An open combustion appliance with a standing pilot may not be installed in an attic, when a whole house fan exhausts into the attic.

b. When such a condition is existing, attic venting Net Free Ventilation Area (NFVA) must be great enough to prevent pressure within the attic from adversely affecting performance of the

1. appliance (pilot does not blow out, and the appliance passes spillage and CO tests).

C. Red Work Zone

2.

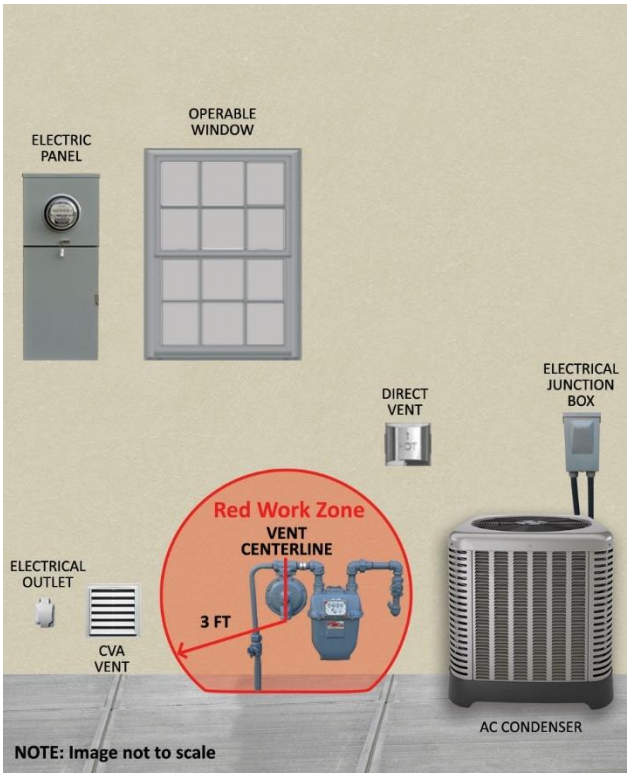
When outdoor equipment is part of the Participating Contractor’s scope of work (SOW), potential sources of ignition must not be located within the Red Work Zone (RWZ), as illustrated in the Red Work Zone Image. The RWZ is defined as the area within a three-foot radius measured from the opening of the regulator vent’s centerline, see accompanying image for clarification

Existing conditions encroaching within the RWZ will require a recommendation of correction. Conditions created encroaching within the RWZ as part of the SOW will require correction before the issuance of an incentive.

a. Applies to gas and electric appliances, central AC condensers. Does not apply to conduit and low voltage wires, in their intended modes of use or operation.

b. Clearances shown in the RWZ illustration must be maintained for all equipment installed, repaired, or modified as part of the SOW.

c. No combustion-air vents, or operable windows may be installed as part of the project's SOW within the area designated as the RWZ.



D. CVA and Appliance Installation

All unattended combustion appliances must be inspected for sufficient CVA.

Inspection for sufficient CVA is required for appliances located in an enclosed room or space, including:

a. Interior rooms/spaces in which CVA is based on room volume, and

b. Appliance enclosures vented to outdoors through vent openings or ducts.

See Chapter 4, "Combustion and Ventilation Air (CVA)" for additional information.

For new installations, it is the contractor's responsibility to verify that CVA and all other aspects of the installation—including appliance venting, appliance location and installation, and gas piping—are in conformance with manufacturer's instructions and local code.

E. Visual Inspection of Appliances

Conduct a visual inspection of the vent system, heat exchanger, burners, and safety features.

Appliances must not have defective or missing components or improper alterations.

All safety features must be functioning properly, including spill switch, roll out switch, combustion chamber switches, etc.

A proper flexible gas connector must be present. If any of the following scenarios are observed on-site, a Notice of Unsatisfactory Condition will be provided to the homeowner. The following are **not** allowed:

a. Kinks or visible signs of corrosion.

3.

b. Soldered connections ("butt soldered").

4.

c. Pre-1973 date of manufacture (the date is stamped on an attached ring).

d. Copper gas lines are not allowed.

Gas line connected to an FAU

a. Rigid pipe must extend from the gas control valve to outside of the appliance housing.

5.

b. A flexible gas connector must connect the rigid pipe outside of the housing to the gas shutoff valve.

F. Perform a complete inspection of the vent system.

Vent system must be aligned properly and connected securely.

1. Vent defects must be identified:

2.

a. Disconnections, loose connections, leaks, and obstructions.

b. Missing/defective vent cap.

c. Defective, multiple, or misaligned draft hood.

d. Excessive deterioration, rust, or holes in the draft hood.

3.

e. Single-wall vent pipe where double-wall vent pipe is required.

All vent systems must meet proper clearance requirements, with adherence to SDG&E/SoCalGas standards.

a. Proper vent pipe clearance from combustible materials, as specified by the vent pipe manufacturer (or local code, if more restrictive).

b. Typical clearances from combustibles (e.g., wood, foam pipe insulation) are:

4.

1) 1″ for double-wall vent pipe (Type B)

2) 3″ for double-wall vent pipe (Type L)

3) 6″ for single-wall vent pipe

Vent System Terminations (except direct vent appliances)

a. Vents ≤4′ from a wall or window must terminate 2′ above the highest eave.

5.

b. Vents > 4′ from a wall or window must terminate at least 1′ above the roof line.

c. Vents extending through a sidewall must turn 90 degrees and extend vertically and terminate at least 1′ above the roof line.

d. All vent systems must terminate in a proper vent cap.

Vents Terminating Near an Evaporative Cooler

a. Gas appliance vent system(s) must terminate 10′ away from, or 3′ above, the cooler inlet.

b. Space heater exemption:
   1) Vent termination clearance is *not* required under either of the following conditions:
      a) The cooler and/or discharge openings are equipped with winter cover(s), or
      b) The cooler shares the duct system with the FAU, and a functional damper is present that isolates the cooler from the duct system during the heating season.
   2) When a *space heater exemption applies*, the occupants must be advised by the contractor to do the following (as applicable) during the heating season:
      a) Keep the winter cover(s) in place, or
      b) Keep the damper completely closed, to isolate the cooler from the FAU duct system.

All vent pipe beyond the vent connector and the ceiling/wall must be double-wall.

A burner-off visual inspection (Cold Check) is performed on gas appliances to look for evidence of defects in the heat exchanger or burners (e.g., cracks, metal fatigue, soot, rust, etc.).

6.

7. A burner-on inspection (Hot Check) will be performed on open combustion appliances to look for the following:

8. a. Delayed Ignition.

b. Excessive flame roll-out.

c. Abnormal flame characteristics, including:
   1) Flame interference in an FAU caused by the air handler
   2) Flickering burner
   3) Yellow flame (more than 50% yellow, when burner is not designed to burn yellow)
   4) Smothering flame (flame recirculation)
   5) Lifting Flame
   6) Soft lazy flame

9. d. A visually-detected crack in the heat exchanger or burners.

Other evidence of defective heat exchanger or burner (flame impingement, misalignment, plugged orifices, soot, etc.).

1.

G. Carbon Monoxide (CO) Alarms

The program requires a minimum of one CO monitor per floor of living space and must comply with manufacturer's installation specifications

a. Contractors must adhere to code regulations.

Chapter 4
Combustion and Ventilation Air (CVA)

A. Introduction

This chapter explains Combustion Ventilation Air (CVA) and how to evaluate it.

Acronyms and definitions are in Appendix S.

B. CVA Basics

Combustion ventilation air (CVA) requirements apply to all combustion appliances (open or closed combustion) that draw combustion air from the CAZ.

a. CVA is most critical for natural draft appliances, which depend on dilution air for buoyancy of combustion gases as they rise through the vent pipe and exhaust into the atmosphere.

b. CVA is also needed for mechanical/induced draft open combustion appliances, and for closed combustion appliances that are *not* direct vent (combustion air intake terminates in CAZ).

Direct vent appliances draw combustion air into the firebox through a pipe/duct that terminates outdoors, and therefore do not require CVA calculations.

Both combustion and ventilation air are needed.

a. Combustion air enters the CAZ primarily through “lower” CVA vent/ducts, and it provides oxygen to support combustion.

b. Ventilation air leaves the CAZ through “upper” CVA vents/ducts, and it:
   1) Provides ventilation for the space,
   2) Allows heat and combustion gases to move up and away from the appliance, and
   3) Properly vents gases outdoors, when the vent/duct communicates with outdoors.

Upper and Lower CVA vents and ducts are located as described in Section D, Item 1. below.

CVA may be taken from:

a. Indoors, based on room volume.

b. Outdoors, based on vent or duct size.

c. Both indoors and outdoors:
   1) Applicable **only** when the CAZ is **not** conditioned space.
   2) This method allows for reduced size of vents/ducts to outdoors.
   3) Vent NFVA only needs to make up for the shortage in room volume.

CVA Calculations

a. Calculations for **indoor** CVA determine whether room volume is adequate for safe operation of combustion appliances in the CAZ. Adequate CVA supports proper combustion, and may help prevent an appliance from backdrafting when the CAZ is under negative pressure.

b. Calculations for **outdoor** CVA determine whether NFVA of vents/ducts will supply adequate oxygen to the burner(s), and will ventilate heat and combustion gases out of the CAZ.

C. Affected Appliances

CVA calculations are required for the following appliances:

a. Furnaces and Water Heaters that draw combustion air from the CAZ.

b. Gas cooking appliances, in homes built in 2008 or later.

CVA calculations are not required for the following appliances:

1. a. Direct Vent Appliances (outdoor combustion air is piped directly into the firebox)

b. Clothes Dryers

2. *Note:* When a dryer is in a small enclosed space, makeup air must be provided to the dryer by a minimum 100 sq. in. NFVA vent communicating with an adjacent space of adequate volume.

c. Abandoned appliances

D. CVA Vent and Duct Criteria

CVA Vent and Duct Locations

1. a. Upper Vents and Ducts
   1) Upper CVA vent openings (to indoor spaces and to outdoors) must be in the ceiling, or must begin within 12" of the ceiling.
   2) Upper CVA ducts to outdoors must begin within 12" of the ceiling.
   3) Pre-existing upper openings and ducts are acceptable at any height above the draft hood.

b. Lower Vents and Ducts
   1) Lower CVA vent openings (to indoor spaces and to outdoors) must be located in the floor, or must begin within 12" of the floor.
2. 2) Lower CVA ducts to outdoors must begin within 12" of the floor.

CVA Dimensions, NFVA, and Mesh

a. The smallest dimension of combustion air openings/ducts is 3" (minimum 3" x 3" rectangular vent/duct; minimum 3" diameter round duct/vent).

b. Mesh
   1) New vents to outdoors must be screened with mesh that is not less than ¼" weave.
   2) Mesh is not needed on CVA vents to *indoor* rooms/spaces.

c. Net Free Venting Area (NFVA)
   1) When NFVA is stamped on the vent, it may be assumed to be correct.
   2) When NFVA is not stamped on the vent, NFVA can be determined by using guidelines in Section I below.
   3) When calculating NFVA, the blocking effects of mesh and louvers must be considered, as described in Section I below.

CVA air ducts:

a. New ducts:
   1) Ducts must be galvanized steel or a material with equivalent corrosion resistance, strength, and rigidity.
   2) Building cavities (unobstructed stud and joist cavities) may also be used.

3.

b. Ducts that bring in outdoor air must terminate in an unobstructed space, allowing free communication with outdoors.

c. Separate Ducts
   1) A duct may serve only one space/enclosure.
   2) Upper and lower CVA must be provided by separate ducts (can't be a single duct).

d. Horizontal upper CVA ducts must be level or slope upward toward the air source (i.e., must *not* slope downward toward outdoors).

CVA vent openings and ducts may not connect an appliance enclosure with a space in which the operation of a fan (e.g. FAU, whole house fan, dryer, exhaust fan, etc.) can adversely affect performance of appliance(s) in the enclosure.

4.

CVA Vents and Return Air Inlets

5.

a. Return air inlets must not be located within 10' of an appliance firebox or draft hood in the same enclosed room or confined space.

b. This 10' separation applies to a return grille located in a utility room, basement, or other enclosed room containing an open combustion FAU (particularly if the CAZ containing the FAU is a confined space with insufficient room volume).

6.

FAU or DHW Indoors:

a. An FAU must not take CVA from the living space.

b. When an FAU or DHW enclosure has CVA vents to indoors, infiltration measures may <u>not</u> be installed, unless all of the following modifications are made:
   1) CVA vents to indoors are sealed.
   2) CVA is obtained entirely from outdoors.

7.

   3) The enclosure door is weather-stripped (it must isolate enclosure from the living space).

FAU or Water Heater in Bedroom or Bathroom:

a. An open combustion FAU or DHW must **not** be located in a bedroom or bathroom.

b. When one is, infiltration measures may **not** be installed, unless all of the following is true:
   1) The appliance is located entirely within an enclosure.
   2) All CVA venting is to outdoors.

1.

   3) The enclosure door is weather-stripped (sealed) and self-closing (spring-loaded).

E. Indoor CVA and ACHn

Indoor CVA is based on room volume, and the required cubic footage is a function of the air infiltration rate (Air Changes per Hour at natural pressure, or ACHn) in the CAZ.

a. ACHn applies to the entire home, when appliances use indoor room volume for CVA.

b. ACHn applies to the room/space (CAZ) where the appliances are located, when that is separate from the living space (e.g., attached garage, or multi-family mechanical room).

Calculating ACHn

a. The following equations may be used to convert CFM50 to ACHn.

b. First, calculate "Interior Volume" of the dwelling, using interior dimensions or outdoor dimensions minus wall thickness.

2. c. Interior Volume (cu. ft.) = (floor area in sq. ft.) x (ceiling height in feet).

d. Then, use a blower door to measure CFM50 shell leakage, and calculate ACHn to two decimal points, using one of the following equations:

Equation 5-1 for a **1-story** dwelling: $$\textbf{ACHn} = \frac{\textbf{(CFM50) x 2.61}}{\textbf{interior volume}}$$

Equation 5-2 for a **2-story** dwelling: $$\textbf{ACHn} = \frac{\textbf{(CFM50) x 3.26}}{\textbf{interior volume}}$$

Equation 5-1 for **3 stories or higher**: $$\textbf{ACHn} = \frac{\textbf{(CFM50) x 3.73}}{\textbf{interior volume}}$$

Example for one-story dwelling: Assume 1,000 sq. ft. of floor space, 8' ceilings, and 1,200 CFM50 blower door reading:

$$\textbf{ACHn} = \frac{1{,}200 \times 2.61}{(1{,}000 \text{ sq. ft.}) \times (8 \text{ ft.})} = \frac{3{,}132}{8{,}000} = 0.3915 = \textbf{0.39 ACHn}$$

3.

When the air infiltration rate is ≥0.40 ACHn:

a. The "**Standard Method**" for CVA calculations may be used *(see Table 5-1. below).*

4. b. Minimum CVA room volume is 50 cu. ft. per 1,000 Btuh input.

When the air infiltration rate is < 0.40 ACHn:

5. a. the **"Known Air Infiltration Rate Method"** for calculating minimum CVA room volume must be used *(see Table 5-2. below).*

When the air infiltration rate is > 0.40 ACHn:

6. The "**Known Air Infiltration Rate Method**" for CVA calculations may be used to **reduce** minimum CVA room volume to as little as:

a. 35 cu. ft. per 1,000 Btuh input, for natural draft appliances, and

b. 25 cu. ft. per 1,000 Btuh input, for appliances with fan-assisted combustion systems.

When CVA room volume in a CAZ is *not* adequate:

a. Additional room volume can be provided by adjacent room(s) with adequate volume.

b. To include adjacent room volume, use any of the following methods:

1) Install upper and lower CVA vents to communicate with an adjacent room/space.

a) Unscreened louvered grilles may be installed.
b) The upper vent must begin within 12″ of the ceiling.
c) The lower vent must begin within 12″ of the floor.
d) NFVA of each vent must be 1 sq. in. per 1,000 Btuh input, with a *minimum of 100 sq. in. per vent.*

2) Replace solid doors to adjacent rooms with louvered doors.
3) Permanently remove doors (and hinges) to adjacent rooms.

*Note: CVA may not be drawn from a sleeping room, so these methods may **not** be applied to bedroom doors.*

F. CVA From Outdoors

Combustion air may be obtained from outdoors by means of:

1.
a. Permanent openings (undampered vents) of the required size venting directly to outdoors through the enclosure floor, roof, or walls; or
b. Continuous vertical or horizontal ducts of the required cross-sectional area extending from the enclosure to outdoors (or into an area communicating with outdoors, such as a vented attic or crawlspace).

When drawing CVA from the attic:

2.
a. Attic must have unobstructed vent openings providing a free flow of air from outdoors (e.g., by cross ventilation).
b. NFVA of attic venting must be adequate to provide the required volume of combustion air.
c. Attic vents may be upper-only or lower-only (both not required).
d. Vertical ducts must extend into an unobstructed space.
e. CVA vent openings, and ducts terminating above the attic floor, must be protected from loose fill ceiling insulation (i.e., by a sleeve on the duct, or by blocking, that extends at least 3” above the insulation).
3.
f. Lower CVA **ducts** terminating in the attic must **not** be screened at either end.

When drawing CVA from the crawlspace:

4.
a. Crawlspace must have unobstructed vent openings providing a free flow of air from outdoors (e.g., by cross ventilation).
b. NFVA of crawlspace venting must be adequate to provide required volume of combustion air.
5.
c. Crawlspace vents may be upper-only (lower CVA venting not required).

For *existing* appliance(s) in a garage or enclosed porch with inadequate room volume:

a. Vent(s) to outdoors can be upper, lower, or both (a single vent opening is acceptable).
b. Vent NFVA must be at least 1 sq. in. per 4,000 Btuh total input in the space.

Note: When a **new** appliance is installed, CVA venting must be in conformance with manufacturer’s instructions and requirements of the local jurisdiction.

G. Summary of CVA Requirements

Table 5-1 provides a summary of requirements for CVA obtained from indoor and outdoor sources, and equations to make required calculations.

Table 5-1. CVA Calculations

Combustion Air Source	CVA Requirements	Equations
All combustion air from INDOORS, based on room volume of the CAZ	• Minimum room volume is 50 cu. ft. per kBtuh total input in the CAZ. * • The "Known Air Infiltration Rate Method" in Table 5-2 *must* be used when infiltration is known to be < 0.40 ACHn. • It *may* be used to *reduce* required cu. ft. when infiltration is > 0.40 ACHn	**CVA cu. ft. = (kBtuh) x (50)*** **"Standard Method"**
All combustion air from INDOORS, based on room volume of the CAZ plus volume of other interior rooms(s), using 1 Upper and 1 Lower vent	• Upper and Lower vents into adjacent room(s) can be louvers with no mesh. • Each vent = 1 sq. in. NFVA per kBtuh input in the CAZ—each with a minimum of 100 sq. in. NFVA.	**NFVA sq. in. = 100 + # kBtuh over 100**
All combustion air from OUTDOORS using Upper-only vent(s) or duct(s)	• Appliance must have minimum clearances of 1" on all sides and back, and 6" in front. • Vent/duct NFVA must equal the sum of the vent connector cross-sectional areas. • Vent/duct must provide 1 sq. in. NFVA per 3 kBtuh input in the CAZ	**NFVA Sq. In. = kBtuh ÷ 3**
All combustion air from OUTDOORS using two horizontal ducts, 1 Upper and 1 Lower	• Each horizontal duct must provide 1 sq. in. NFVA per 2 kBtuh input in the CAZ	**NFVA Sq. In. = kBtuh ÷ 2**
All combustion air from OUTDOORS using two vents or vertical ducts, 1 Upper and 1 Lower	• Each vent opening and duct must provide at least 1 sq.in. NFVA per 4 kBtuh input in the CAZ	**NFVA Sq. In. = kBtuh ÷ 4**
All combustion air from a GARAGE or ENCLOSED PORCH using Upper and/or Lower Vent or Duct	• 1 sq. in. NFVA per 4 kBtuh input in the CAZ (*pre-existing* appliances) • 1 or more vents to outdoors in any location (high, low, or in ceiling) • When a *new* appliance is installed, CVA must be in conformance with manufacturer's instructions and local code.	**NFVA Sq. In. = kBtuh ÷ 4**

* A CAZ with less than the minimum required room volume is referred to in the CMC as a "Confined Space."

H. CVA Known Air Infiltration Rate Method

The "Known Air Infiltration Rate Method" of calculating minimum CVA room volume is illustrated in Table 5-2 below.

It must be used when the air infiltration rate in the home (or separate CAZ) is known to be < 0.40 ACHn. It increases the minimum required CVA room volume cu. ft.

It may be used to reduce required CVA room volume, when infiltration is > 0.40 ACHn.

1.

It is not required, when infiltration is known to be ≥0.40 ACHn.

2.

Notes:

3.

a. The "Standard Method" of determining CVA room volume (1 cu. ft. per 1,000 Btuh total input in the CAZ) is based on an assumed air infiltration rate of at least 0.40 ACHn.

4.

5.

b. Calculate ACHn for the "Known Air Infiltration Rate Method", per Section E above.

c. When calculating CVA room volume, "Btuh total input in the CAZ" refers to the sum of the inputs of all gas appliances in the CAZ, including space heater(s), water heater, cooktop, and oven/broiler.

Table 5-2. "Known Air Infiltration Rate Method" for Indoor CVA Calculations

Appliance Type	Equation for Minimum CVA Room Volume
Natural Draft Appliances	CVA minimum room volume = (21 ÷ ACHn[†]) x kBtuh input [††]
Appliances with Fan-assisted Combustion System	CVA minimum room volume = (15 ÷ ACHn[†]) x kBtuh input [†††]

[†]0.60 ACHn is the maximum air infiltration rate that may be used in these equations.
[††] For Natural Draft appliances, CVA room volume can be reduced to a minimum of 35 cu. ft. per kBtuh.
[†††] For Fan-assisted (e.g., Induced Draft) appliances, CVA room volume can be reduced to a minimum of 25 cu. ft. per kBtuh.

Example for an induced draft appliance with an input of 63,000 Btu in a building with a known infiltration rate of 0.38 ACHn:

1. **CVA room volume** = (15 ÷ ACHn) x kBtuh input = (15 ÷ 0.38) x 63 = 2487 Cu. Ft.

I. "Reduction Factors" for NFVA Calculations

2. To calculate NFVA of a combustion air opening, the applicable "Reduction Factor" is applied, to account for obstructions (louvers and/or mesh), as shown in Table 5-3 below.

3.

a. In the top row, find the material that "obstructs" the vent/duct opening.

b. In the bottom row, the applicable "Reduction Factor" is directly below the material description.

When determining *NFVA of an existing vent,* use the value stamped on the vent, or this equation: NFVA Sq. In. = [Area of opening Sq. In.] x [Reduction Factor]

When the required NFVA is known*, gross size of the vent needed* can be determined with this equation: Gross Area Sq. In. = [NFVA Sq. In.] ÷ [Reduction Factor]

Table 5-3. Reduction Factors for NFVA Calculations

1/4" Screen (hardware cloth)	1/8" Mesh (wire mesh)	1/16" Mesh (insect screen)	Metal Louvers **or** Metal Louvers **and** 1/4" or 1/8" Mesh	Metal Louvers **and** 1/16" Mesh	Wood Louvers **or** Wood Louvers **and** 1/16" to 1/4" Mesh
0.90	**0.75**	**0.50**	**0.75**	**0.50**	**0.25**

J. Area Calculations for Round Combustion Air Vents and Ducts:

In the Table 5-4, the cross-sectional area of a round duct ["Duct Area (sq. in.)"] is given when the duct diameter or circumference is known.

Table 5-4. Round Vent/Duct Area

Duct diameter (in.)	3	4	5	6	7	8	9	10
Duct circumference (in.)	9.5	12.5	15.7	18.8	22	25	28.3	31.4
Duct Area (sq.in.)	**7**	**12.5**	**20**	**28**	**38.5**	**50**	**63.5**	**78.5**

Chapter 5
CAS/CAZ Testing

Introduction

Participating Contractors are required to follow the order of inspection procedures as described on page 3.

This chapter provides an overiew of:

A. General CAS/CAZ testing guidelines

1. B. Criteria for CAS testing under WCD

C. Ambient CO monitoring in the work environment

D. Manometer set-up and operation

E. Preparation for WCD

F. Determining WCD

G. CAS testing sequence

H.- Q. CAS testing protocols for each type of appliance

2. Acronyms and definitions are in Appendix S.

A. General CAS/CAZ Testing Guidelines (All Appliances):

1.

2. "CAS/CAZ" refers to performing CAS testing in each separate Combustion Appliance Zone (CAZ).

3. CAS/CAZ testing is performed for natural gas and liquid petroleum gas (propane) appliances.

4. CAS testing is not required for non-gas combustion appliances, such as solid fuel (wood and pellet) stoves and fireplaces, and electric appliances (water heaters, furnaces, etc.).

Appliances that have a direct effect on the living space:

a. Appliances located in conditioned living space, utility rooms, attached garages, attics, crawlspaces, or an enclosure within the living space accessed from indoors or outdoors.

b. All operable gas appliances in locations that have a direct effect on the living space are subject to full CAS/CAZ testing.

5.

c. Inoperable combustion appliances in locations that have a direct effect on the living space are subject to checks for gas leaks, vent system inspection, CVA calculations, and all other feasible visual safety evaluations.

Appliances that do not have a direct effect on the living space:

a. They are appliances that are outside the thermal boundary and located more than 4 feet from an operable door, window, or gravity inlet leading indoors.

b. Appliances that are not part of the SOW and do not have a direct effect on the living space are subject to checks for gas leaks and vent system inspection.

Any sign of an appliance defect that presents an immediate danger to the homeowner or inspector (e.g., cracked heat exchanger, severe delayed ignition, gas leak, etc.) requires immediate shutdown of the unit.

Ambient CO level must be monitored at all times, with a personal CO monitor.

CO Analyzer "Zeroing"

6. a. Just prior to measuring the First Living Space Ambient CO, "zero" the CO analyzer in clean air outdoors.

7. b. Auto-Zeroing—for Instruments that automatically self-zero—operate in accordance with
8. manufacturer's instructions (e.g., outdoor reading will always be "000").

CO Analyzer Operation

a. For Ambient CO measurements, analyzer must be operated in "as-measured" mode (not "air-free") for natural gas appliances.

9. b. Keep the CO analyzer on during the entire Ambient CO sequence, when possible. If turned off during testing, the zeroing process must be repeated before resuming Ambient CO tests.

PART 1—PREPARATION FOR CAS TESTING

B. Criteria for CAS Testing Under Worst Case Depressurization (WCD)

1. CAS testing of open combustion and induced draft gas-fueled appliances, space heaters and water heaters must be performed under WCD, *when the appliance has a direct affect on the living space.*

2. CAS testing is performed under natural conditions(NC) for these appliances:

a. Natural draft appliances, when spillage or undiluted CO fails under WCD.

b. All direct vent furnaces, regardless of location.

c. Natural draft water heaters located in:
   1) an attached garage without a door into the home, or
   2) an enclosure recessed into the home with CVA venting to outdoors.

3. d. Fan-assisted appliances located in an area that does not have direct effect on the living space.

e. Natural draft appliances, when spillage or undiluted CO fails under WCD.

CAS testing under WCD is not required for the following appliances:

a. Induced draft combustion appliances that are located outside of the thermal envelope and do not have a direct effect on the living space. They include the following:
   1) Induced draft appliances located outdoors, or in a ventilated area (e.g., attic, crawlspace, porch, or detached enclosure), or are open to the atmosphere (package units)

b. Water heaters located in:
   1) an attached garage with no walk-through door into the home,
   2) a detached garage or enclosure outside the envelope, or
   3) an exterior-accessed enclosure recessed into the home, with CVA from outdoors.

c. Gas oven, broiler and cooktop

d. Direct vent appliances

CAS testing under WCD is prohibited under the following conditions:

a. A gas leak is present that has not been repaired or isolated (see Chapter 2).

b. PACM, black organic matter, rodent feces, or any other hazardous material is present.

c. An appliance condition poses an immediate threat to the safety of the homeowner or the inspector, including but not limited to cracked heat exchanger or burner(s), or other major defect that may present an immediate hazard.

4.

d. A condition is present that poses a risk of causing damage to the home.

e. Customer refuses.

C. Ambient CO Monitoring in the Work Environment

Ambient CO levels must be monitored at all times with a dedicated ambient CO monitor per BPI 1200 standards.

1. Actions must be taken when elevated CO is found at the indoor ambient CO action levels listed below. (Also see Appendix C for Zone Ambient and Appendix D Appliance Ambient CO Action Levels
2. and required responses.)

a. Ambient CO from 9 to 35 PPM:
   1) Advise the occupants.
   2) Open windows and exterior doors to ventilate the dwelling.
   3) When CO appears to be created by gas appliance(s), advise the homeowner or their designated representative to have the appliance(s) serviced by a qualified professional.

b. Ambient CO from 36 to 69 PPM:
   1) Advise the occupants.
   2) Open windows and exterior doors to ventilate the dwelling.
   3) Immediately shut down all possible sources of CO.
   4) When CO appears to be created by gas appliance(s), advise the homeowner or their designated representative to have the appliance(s) serviced by a qualified professional.

c. Ambient CO of ≥70 PPM:
   1) Terminate the inspection immediately.
   2) Notify the occupants, and evacuate the area.
   3) From *outside* the home, immediately contact a certified professional to address the hazard.
1. 4) Notify the homeowner or their designated representative, if not present at the jobsite.

2. D. Manometer Set-up and Operation:

The following guidelines apply to the DG 700 (for other brands, follow manufacturer's instructions).

a. Channel A Input tap (top left tap):

b. When the manometer is *inside* the CAZ, Channel "A" Input is left open to the CAZ.

When the manometer is located *outside* of the CAZ, tubing goes from Channel "A" Input into the CAZ.

a. Channel "A" Reference tap (bottom left tap):

1) Run tubing from channel "A" Reference to outdoors through a window, door, or other gap/crack. If the attic is well ventilated, tubing can be run into the attic.
2) When possible, insert a small diameter metal tube into the tubing and under the closed door (between the door and the door threshold.)
3) When necessary to crack open a window, door, or attic access to run tubing, temporarily seal the gap with masking tape.

Set the manometer to the "PR/PR" mode.

E. Preparation for WCD

3. All combustion appliances located in the CAZ are put into standby mode (turned off at the thermostat, DHW set to "Pilot").

Solid fuel appliances:

1.
a. Fires in all wood stoves and fireplaces are extinguished; no hot coals or embers present.

2.
b. Fireplace doors are closed

c. The damper is closed (as far as possible, when blocked partially open for gas-fueled fireplaces).

Supply registers are open.

3.
Exception: Supply register(s) are closed when located in a utility room or basement containing a natural draft appliance.

4. The following must be operating during WCD testing:

a. FAU air handler:
   1) If possible, operate only the air handler (not the furnace or A/C), and run it at high speed.
   2) If available, turn the Fan control to "On" (with Heating/Cooling switch off).
   3) Air filter(s) must be clean.
   4) If necessary, filters must be cleaned, replaced, or removed.

b. Clothes Dryer:
   1) Operate in air-only mode (no heat).
   2) Dryer lint screen must be clean.
   3) Check for blockage at the exhaust terminal and damper, and clean if necessary. Damper must open properly.
   4) Remove wet clothing (dry clothing may remain in the drum).

5.
c. Kitchen exhaust fans, bathroom and utility room exhaust fans, central vacuum system, and manually-controlled attic ventilators.

d. Exhaust and balanced dwelling unit mechanical ventilation system(s).

Do not operate the following during WCD testing:

a. Whole house fans.

b. Recirculating range hood fans (e.g., with charcoal filter).

c. Evaporative Coolers.
   1) If interior cooler vent covers are available, install a cover at each outlet.

2) If interior cooler vent covers are not available and occupants seal off the cooler(s) during winter (e.g., with an exterior cover or plastic covering the outlets), *temporarily seal* all cooler interior outlets.

3) gas-fueled fireplaces

F. Determining WCD

Follow these steps for **each** separate CAZ containing an open combustion appliance affecting the living space.

WCD Determination—Step 1: Windows and Doors

a. The following are **closed**:

1) All exterior doors and windows

1. 2) Doors to rooms that do not contain any source of supply or exhaust ventilation.

a) Sources of supply ventilation include FAU supply registers, positive pressure mechanical ventilation, or any other source of positive pressure.

b) Sources of exhaust ventilation include dryers, exhaust mechanical ventilation, local exhaust ventilation, central vacuum system inlet, etc.

3) Doors to rooms containing only a supply register and/or supply ventilation.

4) Appliance enclosure doors (*except* during tests that require them to be opened).

5) Passive vents to outdoors associated with mechanical ventilation or pressure relief.

b. The following are **open**:

1) Doors to rooms that have only an exhaust fan or FAU return grille.

2) Door to utility room with clothes dryer exhausted outdoors.

Exception: When an open combustion appliance in *that room* is tested, the door is closed during

2. testing.

WCD Determination—Step 2

a. This additional step is performed on door(s) leading into each separate room that contains both supply and exhaust ventilation sources.

b. This additional step is also performed on:

1) the walk-through door into an attached garage

2) a solid door into the laundry/utility room.

Note: Does not apply to laundry doors that do not substantially air seal the laundry from the living space.

c. To determine proper configuration of doors, have the supply system/fan and exhaust devices operating, and use either Method 1. or Method 2. below for each applicable room.

d. Method 1: Smoke the Door(s)

1) Apply smoke to each closed door individually.

2) If smoke goes under the door (into the room), open it.

3) If smoke is blown away from the door, it remains closed.

e. Method 2: Measure Differential Pressure

1) With the manometer outside the closed door, leave Channel "A" Reference tap open.

2) Place tubing from Channel "A" Input tap under the door, and note any pressure change.
   a) If the reading shows a lower pressure in the room, open the door.
   b) If the reading shows a higher pressure in the room, the door remains closed.

WCD Determination—Step 3

Applies to CAS testing of appliances in a basement, unconditioned garage, attic, or crawlspace.

a. Appliances located in a basement:
   1) If the basement is conditioned space, position the door from the basement to the main living area, and perform CAS testing on appliances in the basement, the same as for appliances elsewhere in conditioned space.
      a) If the basement is not conditioned space:
         - Close the door between the basement and the living space above (subject to Step 2, when applicable).
         - Perform CAS testing on appliances in the basement the same as for appliances elsewhere in unconditioned space (e.g., attached unconditioned garage).

b. Appliances located in an attached unconditioned garage:
   1) Close drive-through door, walk-through door(s) and windows to outdoors.
   2) Operate air handler and all exhaust devices in the garage (included vented clothes dryer) and in the living space (including exhaust and balanced mechanical ventilators).
   3) Position the walk-through door into the living space as prescribed in Step 2 above.

c. Appliances located in an attic or crawlspace:
   1) Devices exhausting into the attic/crawlspace are off during tests on open combustions appliances in those locations.
   2) Examples include: exhaust fans blowing directly into the attic (not ducted outdoors) and clothes dryer moisture exhaust blowing directly into the crawlspace (not ducted outdoors).

PART 2—CAS TESTING FOR GAS APPLIANCES

G. Testing Sequence

Establish WCD in the CAZ when applicable, per Sections E and F above.

Adjust controls so the appliances will operate continuously while CAS testing is being conducted (except when cool-down for retest is applicable).

CAS testing includes the following procedures:

a. Spillage check for natural draft appliances

b. Appliance ambient CO testing

c. Undiluted CO measurement for natural draft appliances

Testing sequence/priority when mulltiple appliances share a CAZ :

a. Test appliances in order of lowest to highest Btuh input rating.

b. When multiple appliances share vent systems, follow this testing sequence:
   1) Check spillage (if natural draft) at appliance #1 (lowest Btuh input).

2) Measure ambient CO at appliance #1.
3) Measure undiluted flue gas CO (if natural draft) at appliance #1.
4) With the appliance #1 still operating, place appliance #2 (next higher Btuh appliance) in operation.
5) Recheck spillage at appliance #1.
6) Check for spillage (if natural draft) at appliance #2.
7) Measure ambient CO at appliance #2.
8) Measure undiluted flue gas CO (if natural draft) at Appliance #2.
9) If there are more than two appliances sharing a common vent, continue this process for each additional appliance in order of increasing Btuh until all appliances are operating simultaneously.

CAS testing of natural draft appliances includes the following procedures:

a. Spillage check for all natural draft appliances:
5. 1) Check for spillage after 5 minutes of burner operation.
2) Start with space heating appliance(s) already operated for Living Space Ambient CO measurements.

b. Appliance ambient CO
1) Appliance ambient CO is measured immediately after the spillage check.
2) Appliance ambient CO shall be measured prior to undiluted CO measurement, when both are required.

c. Undiluted CO measurement for natural draft appliances
1) Measure CO in flue gases ahead of dilution air.
2) FAUs: Measure CO inside each exhaust port, and record the highest reading.
3) Wall Furnaces: Measure CO inside the flue on both sides of the baffle, and record the higher reading.
4) Floor Furnaces and Vented Room Heaters: Measure CO inside the flue.
5) Water Heaters: Insert probe into the flue, measuring CO on both sides of the turbulator and record the higher reading.
6. 6) When flue gas measurement is not feasible, CO measurement is limited to Appliance Ambient CO.

To analyze results, see the following Appendices:

a. For zone ambient CO action levels, Appendix C
b. For Appliance Ambient CO action levels, Appendix D.
1. c. For SDG&E/SoCalGas Undiluted (flue gas) CO action levels, Appendix E.
2. d. For LPG appliances, Appendix F (CO action levels from NFGC table G.6).

H. Natural Draft Space Heating Appliances

Establish WCD in the CAZ where appliance(s) will be tested, per Section G. above.

For the appliance being tested, operate the main burner for five minutes.

All other appliances remain off.

Exception: When two appliances share a common vent system, the first appliance stays on, and both appliances operate concurrently, as described above in section G4.

Perform spillage check:

3. a. Check for spillage along the entire draft hood opening, near the top of the opening using one of two methods.
   1) Use a small mirror. Appliance fails spillage check if moisture condenses on the mirror.
4. 2) Apply smoke. Appliance fails spillage check if smoke is pushed away from the draft hood.

b. If the appliance fails spillage under WCD:
   1) Turn off the unit.
   2) Wait 15 minutes for vent to cool.
   3) Re-test spillage under natural conditions (NC) at five minutes from start-up.

Measure appliance ambient CO.

a. FAUs:
5. 1) Measure the supply register CO inside the supply register nearest the FAU and direct the probe into the airflow.

b. Wall Furnaces
   1) The test probe is placed just above the heat exchanger on both sides of draft hood inlet, or
   2) In the air flow of the built-in circulating fan, when present with the unit operating

c. Floor Furnaces and Free-Standing Heaters
   1) Test probe is placed 6” above the top of the appliance.

6. Measure undiluted flue gas CO.

a. Measure CO in flue gases ahead of dilution air.

b. FAUs: Measure CO inside each exhaust port, and record the highest reading.

c. Wall Furnaces: Measure CO inside the flue on both sides of the baffle, and record the higher reading.
7.

d. Floor Furnaces and Vented Room Heaters: Measure CO inside the flue.

Evaluate test results in accordance with Appendices C, D, E and F.
1.

2.

3.

I. Induced Draft Space Heating Appliances

When required, establish WCD in the CAZ where appliance(s) will be tested, per Section G. above.

4. For the appliance being tested, Operate the main burner for five minutes.

All other appliances remain off.

5. Exception: When two appliances share a common vent system, the first appliance stays on, and both appliances operate concurrently, as described above in section G4.

Perform CO measurements:

a. Supply register reading only

FAUs: Measure appliance ambient CO.

a. Measure the supply register CO inside the supply register nearest the FAU and direct the probe into the airflow.

Evaluate test results in accordance with Appendix D.

J. Non-FAU Direct Vent Space Heating Appliances

Perform CO measurements:

6. Operate the main burner for five minutes.

All other appliances remain off.

1. Exception: When two appliances share a common vent system, the first appliance stays on, and both
2. appliances operate concurrently, as described above in section G4.
3. a. Measure appliance ambient CO

Measure 6" above the top of the unit.

Measure undiluted flue gas CO test at the exhaust terminal when safely accessible.

4. Evaluate test results in accordance with Appendix D.
5.
6.

K. FAU Direct Vent Space Heating Appliances

1. Perform CO measurements: (Supply register reading only)

a. Operate the main burner for five minutes.

b. All other appliances remain off.

2. Exception: When two appliances share a common vent system, the first appliance stays on, and both appliances operate concurrently, as described above in section G4.

3. FAUs: Measure appliance ambient CO.

a. Measure the supply register CO inside the supply register nearest the FAU and direct the probe into the airflow.

Evaluate test results in accordance with Appendix D.

1.

L. Hydronic FAU Space Heating Appliances

1. CAS testing will take place at the boiler that generates heat to the FAU coil as described in Section M (next) for a DHW.
2.

M. Natural Draft Water Heating Appliances

Establish WCD in the CAZ where appliance(s) will be tested (see Section G above).

For the appliance being tested, operate the main burner for five minutes.

a. All other appliances remain off.

Exception: When two appliances share a common vent system, the first appliance stays on, and both appliances operate concurrently, as described above in section G4.

Perform spillage check:

a. Check for spillage along the entire draft hood opening, near the top of the opening using one of two methods.
   1) Use a small mirror. Appliance fails spillage check if moisture condenses on the mirror.
   2) Apply smoke. Appliance fails spillage check if smoke is pushed away from the draft hood.

3. b. If the appliance fails spillage under WCD:
   1) Turn off the unit.
   2) Wait 15 minutes for vent to cool.
   3) Re-test spillage under natural conditions (NC) at five minutes from start-up.

Measure appliance ambient CO.

a. Measure 6” above of the water heater (and inducer unit, if applicable), and indoor vent pipe joints, if present on mechanical vent units.

4.

Measure undiluted flue gas CO.

1) Insert probe into the flue, measuring CO on both sides of the turbulator and record the higher reading.

5.

Evaluate test results in accordance with Appendices C, D, E and F.

6.

N. Sealed Combustion Water Heating Appliances

1. Operate the main burner for five minutes.

2. All other appliances remain off.

a. Exception: When two appliances share a common vent system, the first appliance stays on, and both appliances operate concurrently, as described above in section G4 (above).

3.

Perform CO Measurements:

4. a. Measure appliance ambient CO 6” above of the water heater (and inducer unit, if applicable), and indoor vent pipe joints, if present on mechanical vent units.

Evaluate test results in accordance with Appendix D.

O. Open Combustion Gas-Fueled Fireplaces

1. CAS and CAZ testing is required for gas-fueled fireplaces
   a. Wood burning fireplaces with gas-fueled log lighters are exempt.
2. Conduct damper and chimney inspection.
   a. With the damper open, inspect the chimney for obstruction by anything hazardous or flammable (e.g., bird’s nest), a crushed chimney cap, or excessive build-up of creosote.
      1) Flammable obstructions and crushed chimney cap must be corrected.
      2) Customer must be advised if excessive creosote is present (it may cause a chimney fire).
   b. Verify that the damper is in a fixed open position:
      1) The damper must be in a fixed open position when the fireplace is gas-fueled.
      2) The damper opening must provide a gap large enough to allow proper drafting of combustion gases up the chimney (typically, minimum 0.5").

3) If the damper is not in a fixed open position, a damper clamp must be installed.

Establish WCD in the CAZ where appliance(s) will be tested (see Section G above).

a. All other appliances remain off.

Conduct burner-on CAS checks

a. On start-up, check for delayed ignition and/or flame roll out, which require correction.

4. b. Operate the burner for a minimum of five minutes for spillage and CO checks.
Note: Ceramic logs may require up to 20 minutes to reach steady state.

5. c. Spillage checks:

1) Smoke is applied along the top of the fireplace at the outer edge of the opening.

2) Spillage passes only if smoke is drawn inward along the entire fireplace opening.

d. CO testing:

1) Measure appliance ambient CO in the ambient zone, directly above the unit just outside the fireplace opening.

2) Measure flue gas CO just inside the outer edge of the opening at the top of the fireplace.

e. Evaluate test results in accordance with Appendices C, D, E and F.

P. Sealed Combustion Insert Fireplaces

1. Applies to sealed fireplaces with gas control valve (GCV).

2. Conduct visual inspection of appliance and venting

a. Follow guidelines in Chapter 3.

b. Inspect the seal between the glass and firebox for cracks and other defects.

3. Conduct burner-on CAS checks

a. On start-up, check for delayed ignition and/or flame abnormalities, which require correction.

b. Operate the burner five minutes for CO tests.

c. Measure appliance ambient CO just outside of the fireplace, directly above the unit.

d. Evaluate test results in accordance with Appendix D.

1.

Q. Gas Cooking Appliances

Conduct visual inspection of the appliances:

a. Remove pots and pans from the cooktop and oven/broiler.

b. If there is foil in the oven that is greasy/dirty and/or covers openings in the bottom of the oven, remove the foil.

c. If any burner is greasy/dirty, or if the oven/broiler is greasy/dirty, customer should be advised that cleaning the greasy/dirty components will improve chance for appliance(s) to pass CO tests.

d. Check oven and broiler doors for proper operation

1) If defective, correction will be recommended.

e. Check for evidence of any burners being misaligned or otherwise compromised.

Establish Test Conditions

a. **Close** all interior doors, including the interior kitchen doors (when applicable), exterior doors and windows.

b. Turn **Off**:

1) all ducted exhaust fans affecting the CAZ, including the range hood.

2. 2) all other gas appliances (DHW pilot may be on, but main burner is off).

c. WCD is not established for CAS testing of cooking appliances.

Appliance-On Tests—Cooktop Burners

a. Check burners for proper operation.

1) Burners must ignite properly and burn cleanly.

3. b. Measure cooktop CO in the kitchen, with oven and broiler off.

1) Measure ambient CO for cooktop:

a) Operate all cooktop burners (and griddle if present) on highest setting for one minute.

b) Measure ambient CO in the center of the kitchen at a height of 6'.

2) Measure concentrated CO for each cooktop burner individually, with the probe held horizontally 15" above each burner. (Do *not* point the probe downward toward the flame.)

c. Evaluate test results in accordance with Appendices C, D, E and F.

Appliance-On Tests—Oven Burner(s)

4. a. Check burners for proper operation.

1) Burners must ignite properly and burn cleanly.

2) If ignition or flame issues are present, clean-and-tune service will be recommended.

b. Measure ambient CO for Oven.

1) With Cooktop and separate Broiler burners unit Off:

a) Operate Oven on highest setting for 5 minutes.

b) Make sure the self-cleaning feature is *not* activated.

2) Measure ambient CO in the center of the kitchen at a height of 6'.

5. c. Measure undiluted CO inside the oven exhaust port, ahead of dilution air.

d. Evaluate test results in accordance with Appendices C, D, E and F.

Appliance-On Tests—Broiler Burner

a. Check burners for proper operation.

1) Burners must ignite properly and burn cleanly.

2) A Clean-and-Tune will be recommended, if ignition or flame issues are present.

b. Measure ambient CO for Broiler.

1) With cooktop and oven burners Off, operate Broiler for 5 minutes.

2) Measure ambient CO in the center of the kitchen at a height of 6'.

c. Measure undiluted CO inside the oven exhaust port, ahead of dilution air.

d. Evaluate test results in accordance with Appendices C, D, E and F.

R. Dryer CAS Testing (Units Located in the Living Space)

If the dryer is inside the thermal envelope:

a. It must be properly vented to the outdoors.

b. If not, a correction is required.

1. When a dryer is in an enclosed living space a makeup air opening of not less than 100 sq.in. should be provided in homes built in 2008 or later.

Measure Ambient CO:

2. a. Operate the dryer in drying mode with burner operating.

b. After 1 minute of operation, measure appliance ambient CO in the atmosphere just behind and above the dryer

3. c. If necessary, place a wet cloth in dryer to ensure that burner is operating

Measure Undiluted CO:

a. Operate the dryer in drying mode with burner operating.

4. b. Measure undiluted CO at the exhaust port after 1 minute of operation.

Evaluate test results in accordance with Appendices C, D, E and F.

5.

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Chapter 6
Duct Leakage Testing

Participating Contractors are required to follow the order of inspection procedures as described on page 3.

See Appendix L: BPI's "Guidance on Pre-Installation Duct Testing".

A. Non-feasibility Criteria for Dust Testing

Duct testing is not permitted if any of the following conditions are present:

a. Ducts are made of possible asbestos containing material (PACM).

1. b. Metal ducts are insulated or sealed with PACM.

c. Friable PACM is present (e.g., frayed PACM duct sealant or insulation, or a damaged transite pipe).

d. A combustion hazard is present (e.g., a gas leak, excessive ambient or flue gas CO).

e. Any health or safety issue that impacts the occupants is present (see Chapter 2, Section C regarding hazardous materials).

f. Duct testing will create an unsafe condition.

g. Contractor chose the vintage table default path for pre-inspections, or did not select duct sealing as a measure.

h. Homeowner refuses.

2. Use Vintage Defaults in Appendix A, when duct leakage testing has not been performed.

1. ## B. Leakage to Outside (LTO) Test Procedure[1]

2. Positive pressure testing is the only approved method for the duct leakage to outside (LTO) procedure in the Home Upgrade program.

House Setup for Duct LTO Test

a. Turn off all exhaust fans, clothes dryer, heating and cooling equipment (including evaporative cooler and whole house fan), and combustion appliances.

b. Conduct a visual inspection of duct system to verify that there is no PACM attached to the system. Closely inspect all accessible boots on pre-1978 homes.

c. Close all exterior doors, windows, and access hatches to attic and crawlspace.

d. Open all interior doors to conditioned rooms.

e. Open door(s) to basement, if present and it is a conditioned space.

f. Close all dampers, and extinguish all fires, when a fireplace or wood stove is present.

[1] The test procedures in this section are for The Energy Conservatory (Minneapolis) equipment. See manufacturer's instruction manuals for other equipment brands.

1) Do not seal fireplace openings.
2) Caution*:* Do not allow blower door testing to rekindle embers or fan a fire in a solid fuel appliance.
3) See Appendix N: "BPI Guidance on Fireplaces and Blower Door Testing in the Presence of ACM."

g. Lap seal all of the following:
   1) Supply registers. (Seal for Duct testing only, not for Blower Door tests.)

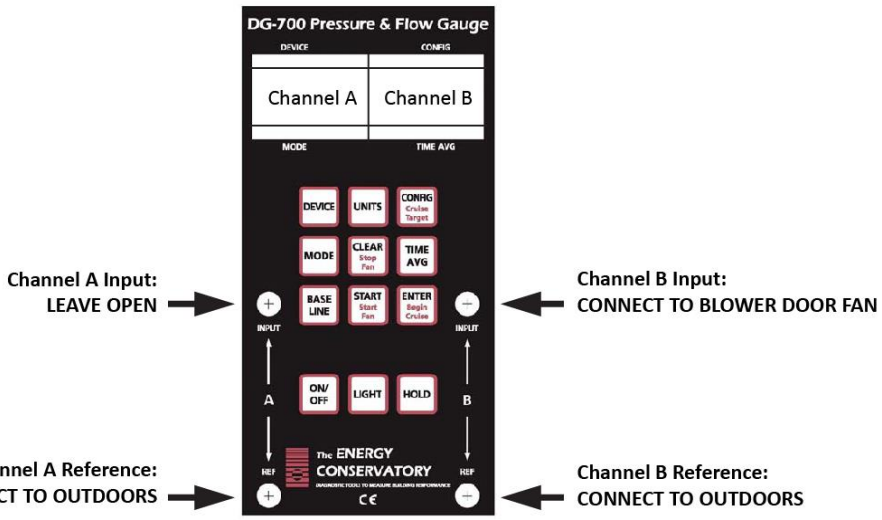
      Exception*:* Do not lap seal at any location where PACM will be disturbed.

h. Place covers (if present) on evaporative cooler supply outlets, air conditioners, and pet doors.
   1) Do not seal off whole house fan shutters entirely. Use three strips of masking tape, applied perpendicularly across the louvers (near the ends and center), to keep them from blowing open.
   2) If a pet door has no cover, and test pressure pushes it open, apply one or more horizontal strips of masking tape across it, to keep the pet door closed during testing.

Blower Door and DG-700 Setup for Duct LTO Test

3.
a. Select an exterior door that will allow adequate airflow from outdoors and an unobstructed work area inside.
b. Assemble the frame, panel, fan, and manometer.
c. Orient the fan for a *pressurization* test (flow rings *outdoors*), and install it in the panel.
d. Speed Control: Connect the fan speed controller to the fan, and plug it into a 110V outlet.
e. Tubing: Make tubing connections, as illustrated and described below.
   1) Standard Tubing Arrangement
      a) Extend tubing from Channel "A" and "B" *Reference* taps to outdoors.
      b) Use a tee to join the tubes into one tube that extends outdoors, and insert that tube through a hole in the Blower Door panel.
      c) Extend the outdoor tubing at least 5 feet away from the fan flow in a protected area (e.g., along the foundation).
      d) To protect from wind, tubing can be placed inside a bottle or other container, or inside an outbuilding (garage, shed, etc.).
   2) *Optional* Tubing Arrangement
      a) Recommended when most ductwork is in an unconditioned zone (e.g., attic or crawlspace).
      b) Test accuracy can be improved by terminating the Channel "A" and "B" Reference tubing inside the zone containing the majority of the ductwork, instead of outdoors.

Duct Leakage to Outside Test: Blower Door Manometer Hose Connections



f. Set up Blower Door DG 700

1) **Mode**: Press MODE button until "PR/FL @25" appears in the MODE screen (lower left)

2) **Device**: Press DEVICE button until "BD 3" appears in the DEVICE screen (upper left).

3) **Units**: Press UNITS button if necessary, until Channel "B" shows "CFM" for airflow units.

4) Configuration:

a) Press the CONFIG button to select Flow Ring being used (A1, B2, C3, or Open).

b) Use the Flow Ring that best matches actual Channel "B" airflow, per the table below.

Fan Configuration	Flow Range (cfm)
Open (no Flow Ring)	6,300 – 2,425
Ring A	2,800 – 915
Ring B	1,100 – 300
Ring C	330 – 85

5) **Time Averaging**: To reduce fluctuations in Channel "B" CFM readings, press TIME AVG to select a period longer than the default 1-Sec. Averaging ("5," "10," or "Long"). 5-Sec Averaging is recommended to start.

4.

Duct Blaster® and DG-700 Setup for Duct LTO Test

a. Remove the air filter from the HVAC system.

b. Attach the Duct Blaster black plastic "transition piece" to the return grille closest to the FAU, and lap seal the remainder of the return grille.

c. Completely lap seal all other returns, when present.

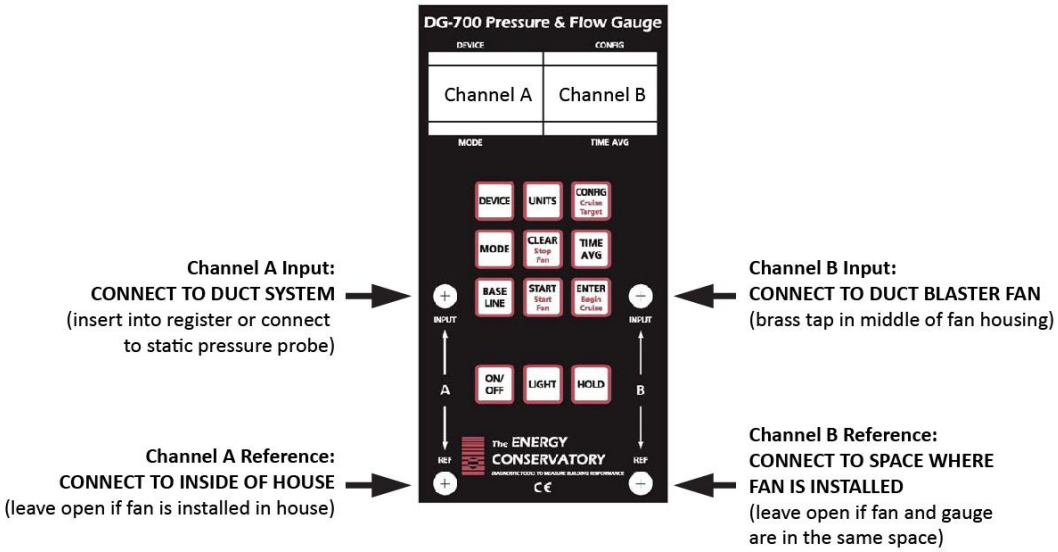
d. If unfeasible to attach the transition piece and flex duct to the return grille, tape/seal the Duct Blaster housing directly to the air handler cabinet.

e. Tubing: Make tubing connections, as illustrated on the next page.

f. Ring: Attach the appropriate Flow Ring to the inlet of the Duct Blaster fan (see "Config" below).

g. To measure duct pressure, insert the end of tubing (or static pressure probe or pitot tube) from Channel "A" Input into the supply register nearest the FAU.

Duct Leakage to Outside Test: Duct Blaster® Manometer Hose Connections



h. Duct Blaster DG-700 settings:
   1) **Mode:** Select PR/FL (pressure/flow). *Do not use "PR/FL @25."*
   2) **Device:** DB B (Duct Blaster Black)
   3) **Units:** Make sure Channel "B" display shows "CFM". Press UNITS button to change it.
   4) Configuration:
      a) Press the CONFIG button to select Flow Ring being used (A1, B2, C3, or Open).
      b) Use the Flow Ring that best matches actual Channel "B" airflow, per the table below.

Fan Configuration	Flow Range (cfm)
Open (no Flow Ring)	1,500 – 600
Ring 1	800 – 225
Ring 2	300 – 90
Ring 3	125 – 20

5.

Test Procedures for Duct LTO Test:

a. Measure "Baseline" Pressure on the Blower Door DG-700.
   1) With both the Blower Door and Duct Blaster fans sealed (covers on), measure Baseline WRT outside.
   2) Press the BASELINE button ("BASELINE" will begin to flash on the Channel "A" screen).
   3) Press START ("BASELINE" stops flashing in Channel "A," and Channel "B" becomes a timer).
   4) Wait minimum 10 seconds (or until the Channel "A" reading becomes stable)
   5) Press ENTER, and Channel "A" now displays the "baseline adjusted reading."
      a) "ADJ" appears in the Channel "A" display.

b) The baseline pressure is automatically subtracted from the current pressure measurement, eliminating the need to manually correct for baseline pressure.

b. Uncover Blower Door and Duct Blaster fans.

c. Turn on the Blower Door speed controller and slowly bring house pressure up to +25 Pa. The Cruise Control feature can be used to maintain a constant 25 Pa (see Section E below).

d. With the Blower Door running:
   1) Turn on the Duct Blaster fan, and slowly increase fan speed until the Channel "A" display reads zero (which means Duct Pressure equals House Pressure).
   2) The cruise control feature can be used to maintain a constant zero Pa reading (see Section E below).

e. Check temporary seals on return grilles, supply registers, exhaust fans, etc. to make sure they are holding. Repair any seal that has blown loose.

f. If Cruise Control is *not* being used:
   1) Check Channel "A" pressure on the Blower Door DG-700 to ensure that house pressure is +25, and adjust fan speed as needed.
   2) Check Channel "A" pressure on the Duct Blaster DG-700 to make sure it reads zero, and adjust fan speed as needed.

g. Record the CFM flow shown on Channel "B."
   1) Photograph the manometer's digital displays and tubing connections.
   2) Photograph the Duct Blaster and Blower Door, to show which rings are installed.

h. When "----" or "LO" appears on Channel "B" display, change configuration as described in Section F below.

i. If the maximum duct pressure achieved is less than 10 Pa, use Vintage Table Default value in Appendix A.

6. Return house and duct system to normal operating conditions. Remove all tape and masking materials used to set up test.

7.

C. Total Duct Leakage Test Procedure

Set up the House for Total Duct Leakage Test:

a. Turn off the FAU system.

b. Conduct visual inspection of duct system to verify that there is no PACM attached to the system. Closely inspect all accessible boots on pre-1978 homes.

c. Close exterior doors and windows—but *leave one open* enough to allow free flow of air from outdoors and prevent depressurizing the living space.

8.

d. Open all interior doors to conditioned rooms.

e. Lap seal all supply registers.

Note: Supply registers are sealed for Duct Testing, but *not* for Blower Door shell testing.

Duct Blaster and DG-700 Setup for Total Duct Leakage Test

a. Remove the filter from the HVAC system.

b. Attach the Duct Blaster black plastic transition piece to the return grille closest to the FAU, and lap seal the remainder of the return grille.

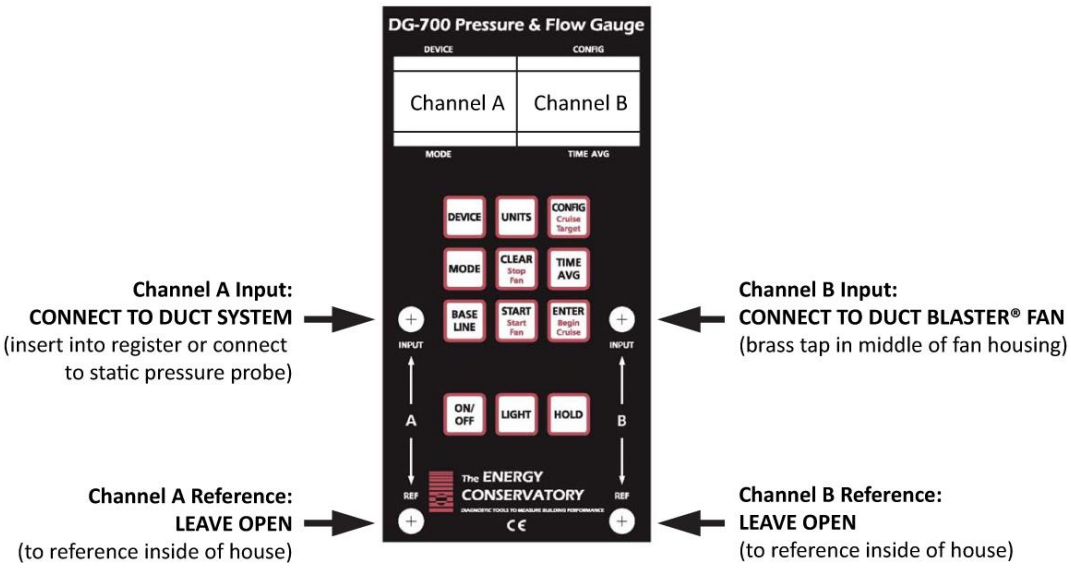
c. Completely lap seal all other returns, when present.

d. If unfeasible to attach the transition piece and flex duct to the return, tape/seal the Duct Blaster directly to the air handler cabinet.

e. Connect the fan speed controller to the fan, and plug into a 110V outlet.

f. Set up Duct Blaster DG-700 tubing according to the following illustration.

Total Duct Leakage Test: Duct Blaster® Manometer Hose Connections



g. To measure duct pressure, insert the end of tubing (or static pressure probe or pitot tube) from Channel "A" Input into the supply register nearest the FAU.

h. Set Duct Blaster DG-700 parameters:
   1) Mode: Select PR/FL @25 (Pressure/Flow @25 Pa), to measure duct leakage at 25 Pa.
   1) Device: DB B (Duct Blaster Black).
   2) Units: Make sure Channel "B" display shows "CFM." Press "Units" button to change it
   3) Configuration:
      a) Press the CONFIG button to select Flow Ring being used (A1, B2, C3, or Open).
      b) Use the Flow Ring that best matches actual Channel "B" airflow, per the table below.

Fan Configuration	Flow Range (cfm)
Open (no Flow Ring)	1,500 – 600
Ring 1	800 – 225
Ring 2	300 – 90
Ring 3	125 – 20

2. **Test Procedures for Total Duct Leakage Test:**

a. Turn on the Duct Blaster, and bring duct system pressure up to 25 Pa.
b. Record the flow CFM shown on Channel "B."
   1) Photograph the manometer's digital displays and tubing connections.
   2) Photograph the Duct Blaster, to show which ring is installed.
c. If "----" or "LO" appears on Channel "B," change configuration as described in Section F below.
d. If the maximum pressure achieved is less than 10 Pa, use Vintage Table Default values in Appendix A.

3. Return house and duct system to normal operating conditions. Remove all tape used to set up test.

D. Cruise Control

Duct Leakage-to-Outside"Cruise" Procedure

a. Blower Door DG-700 Operation

9.
   1) Connect a fan control cable from the Blower Door DG-700 fan control output jack to the speed controller communication jack.
   2) Press MODE to select "PR/FL@25," so the DG-700 will automatically maintain a house pressure of 25 Pa.
   3) Adjust the knob on the Blower Door fan speed controller to the **just-on** position (control knob turned clockwise just enough to hear a click; On/Off switched (if present) flipped to On). The fan will *not* be turning.
   4) Press the "Begin Cruise" button. Cruise target pressure will appear in Channel "A," and the Cruise icon will flash.
   5) Press "Start Fan." The fan will begin ramping up to the target building pressure.

b. Duct Blaster DG-700 Operation
   1) Connect a fan control cable from the Duct Blaster DG-700 fan control output jack to the speed controller communication jack.
   2) Press MODE to select "PR/FL" (do **not** select "PR/FL@25")
   3) Adjust the knob on the Duct Blaster fan speed controller to the **just-on** position (control knob turned clockwise just enough to hear a click; On/Off switched (if present) flipped to On). The fan will *not* be turning.
   4) Press the "Begin Cruise" button. Cruise target pressure will appear in Channel "A", and the Cruise icon will flash.
   5) Press the "CONFIG Cruise Target" button twice, to change target Cruise pressure to **"+0."**

10. *(Remember, DG-700 Mode must be set to PR/FL, not PR/FL @25).*
   6) Press "Start Fan." The fan will begin ramping up to the target duct pressure.

c. Continue with Duct LTO test (per Section C above).

"CLEAR Stop Fan" Button

a. "Stop Fan" turns off the fan when done cruising.
   1) The "Cruise" icon flashes and Channel "A" shows the Cruise target pressure.
   6) Cruising may be resumed by pressing "Start Fan."

b. Press CLEAR button to exit the cruise feature.

E. When "----" or "LO" Appears On Channel "B" Display

These warning symbols appear in the DG-700 CFM display when fan flow is out of range, and the DG-700 cannot calculate a reliable leakage estimate.

"----" or "LO" Continuously Displayed

a. **"----"** means Duct Pressure is too low (< 5 Pa).

11. b. **"LO"** means Fan Flow CFM is negligible.

c. When this happens, remove the Flow Rings, or install a larger Flow Ring to allow more fan flow.

12.

"LO" alternating with a CFM reading.

a. This means you are trying to measure an airflow outside the range of the current fan Configuration.

13. b. Change Configuration to match the flow rate—as shown in separate tables above for Blower Door and Duct Blaster.

1) Install a Flow Ring (if in "Open Fan" mode), or

2) Install a higher # Flow Ring (with smaller opening).

Remember: If the flow ring is changed, be sure to use the CONFIG button to change Configuration in the DG-700 to match the new fan Configuration.

F. Duct Blaster Flow Conversion Table

14. To correct a Channel "B" CFM reading taken when the DG-700 "Config" selection did not match the Flow Ring actually installed, use the Duct Blaster Operation Manual, Appendix B, Flow Conversion Table (see excerpt on the next page).

1. This procedure may be used only when necessary to avoid returning to a home to re-test, if discovered after the fact that the flow ring used did not match the "Config" settings on the manometer.
2. Using the Flow Conversion Table, do the following:
   a. Select the column for the "Config" selection visible at the top of the Channel "B" display (Open, A1, B2, or C3). That is the configuration for which the DG-700 was improperly set.
   b. Move down that column to the flow reading closest to the test result (Channel "B" CFM reading).
   c. Move across that same row to the column for the *ring actually installed* during the test.
   d. That value is the "corrected" CFM for the ring actually used. Record that as the CFM test result, instead of the incorrect Channel "B" CFM reading.
3. Example:
   e. Assume the DG-700 "Config" icon is "B2" (the gauge is told Ring 2 is installed), and the Channel "B" display shows **85** CFM.
   f. However, Ring 1 is *actually* installed in the Duct Blaster fan.
   g. Using the "Flow Conversion Table," do this:
      1) Select the "Ring 2" column in the table, and move down to the row showing the value **85**.
      2) Move left across that row to the "Ring 1" column, where the value is **225**.

h. The "corrected" flow is **225 CFM**, which is recorded as the CFM test result.

Table 6-1. Minneapolis Duct Blaster® Operation Manual Appendix B: Flow Conversion Table

Series B Duct Blaster (110V and 230V

Flow (cfm)

Fan Pressure	Open Fan	Ring 1	Ring 2	Ring 3
(Pascals)				
4				12
6				15
8				17
10				19
12				21
14				23
16				24
18				26
20				27
22				29
24				30
26	560	209	80	31
28	581	217	83	32
30	602	225	85	34
32	622	232	88	35

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Chapter 7
Building Air Leakage Testing

Participating Contractors are required to follow the order of inspection procedures as described on page 3.

See Appendix N: "BPI Guidance on Fireplaces and Blower Door Testing"

A. Non-Feasibility Criteria

Blower door testing is not permitted if any of the following conditions are present:

a. Any friable asbestos (PACM) is present.
   1) See Appendix M, "BPI Clarification on Blower Door Testing in the Presence of ACM."

1.

b. A combustion hazard is present (e.g., a gas leak, excessive ambient or flue gas CO).

c. Any health or safety issue that will impact the occupants is present (see Chapter 2, Section C regarding hazardous materials).

d. Blower Door testing will create an unsafe condition

e. Customer refuses.

2. Use Vintage Defaults in Appendix A, when shell leakage testing cannot be performed.

B. Blower Door *Pressurization* Test Procedure

3. *Pressurization* Blower Door testing is the *standard* test method for Home Upgrade.

House Setup for Blower Door Test

a. Turn **off** all exhaust fans, clothes dryer, heating and cooling equipment (including evaporative cooler and whole house fan), and combustion appliances.

b. **Close** all exterior doors, windows, and access hatches to attic and crawlspace.

c. **Open** all interior doors to conditioned rooms.

d. **Open** door(s) to basement, if present and it is a conditioned space.

e. **Close** all dampers, and extinguish all fires, when a fireplace or wood stove is present.
   1) Do not seal fireplace openings.
   2) *Caution:* Do not allow blower door testing to rekindle embers or fan a fire in a solid fuel appliance.
   3) See Appendix N: "BPI Guidance on Fireplaces and Blower Door Testing."

f. Lap seal all of the following:
   1) Exhaust fans (bathroom, utility room, etc.) and kitchen range hood that are within the conditioned space *and* vented outdoors.

      Exception*:* Do not lap seal at any location where PACM will be disturbed.

g. Place covers (if present) on evaporative cooler outlets, window air conditioners and pet doors.

1) Do not seal off whole house fan shutters entirely. Use three strips of masking tape, applied perpendicularly across the louvers (near the ends and center), to keep them from blowing open.
2) If a pet door has no cover, and test pressure pushes it open, apply one or more horizontal strips of masking tape across it, to keep the pet door closed during testing.

h. Leave **open** supply registers and return grilles (do *not* seal them off with tape or plastic).

Blower Door and DG-700 Setup[2]

a. Select an exterior door location that will allow adequate airflow from outdoors, and an unobstructed work area inside.

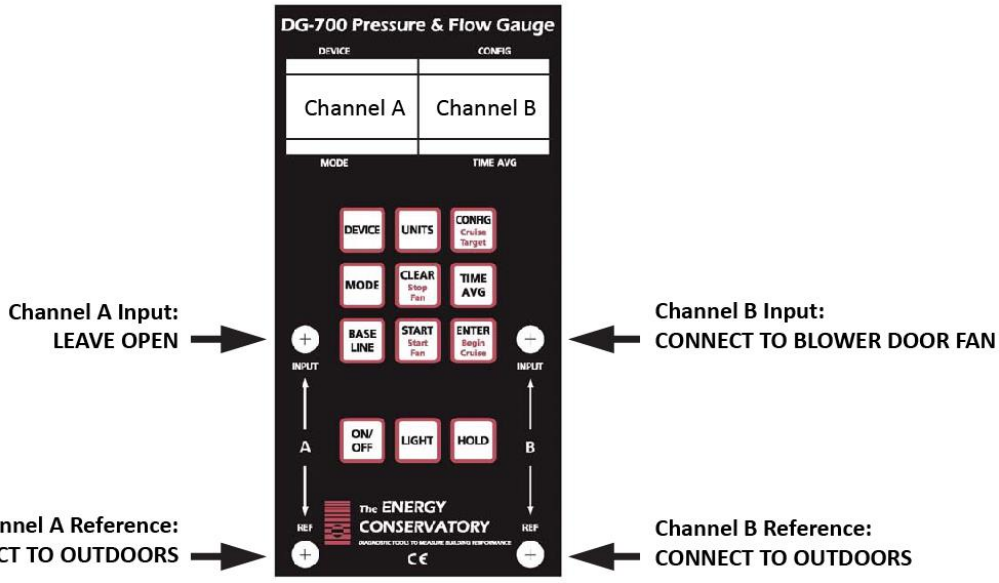
4. b. Assemble the frame, panel, fan and manometer.

c. Orient the fan for a *pressurization* test (flow rings *outdoors*), and install it in the panel.

d. **Speed Control**: Connect the fan speed controller to the fan, and plug it into a 110V outlet.

e. **Tubing**: Make tubing connections, as illustrated below.
1) Extend tubing from Channel "A" and "B" *Reference* taps to outdoors.
a) Use a tee to join the tubes into one tube that extends outdoors, and insert that tube through a hole in the Blower Door panel.
4) Extend the tubing at least five feet away from the fan flow in a protected area (e.g., along the foundation).
a) To protect from wind, tubing can be placed inside a bottle or other container, or inside an outbuilding (garage, shed, etc.).

Positive Blower Door Test - Manometer Hose Connections



2. Set up DG 700

[2] The test procedures in this section are for The Energy Conservatory (Minneapolis) equipment. See manufacturer's instruction manuals for other equipment brands.

f. Mode: Press MODE button until "PR/FL @50" appears in the MODE screen (lower left).

g. Device: Press DEVICE button until "BD 3" appears in the DEVICE screen (upper left).

h. Units: Press UNITS button if necessary, until Channel "B" shows "CFM" for airflow units.

i. Configuration:
   1) Press the CONFIG button to select Flow Ring being used (A1, B2, C3, or Open).
   2) Use the Flow Ring that best matches the Channel "B" airflow, per the table below.

Fan Configuration	Flow Range (cfm)
Open (no Flow Ring)	6,300 – 2,425
Ring A	2,800 – 915
Ring B	1,100 – 300
Ring C	330 – 85

   3) **Time Averaging**: To reduce fluctuations in Channel "B" CFM readings, press TIME AVG to select a period longer than the default 1-Sec. Averaging ("5," "10," or "Long"). 5-Sec Averaging is recommended to start.

3. ***Pressurization* Test Procedure**

j. Measure "Baseline" building pressure on the DG-700.
   1) With the Blower Door fan sealed, measure Baseline WRT outside.
   2) Press the BASELINE button ("BASELINE" will begin to flash on the Channel "A" screen).
   3) Press START ("BASELINE" stops flashing in Channel "A," and Channel "B" becomes a timer).
   4) Wait minimum 10 seconds (or until the Channel "A" reading becomes stable)
   5) Press ENTER, and Channel "A" now displays the "baseline adjusted reading."
      a) "ADJ" appears in the Channel "A" display.
      b) The baseline pressure is automatically subtracted from the current pressure measurement, eliminating the need to manually correct for baseline pressure.

k. Uncover Blower Door fan.

l. Turn on the Blower Door speed controller and slowly bring house pressure up to **+50 Pa.** The Cruise Control feature can be used to maintain a constant 50 Pa (see Section E below).

m. Record the flow CFM shown on Channel "B."
   1) Photograph the manometer's digital display and tubing connections.
   2) Photograph the blower door to illustrate which rings are installed.

n. When "----" or "LO" appears on Channel "B" display, change configuration as described in Section F below.

o. If the maximum pressure achieved is less than 10 Pa, use Vintage Table Default values in Appendix A.

p. Disassemble the equipment safely and appropriately.

q. Return the house to the previously existing conditions.

C. Blower Door *Depressurization* Test Procedure[3]

Depressurization Blower Door testing is an allowable alternative to the *Pressurization standard test method* only if a health and safety issue precludes use of the pressurization test.

House Setup for Blower Door Test

a. Turn **off** all exhaust fans, clothes dryer, heating and cooling equipment (including evaporative cooler and whole house fan), and combustion appliances.

b. **Close** all exterior doors, windows, and access hatches to attic and crawl spaces.

5.

c. **Open** all interior doors to conditioned rooms.

d. **Open** door(s) to basement, if present and it is a conditioned space.

e. Lap sealing **limitations**:
   1) Lap seal an exhaust fan or kitchen range hood ***only if*** it is vented outdoors and does ***not*** have a functional damper.
   2) Do **not** lap seal at any location where PACM will be disturbed.

f. **Close** all dampers, and extinguish all fires, when a fireplace or wood stove is present.
   1) Do **not** seal fireplace openings.
   2) ***Caution:*** Do **not** allow blower door testing to rekindle embers or fan a fire in a solid fuel appliance.
   3) See Appendix N: "BPI Guidance on Fireplaces and Blower Door Testing in the Presence of ACM."

g. Place covers (if present) on evaporative cooler supply outlets, air conditioners, and pet doors.
   1) Do **not** seal off whole house fan shutters entirely. Use three strips of masking tape, applied perpendicularly across the louvers (near the ends and center), to keep them from blowing open.
   2) If a pet door has no cover, and test pressure pushes it open, apply one or more horizontal strips of masking tape across it, to keep the pet door closed during testing.

h. Leave **open** supply registers and return grilles (do *not* seal them off with tape or plastic).

2. **Blower Door and DG-700 Setup[4]**

i. Select an exterior door that will allow adequate airflow from outdoors and an unobstructed work area inside.

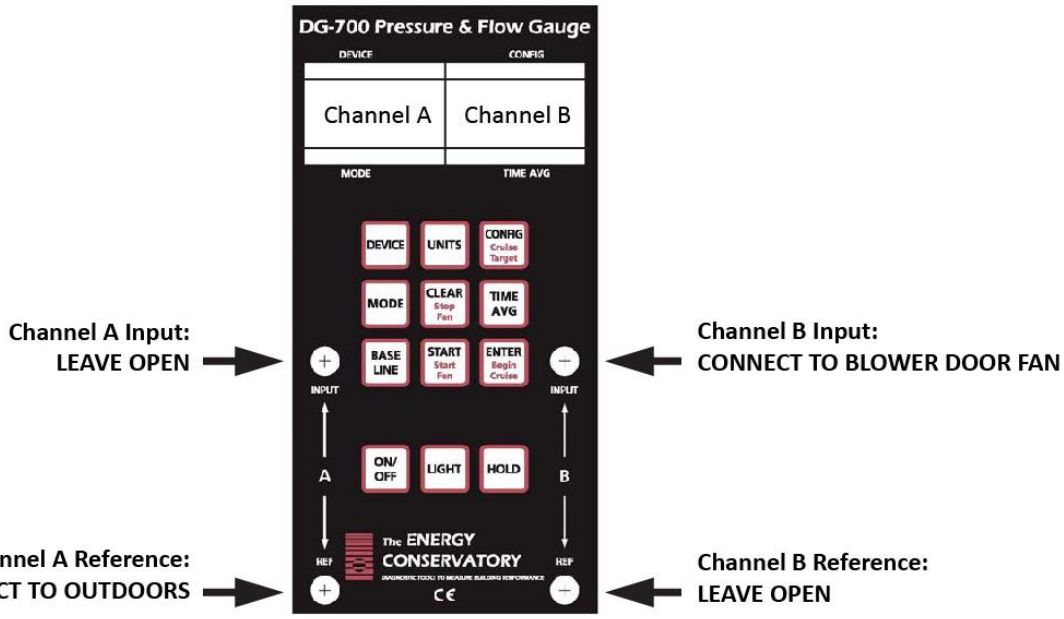
j. Assemble the frame, panel, fan, and manometer.

k. Orient the fan for a *Depressurization* test (flow rings facing *indoors*), and install it in the panel.

l. **Speed Control**: Connect the fan speed controller to the fan, and plug it into a 110V outlet.

[3] The test procedures in this section are for The Energy Conservatory (Minneapolis) equipment. See manufacturer's instruction manuals for other equipment brands.

Negative Blower Door Test - Manometer Hose Connections



m. **Tubing**: Make tubing connections.

1) Extend tubing from Channel "A" and "B" Reference taps to outdoors.

a) Use a tee to join the tubes into one tube that extends outdoors, and insert that tube through a hole in the Blower Door panel.

2) Extend the tubing at least 5 feet away from the fan flow in a protected area (e.g., along the foundation).

a) To protect from wind, tubing can be placed inside a bottle or other container, or inside an outbuilding (garage, shed, etc.).

3. **Set up DG-700**

n. **Mode**: Press MODE button until "PR/FL @50" appears in the MODE screen (lower left).

o. **Device**: Press DEVICE button until "BD 3" appears in the DEVICE screen (upper left).

p. **Units**: Press UNITS button if necessary, until Channel "B" shows "CFM" for airflow units.

q. Configuration:

1) Press the CONFIG button to select Flow Ring being used (A1, B2, C3, or Open).

2) Use the Flow Ring that best matches the Channel "B" airflow, per the table below.

Fan Configuration	Flow Range (cfm)
Open (no Flow Ring)	6,300 – 2,425
Ring A	2,800 – 915
Ring B	1,100 – 300
Ring C	330 – 85

3) **Time Averaging**: To reduce fluctuations in Channel "B" CFM readings, press "TIME AVG" to select a period longer than the default 1-Sec. Averaging ("5", "10" or "Long"). 5-Sec Averaging is recommended to start.

4. **Depressurization Test Procedure**

r. Measure "Baseline" building pressure on the DG-700.
   1) With the Blower Door fan sealed, measure Baseline WRT outside.
   2) Press the BASELINE button ("BASELINE" will begin to flash on the Channel "A" screen).
   3) Press START ("BASELINE" stops flashing in Channel "A," and Channel "B" becomes a timer).
   4) Wait minimum 10 seconds (or until the Channel "A" reading becomes stable).
   5) Press ENTER, and Channel "A" now displays the "baseline adjusted reading."
      a) "ADJ" appears in the Channel "A" display.
      b) The baseline pressure is automatically subtracted from the current pressure measurement, eliminating the need to manually correct for baseline pressure.

s. Uncover Blower Door fan.

t. Turn on the Blower Door speed controller and slowly bring house pressure up to **–50 Pa.** The Cruise Control feature can be used to maintain a constant 50 Pa (see Section E below).

u. Record the flow CFM shown on Channel "B."
   1) Photograph the manometer's digital display and tubing connections.
   2) Photograph the blower door to illustrate which rings are installed.

v. When "----" or "LO" appears on Channel "B" display, change configuration as described in Section F below.

w. If the maximum pressure achieved is less than 10 Pa, use Vintage Table Default values in Appendix A.

x. Disassemble the equipment safely and appropriately.

y. Return the house to the previously existing conditions.

6. ## D. Cruise Control

Blower Door **Cruise** Procedure

a. DG-700 Operation
   1) Connect a fan control cable from the DG-700 fan control output jack to the speed controller communication jack.
   2) Press MODE to select "PR/FL@50," so the DG-700 will automatically maintain a house pressure of 50 Pa.
   3) Adjust the knob on the Blower Door fan speed controller to the **just-on** position (control knob turned clockwise just enough to hear a click; On/Off switched (if present) flipped to
7. on). The fan will *not* be turning.
   4) Press the "Begin Cruise" button. Cruise target pressure will appear in Channel "A," and the Cruise icon will flash.

b. Press "Start Fan." The fan will begin ramping up to the target building pressure.

"CLEAR Stop Fan" Button

a. "Stop Fan" turns off the fan when done cruising.
   5) The "Cruise" icon flashes and Channel "A" shows the Cruise target pressure.

6) Cruising may be resumed by pressing “Start Fan.”

b. Press CLEAR button to exit the cruise feature.

E. When “----” or “LO” Appears On Channel “B” Display

1. These warning symbols appear in the DG-700 CFM display when fan flow is out of range, and the DG-700 cannot calculate a reliable leakage estimate.
2. **“----” or “LO” Continuously Displayed**

c. **“----”** means Duct Pressure is too low (< 5 Pa).

d. **“LO”** means Fan Flow CFM is negligible.

e. When this happens, remove the Flow Rings, or install a larger Flow Ring, to allow more fan flow.

3. **“LO” alternating with a CFM reading**

f. This means you are trying to measure an airflow outside the range of the current fan Configuration.

g. Change Configuration to match the flow rate—as shown in separate tables above for Blower Door and Duct Blaster.

1) Install a Flow Ring (if in “Open Fan” mode), or

2) Install a higher # Flow Ring (with smaller opening).

Remember: If the flow ring is changed, be sure to use the CONFIG button to change Configuration in the DG-700 to match the new fan Configuration.

F. Blower Door Flow Conversion Table (Model 3) *

To correct a Channel "B" flow reading taken when the DG-700 "Config" selection did not match the Flow Ring actually installed, use the Blower Door Operation Manual, Appendix B, Flow Conversion Tables for Model 3 (see next page).

1. This procedure may be used only when necessary to avoid returning to a home to re-test, if discovered after the fact that the flow ring used did not match the "Config" settings on the
8. manometer.

2. Using the Flow Conversion Table, do the following:

   a. Select the column for the "Config" selection visible at the top of the Channel "B" display (Open, A1, B2, or C3). That is the configuration for which the DG-700 was improperly set.

   b. Move down that column to the flow reading closest to the test result (Channel "B" CFM reading).

   c. Move across that same row to the column for the *ring actually installed* during the test.

   d. That value is the "corrected" CFM for the ring actually used. Record that as the CFM test result, instead of the incorrect Channel "B" CFM reading.

3. Example:

   e. Assume:
      1) The DG-700 "Config" icon is "B2" (the gauge is told Ring B is installed), and the Channel "B" display shows **421** CFM.
      2) However, Ring A is *installed* in the Blower Door fan.

   f. Using the "Flow Conversion Tables" do this:
      1) Select the "Ring B" column in the table, and move down to the row showing **421**.
      3) Move left across that row to the "Ring A" column, where the value is **1281**.

   g. The "corrected" flow is **1281 CFM**, which is recorded as the CFM test result.

*An example of "Flow Conversion Tables" appears on the next page, in an Excerpt from Appendix B of the Minneapolis Blower Door™ Operation Manual.

Appendix B Flow Conversion Tables

Model 3 (110V)

Flow (cfm)

Fan Pressure (Pa)	Open Fan	Ring A	Ring B	Ring C
16				89
18				94
20				99
22				104
24				109
26	2484	931	305	114
28	2576	965	316	118
30	2664	998	327	122
32	2749	1030	338	127
34	2832	1061	348	131
36	2912	1091	358	134
38	2990	1120	368	138
40	3065	1149	377	142
42	3139	1176	387	145
44	3211	1203	396	149
46	3282	1230	404	152
48	3351	1255	413	156
50	3418	1281	421	159
52	3484	1305	430	162
54	3549	1330	438	165
56	3612	1353	446	169
58	3675	1377	454	172
60	3736	1400	461	175
62	3796	1422	469	178
64	3855	1444	476	181

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Chapter 8

HVAC and DHW Systems Data Collection

A. Heating Systems

For procedures and considerations related to CAZ/CAS safety issues, see Chapters 1 – 5.

Determine how many heating systems exist in the home, and what type each system is.

a. If there is more than one system, determine which portion of the home each heating system serves.

1.

2. b. Appropriately name each system for easy identification in inspection documents. Example: "HVAC 1 first floor"

4. Photograph equipment installation and data plate, if accessible.

5. Verify for each heating unit:

   c. Manufacturer

   d. Model number

   e. Fuel type

   f. Location

   g. Age and condition

   h. Btuh Input rating

   i. Btuh Output rating

   j. Efficiency rating (AFUE, HSPF, etc.), when available

   k. Distribution type

   l. (FAU) Presence of a NOx rod

6. Vintage table and program default values will be used when data plate information is not available or is incomplete.

7. For a horizontal FAU, determine if is subject to recall. See Appendix G: NOx Rod Furnace Identification and Inspection Procedure.

3.

G. Cooling Systems

Determine how many cooling systems exist in the home, and what type each system is.

a. If there is more than one system, determine which portion of the home each heating system serves.

b. Appropriately name each system for easy identification in inspection documents. Example: "HVAC 1 first floor"

1. Photograph equipment installation and data plate, if accessible.

2. Verify for each cooling unit:

   c. Manufacturer

d. Model number
e. Age and condition
f. AC tons (1 ton per 12,000 Btu of cooling)
g. SEER and EER ratings
h. Condenser location
i. Distribution type
j. Evaporator coil make and model number (if available)

3. Inspect the circuit breakers (or fuses) at the main service and service disconnect, to ensure that overcurrent protection is appropriate for the amp draw of the system.
4. Inspect condensate drain for any issues.
5. Inspect line-set for any issues.
6. Vintage table and program default values will be used when data plate information is not available or is incomplete.

H. Duct Systems

1. Conduct a visual inspection of the duct system(s), and record the following for each one:
   k. Filter condition
   l. Duct locations (in conditioned space, unconditioned space, or both)
      1) For both supply and return ducts
   m. Duct insulation R-value
      1) For both supply and return sides
      2) For each side, describe differences, if not uniform
   n. Duct condition
      1) For both supply and return ducts
   o. Verify if ducts are buried
      1) To qualify as "buried ducts", all the following must be true:
         a) Duct sleeve R-value must be at least R-6.
         b) Supply ducts completely buried.
         c) Insulation must be level and not mounded over the duct runs.
      2) Describe insulation type(s) and depth(s)
2. Verify that IAQ requirements for duct connections have been met (see Chapter 9, Section D).
3. Vintage table and program default values will be used, when duct R-Value cannot be determined (from markings on flex duct jacket, or evaluation of insulation on rigid ducts).

I. Domestic Hot Water (DHW) Systems

1. For procedures and considerations related to CAZ/CAS safety issues, see Chapters 1 – 4.

2. Determine how many DHW systems exist in the home and the DHW type(s). If there are is more than one system, determine which portion of the home each DHW system serves.
3. Verify for each storage DHW system:
   p. Location
   q. Manufacturer
   r. Model number
   s. Tank size (gallons)
   t. Fuel type
   u. Combustion type (open, closed, mechanical vent)
   v. Btuh Input rating
   w. Energy Factor (if available)
   x. Internal R-value (if available)
   y. External insulation (blanket) present or not
   z. Age and condition
   aa. Temperature setting
4. Verify for each tankless DHW system:
   bb. Location/Type (indoor, outdoor)
   cc. Manufacturer
   dd. Model number
   ee. Fuel type
   ff. Combustion type (open, closed)
   gg. Btuh Input rating
   hh. Burner threshold gpm (minimum gpm required to activate burner)
   ii. Age and condition
5. Vintage table and program default values will be used when data plate information and manufacturer's specifications are not available.
6. QC inspectors will not remove water heater blanket for collection of appliance data.
7. Low-Flow fixtures:
   jj. Verify installation of low-flow shower heads (LFSH) maximum 1.5 gallons per minute (gpm) in all showers.
      1) Record number of installed LFSH and gpm of each.
      2) If DHW is tankless:
         a) Compare LFSH gpm with DHW burner threshold gpm.
         b) Installed LFSH gpm must exceed burner threshold gpm
   kk. Verify installation of Thermostatic Shut-off Valve (TSV) in each shower.

1) For each TSV, record location and type: separate TSV or LFSH with integral TSV (TSV/Showerhead combination).
2) TSVs may not be installed on a shower served by a tankless water heater or continuously-circulating hot water system.
3) TSVs are not required in sit-down showers.

8. Water Heater Pipe Insulation:

ll. Minimum clearance requirements between pipe insulation and the vent connector/pipe and draft hood:
1) 1″ from Type B double-wall gas vent pipe
2) 3″ from Type L double-wall gas vent pipe
3) 6″ from single-wall gas vent connector
4) Draft hood opening must not be obstructed

mm. When pipe insulation is without proper clearance to the vent pipe or the draft hood opening, the inspector will (a) cut the insulation to meet the clearance requirements, or (b) remove the insulation entirely, if the clearance requirements cannot be met.

Chapter 9
Insulation Requirements and Inspection Procedures

A. Attic Insulation Non-Feasibility Criteria

9. Attic Insulation should **not** be installed in the following conditions:
   a. The roof is leaky or shows signs of water damage from leaks that have not been repaired.
   b. Exhaust fan vent(s) terminating in the attic cannot be vented to the outside.
   c. Knob-and-tube wiring is present and:
      1) The wiring has *not* been surveyed/inspected by a C-10 contractor and certified safe to encapsulate (see Section C below), **or**
      2) Insulation over knob-and-tube wiring (live or abandoned) is prohibited by local code.

B. Heat Producing Devices (HPDs)

Prior to insulating the attic the contractor must adhere to the following:

1. a. Take photographs of insulation barriers installed around all Heat Producing Devices (HPDs), eave/soffit vents, and combustion air vents in the attic floor.
      1) HPDs include but are not limited to the following:
         a) Recessed light fixtures (exempt if fixtures are insulation contact rated).
         b) Exposed fluorescent fixtures.
         c) Doorbell transformers.
         d) Fan motors.
         e) Metal flues and vent pipes from combustion appliances and fireplaces.
         f) Masonry chimneys.
         g) Gas and electric appliances (e.g. water heaters and furnaces).
         h) Any other device that produces heat.
   b. Abandoned vent stacks are HPDs, due to the potential for future use.
         a) Contractors are required to remove the abandoned vent stack **or** install an insulation barrier around it.
   c. Insulation barrier materials:
      1) Metal barriers
         a) Metal barriers are recommended to extend at least 4” above the insulation.
         b) Metal barriers must be permanently attached to framing members with mechanical fasteners, where possible.
      2) Flexible mineral fiber (batt insulation) used as a barrier
         a) Batt insulation used as a barrier must extend 14-1/2” beyond the clearance zone (recommended minimum clearance between the HPD and combustible materials).
   d. Recommended barrier clearances between HPDs and installed insulation:

1) It is the responsibility of the contractor to ensure that all code and program requirements for the minimum clearance distance from any combustible material have been met.
2) It is recommended that contractors meet or exceed:
   a) Clearance requirements shown in equipment and insulation manufacturers' specifications, and
   b) Requirements of the local jurisdiction, when applicable.
3) The minimum clearance from any HPD being blocked by a barrier is 3," unless otherwise specified by code.
4) Appliance vent stack clearances to combustible materials:
   a) Double Wall Type B Vent Pipe: 1" or manufacturer's listed clearance.
   b) Double Wall Type L Vent Pipe: 3" or manufacturer's listed clearance.
   c) Single Wall Vent Pipe: 6" clearance per CMC Table 802.7.3.4(1).
5) Gas and electric appliances (e.g. water heaters and furnaces) clearances to combustible materials:
   a) Must follow manufacturer's specifications, when available.
   b) When manufacturer's specifications are not available, clearances must be:
      - 24" from front
      - 12" from top, back, bottom, and sides
   c) Metal insulation barriers may **not** be used.

2. The QC Vendor:

   a. Where accessibility permits, will determine if insulation is properly blocked and that no insulation is in contact with HPDs.

   b. Will not disturb newly-installed insulation materials during the inspection.

1. ## C. Knob-and-Tube Wiring

2. It is the responsibility of the contractor to meet all code and program requirements regarding knob-and-
3. tube wiring.

   Knob-and-tube wiring must not be encapsulated by insulation when prohibited by local code.

4.

   Installation must comply with all provisions of Article 394 of the 2013 California Electrical Code, which is the basis for the following two items (4 and 5).

   Where live knob-and-tube wiring is present:

   a. A C-10 licensed electrical contractor must survey all knob-and-tube wiring located in areas to be insulated, and must complete a "Notice of Survey by Electrical Contractor" (Appendix J), prior to the installation of any insulation.

   b. The "Notice of Survey by Electrical Contractor" must be explained to the homeowner.
      1) The homeowner must sign the notice, acknowledging that nuisance tripping may occur after proper overcurrent protection is installed.
      2) A copy of the notice must be given to the homeowner.

   c. A copy of the "Notice of Survey by Electrical Contractor" must be:

1) Posted at the primary entrance to each attic, basement and/or crawlspace in which installed insulation encapsulates knob-and-tube wiring.
2) Provided to the building department, when required in conjunction with obtaining a permit to insulate the attic, basement and/or crawlspace.

d. The contractor must place a "Warning Placard" (Appendix K), stating that caution is required when entering insulated areas because of covered electrical wiring.
   1) The warning placard must be written in both English and Spanish.
   2) A copy of the warning placard must be posted near **each** openable entrance to each attic, basement and/or crawlspace in which installed insulation encapsulates knob-and-tube wiring

e. Overcurrent Protection
   1) All encapsulated knob-and-tube wiring must have proper overcurrent protection.
   2) New overcurrent protection devices must be:
      a) Circuit breakers, with adequate amperage rating for the circuits they control, or

f. Properly-rated Type S fuses. Fuse ratings must comply with manufacturers' specifications and code.

g. Non-combustible Insulation
   1) Insulation that encapsulates knob-and-tube wiring must be non-combustible
   2) Contractor must submit documentation to the program that:
      a) Identifies the type of insulation installed, and
      b) Verifies that the insulation is non-combustible.

h. Insulation barriers and supports for knob and tube wiring must not contain any electrically-conductive material and must be non-combustible.

5.

Where abandoned and disconnected knob-and-tube wiring is present:

a. A C-10 licensed electrical contractor must survey all knob-and-tube wiring located in areas to be insulated and must complete a "Notice of Survey by Electrical Contractor" prior to the installation of any insulation
   1) The "Notice of Survey by Electrical Contractor" must specify that all knob-and-tube wiring located in all areas to be insulated is **not** live and has been abandoned and disconnected.
   2) A copy of the "Notice of Survey by Electrical Contractor" must be:
      a) Given to the homeowner, and
      b) Posted at the primary entrance to each attic, basement and/or crawlspace in which installed insulation encapsulates knob-and-tube wiring, and
      c) Provided to the building department, when required in conjunction with obtaining a permit to insulate the attic, basement and/or crawlspace.

b. The electrical contractor, by severing wires in the attic or by other means, must ensure that all abandoned and disconnected wiring cannot be energized by reconnecting abandoned feeder conductors to a service panel or other power source.

D. Indoor Air Quality (IAQ)

For purposes of maintaining Indoor Air Quality (IAQ) when attic insulation is installed and is in contact with ductwork, all accessible supply and return duct connections (including duct-to-register boot connections) are to be sealed.

a. Sealing must be performed in accordance with 2016 Title 24 Residential Compliance Manual, Chapter 4, Section 4.4.4., "Duct Installation Standards."

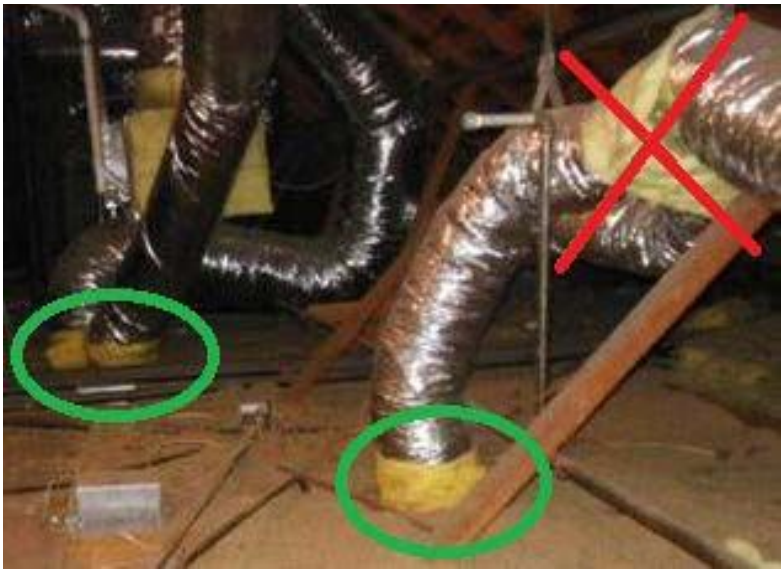
1. b. Duct sealing materials must meet the applicable requirements of UL-181 and be labeled as shown in Table 9-1.

Table 9-1. Duct Sealing Materials

Duct Type	Sealing Material	UL Identification
Rigid Metal and Fiberglass Ducts and Components [UL 181A Standard]	Pressure Sensitive Tape	**Marked "181A-P"** or **"181A-P/181B-FX"**
	Heat Activated Tape	**Marked "181A-H"**
	Mastic	**Labeled "181A-M"** or **"181A-M/181B-M"**
Flexible Ducts [UL 181B Standard]	Pressure Sensitive Tape	**Marked "181B-FX"** or **"181A-P/181B-FX"**
	Mastic	**Labeled "181B-M"** or **"181A-M/181B-M"**

2. Ducts hanging in the attic that do not come in contact with insulation installed by the contractor do not require sealing for IAQ purposes *(see photograph below)*.

3.



When contractors install wall insulation:

a. When ducts are contained within a wall cavity, the contractor must seal all duct-to-register-boot connections, located in walls being insulated.

b. Sealing may be performed inside the register boot.

c. Sealing materials (e.g., mastic and tape) must be in compliance with guidelines in Section D, Item 1 above.

When contractors perform air sealing, install attic insulation, replace windows or if building air leakage is less than 0.35 ACHn, all exhaust fans (vented range hood, bathroom and utility room fans, etc.) must exhaust outdoors through a continuous duct.

E. Attic Insulation Inspection

4. Identify the ceiling type (Standard Attic, Cathedral, Vaulted, Knee Wall, etc.).

Evaluate attic access(s) and access location(s). For each, note accessibility and barriers to entrance (e.g., located above a shelf in a clothes closet).

1. Do not enter and attic where a health or safety issue is identified, including but not limited to:

2. a. Energized knob-and-tube wiring

3. b. A gas leak odor is detected in the attic

c. Insect or animal infestation

d. Unsound structure/framing that may not provide adequate support (e.g., joists that are undersized, too far apart, bowed, or sagging)

4. Before entering an attic accessed from the living space, protect floor and adjacent areas with a drop cloth.

5. When entering an attic:

a. Wear personal protective equipment, such as coveralls or breathable protective suit, safety glasses, dust mask, hard hat, and knee pads.

b. Be equipped with necessary tools, such as measuring tape and a flashlight (an adjustable “head lamp” is recommended, to free up both hands).

6. After safely entering the attic, do the following:

a. Determine insulation type, depth and R-Value based on BPI Standards.
   1) If attic has loose-fill insulation installed, take a minimum of three reference photographs, in diverse locations, clearly showing the level of insulation on a tape measure.
   2) Establish the total area covered by the insulation and its overall condition (take multiple and definitive photos).
   3) Separately record multiple assembly types, R-Values, and insulated areas.
   4) Use Vintage Table Default R-values, when attic insulation is inaccessible.

b. Where accessibility permits, determine if HPD clearance requirements have been met, and that no insulation is inside the clearance zone around each HPD.

c. Where knob and tube wiring is present:
   1) Verify that the “Notice of Survey by Electrical Contractor” has been posted at the primary entrance.
   2) Verify that a warning placard has been posted at each openable entrance.

d. Check for radiant barrier(s):
   1) Determine whether a radiant barrier is present.

2) If so, document with photographs to indicate type and location.

e. Record the presence of attic ventilation fan(s).

f. Identify all hazards or potential hazards (take multiple and definitive photographs).

F. Wall Insulation Inspection

Determine the orientation of the front wall. (with back to the front wall, facing the street will yield the correct orientation).

Determine cavity depth of each wall.

1. Calculate the total (gross) area of each wall (including windows and doors).

R-value

2.

3. a. Pre-retrofit wall insulation R-value will be determined using Vintage Table Defaults.

4. b. The contractor must submit documentation of improved wall insulation R-Value.

Look for evidence of installation: drill-and-fill stucco patches, etc.

5.

G. Floor Insulation Inspection

Determine the type(s) of floor(s) and area of each type.

1. Determine insulation type, depth, and R-Value based on BPI standards.

2. Determine the cavity depth.

3. Calculate the total accessible floor area.

4. Identify all hazards or potential hazards (take multiple and definitive photographs).

5.

Chapter 10
Exterior Window and Door Data Collection

A. Windows

French doors, sliding glass doors and single-lite doors are considered windows, when recording data and modeling. All other doors (less than 50% glazing) are recorded as doors.

Determine orientation of each wall.

1. Identify window frame construction, glazing type and number of panes.
2. a. Specify all window types in the sketch and notes section.
3. Measure windows from outside the home.
4. a. Measure the rough opening.
   b. Record measurements in ½-foot increments (e.g., 3030, 3036, etc.)

5. For each wall, calculate the area of each window, and the total number of windows in the wall.

B. Doors

1. Identify the number of doors and door materials construction for each wall.
2. Determine if the air seal is adequate for each door (or if weather-stripping is needed).
3. Calculate the total area of the doors in each wall.
4. When the door is considered a window (≥50% glazing), record area of it in the window section only.

C. Skylights

1. Calculate the total area for each skylight by measuring the well length and width. Separately measure and record the well height.
2. Identify frame construction and number of panes.

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Chapter 11
Miscellaneous Inspection Data

A. Cool Roof

Verify the manufacturer, CRRC ID #, square footage and roof type.

B. Energy Efficient Ducted Evaporative Cooling Systems (EEDECS)

1. Verify the manufacturer and model number.

   Determine if it is a single-stage or two-stage system, and if it has pressure relief dampers.

1.
2.

C. Pool and Spa Heaters

Identify if there is a pool or spa at the home.

Verify the heating fuel type if applicable.

1.
2. Verify the number of hours the heating source is used per day.
3.

D. Pool and Spa Pumps

1. Pool pump replacement is allowed in the Home Upgrade program, if a single-speed or two-speed pump is replaced with a variable-speed pump and variable-speed drive (digital controller).
2. Spa pump replacement is not considered part of the Home Upgrade program.
3. Inspection procedure for existing (pre-retrofit) pump and controller:

   a. Record brand and model # of existing pump.

   b. Record type of controller (mechanical timer, digital controller, etc.)

   c. Attempt to determine if pump is single speed, two-speed, or variable-speed from pump label, controller settings, etc.

4.

   d. Capture photos of pump, pump data plate, and controller.

   Inspection procedure for replacement (post-retrofit) pump and controller:

   a. Record brand and model # of replacement pump.

   b. Record brand and model # of replacement controller, if controller is not onboard pump.

   c. Verify that the pump's maximum amperage (see data plate) does not exceed overcurrent protection at the circuit breaker and the service disconnect, if present.

   d. Verify that there are no charred wires.

E. ENERGY STAR® Labeled Ceiling Fans with ENERGY STAR CFL(s)

Identify the manufacturer, model number, quantity, and locations.

F. Inspection Recap

List anything that may be vital and unaccounted for in the data collection form.

1. Note anything that was different from the contractor's data, as it may have a significant effect on energy modeling.

1.
2.

Chapter 12
Photographs and House Sketch

A. Photographs

Take multiple and definitive photographs including:

Exterior of home on all sides.

Attic photographs showing insulated and uninsulated spaces, kneewalls, insulation installation quality, Insulation depth with a ruler or tape measure, duct conditions, duct R-value labels, heat producing devices, insulation barriers, knob-and-tube wiring, CVA vents and ducts, safety concerns, etc.

1.

2. Crawlspace photographs showing insulated and uninsulated spaces, insulation installation quality, Insulation depth with a ruler or tape measure, duct conditions, duct R-value labels, heat producing devices, insulation barriers, safety concerns, etc.

3. Appliance photographs showing installed location and configuration.

4. Appliance data plate photographs showing legible equipment data, including brand, model and serial numbers, input, output, efficiencies, etc.

5. Low-flow water fixture installation in showers when used in with tankless water heaters, including LFSHs and TCVsTSVs.

6. Evidence of safety concerns, improper conditions.

7.

8. Any other pertinent conditions or installations related to quality control and/or safety

NOTE: For Advanced Home Upgrade custom path projects, please see the Test-in Photo Documentation requirements. located in the P&P.

B. Sketch floor plan of house

1. Include the following data:

2. Schematic footprint/layout of foundation.

3.

4. Wall linear dimensions.

5. Window types, locations and rough opening dimensions.

6. Roof types (attic, vaulted, cathedral, flat) and locations of changes in roof section types.

7.

8. Knee wall locations and dimensions.

9. Ceiling heights for each ceiling configuration.

10. Floor types (raised, slab, etc.) and locations of changes in floor section types.

11.

12. Identify main entrance.

13. North arrow for building orientation.

Conditioned floor area measurements.

Multiple HVAC zone divisions.

Multiple DHW zone divisions.

Location and dimension of unconditioned areas (screened porches, etc.).

Sketch multiple stories separately. Indicate where adjacent story overlays other floors, indicate living spaces over garages and cantilever floor sections.

Appendix A
Vintage Default Table / Window Default U-Factor and SHGC

A. Vintage Default Table

Home Upgrade
Energy Upgrade California®

Home Upgrade Program Default Assumptions for Existing Residential Buildings by Year Built (Vintage)

	BEFORE 1950	1950-1977	1978-1983	1984-1991	1992	1993-1998	1999-2000	2001	2002-2003	2004-2005	2006 AND LATER
Leakage											
Building (SLA) – Home Upgrade	7.1	7.1	5.2	5.2	5.2	4.6	4.6	4.6	none	none	none
Building (SLA) – Advanced Home Upgrade	10.2	8.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Duct Leakage Percentage	28%	28%	28%	28%	28%	28%	28%	22%	22%	22%	22%
Space Heating Efficiency											
Gas Furnace (central) AFUE	0.75	0.75	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Gas Heater (room) AFUE	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Hydronic/ Combined Hydronic	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Heat Pump (HSPF)	5.6	5.6	5.6	6.6	6.6	6.6	6.8	6.8	6.8	6.8	7.4
Electric Resistance Radiant (HSPF)	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413
Space Cooling Efficiency											
All Types (SEER)	8.0	8.0	8.0	8.9	9.7	9.7	9.7	9.7	9.7	9.7	13.0
Water Heating											
Gas Heater (EF)	0.525	0.525	0.525	0.525	0.525	0.525	0.575	0.575	0.575	0.575	0.575
Insulation R-Value											
Roof/Ceiling	R-11	R-11	R-19	R-19	R-19	R-19	R-19	R-19	R-19	R-19	R-19
Wall	none	none	R-11	R-11	R-13	R-13	R-13	R-13	R-13	R-13	R-13
Raised Floor – Crawl Space	none	none	none	none	R-13	R-13	R-13	R-13	R-13	R-13	R-13
Raised Floor – No Crawl Space	none	none	none	none	R-13	R-13	R-13	R-13	R-13	R-13	R-13
Duct Insulation	R-2.1	R-2.1	R-2.1	R-2.1	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2	R-4.2	R-6

EUC-HU-VDT-V2-0516

Energy Upgrade California® Home Upgrade provides assistance and incentives for home improvement projects that can reduce energy use and make homes more comfortable. This statewide program is managed locally by utilities and regional energy networks and directed by the California Public Utilities Commission in collaboration with the California Energy Commission. Funding comes from utility customers under the auspices of the California Public Utilities Commission. Incentives are offered on a first-come, first-served basis and are effective until the funding is expended or the program is discontinued. Terms and conditions apply. See program rules for details. Programs may be modified or terminated without prior notice.

Home Upgrade Program Default Assumptions for Existing Residential Buildings by Year Built (Vintage) Updated 05/12/16

B. Window Default U-Factor and SHGC

(from pages 98-99 2013 Building Energy Efficiency Standards)

Table 110.6-A Default Fenestration Product U-Factors				
FRAME	PRODUCT TYPE	SINGLE PANE [3, 4] U-FACTOR	DOUBLE PANE [1,3,4,] U-FACTOR	GLASS BLOCK [2,3] U-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/Garden Window	2.26	1.40	N.A.
	Doors	1.25	0.77	N.A.
	Skylight	1.98	1.30	N.A.
Metal, Thermal Break	Operable	N.A.	0.66	N.A.
	Fixed	N.A.	0.55	N.A.
	Greenhouse/Garden Window	N.A.	1.12	N.A.
	Doors	N.A.	0.59	N.A.
	Skylight	N.A.	1.11	N.A.
Non-Metal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Greenhouse/Garden Window	0.99	0.53	N.A.
	Doors	1.94	1.06	N.A.
	Skylight	1.47	0.84	N.A.

1. For all dual-glazed fenestration products, adjust the listed U-factors as follows:
   a. Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.
   b. Add 0.50 to any product with true divided lite (dividers through the panes).
2. Translucent or transparent panels shall use glass block values when not rated by NFRC 100.
3. Visible transmittance (VT) shall be calculated by using reference Nonresidential Appendix NA6.
4. Windows with window film applied that is not rated by NFRC 100 shall use default values from this table.

Table 110.6-B Default Solar Heat Gain Coefficient (SHGC)					
			Fenestration Product SHGC		
FRAME TYPE	PRODUCT	GLAZING	SINGLE PANE [2,3] SHGC	DOUBLE PANE [2,3] SHGC	GLASS BLOCK [1,2] SHGC
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	N.A.
	Fixed	Tinted	0.68	0.60	N.A.
Metal, Thermal Break	Operable	Clear	N.A.	0.63	N.A.
	Fixed	Clear	N.A.	0.69	N.A.
	Operable	Tinted	N.A.	0.53	N.A.
	Fixed	Tinted	N.A.	0.57	N.A.
Non-Metal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	N.A.
	Fixed	Tinted	0.63	0.55	N.A.

1. Translucent or transparent panels shall use glass block values when not rated by NFRC 200.
2. Visible transmittance (VT) shall be calculated by using reference Nonresidential Appendix NA6.
3. Windows with window film applied that is not rated by NFRC 200 shall use default values from this table.

Appendix B
Default Btuh Input Ratings

When the Btuh Input rating cannot be obtained from the manufacturer's nameplate, the following default values may be used:

Forced Air Furnaces:

a. 25,000 Btuh per burner

Wall Furnaces:

1. a. Single Sided: 35,000 Btuh
2. b. Double Sided with two burners: 60,000 Btuh

Floor Furnaces:

a. Standard: 30,000 Btuh (22" wide or smaller)
3. b. Large: 60,000 Btuh (wider than 22")

Free-Standing Heaters:

4. a. Small (up to 25" wide): 25,000 Btuh
b. Standard (26" to 32" wide): 50,000 Btuh
c. Large (34" or wider): 60,000 Btuh

5. Water Heater:

a. 1,000 Btuh per gallon
6. Cooktop Burner:

7. a. 10,000 Btuh per burner

Ovens:

a. 20,000 Btuh per burner

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Appendix C

Zone Ambient CO Action Levels

	Zone Ambient CO Action Levels
Zone/Room Ambient (other than Kitchen)	**9 to 35 ppm:** a. Advise the occupants. a. Open windows and exterior doors to ventilate the dwelling. b. When CO appears to be created by gas appliance(s), advise the homeowner or their designated representative to have the appliance(s) serviced by a qualified professional
	36 to 69 ppm: a. Advise the occupants. b. Open windows and exterior doors to ventilate the dwelling. c. Immediately shut down all possible sources of CO. d. When CO appears to be created by gas appliance(s), advise the homeowner or their designated representative to have the appliance(s) serviced by a qualified professional
	≥ 70 ppm: a. Terminate the inspection immediately. b. Notify the occupants, and evacuate the area. c. From outside the home, immediately contact a certified professional to address the hazard. d. Notify the homeowner or their designated representative, if not present at the jobsite.
Kitchen Room Ambient†	**> 9 ppm:** Recommend Service or Repair

† Kitchen Ambient CO measurements are taken 6 feet above the floor in the center of the kitchen, with all other appliances off and kitchen exhaust fan(s) off.

- First, the cooktop burners (and griddle if present) are operated simultaneously for 1 minute, Ambient CO is measured, and burners are turned off.
- Next the oven burner is operated for five minutes, Ambient CO is measured, and the oven is turned off.
- Then, if a separate broiler burner is present, it is tested the same way as the oven burner.

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Appendix D

Appliance Ambient CO Action Levels

	Appliance Ambient CO Action Levels
Forced Air Unit (FAU) • Natural Draft • Induced Draft • Direct-vent Measured inside supply register nearest the FAU.	**> 1 ppm above zone/room ambient = FAIL** Remediation Required
Floor Furnace	**> 2 ppm above zone/room ambient** Recommend Service or Repair
Gravity Furnace	
Vented Room Heater	
Wall Furnace	
Open Combustion Fireplace	
Insert Fireplace	
Direct-vent Wall Furnace	
Gas-fueled Fireplace	
Storage Water Heater (Natural Draft)	**> 9 ppm** Recommend Service or Repair
Tankless Water Heater (Open Combustion)	
Gas Clothes Dryer	

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Appendix E

SDG&E/SoCalGas Undiluted CO Action Levels

A. CO Action Levels and Test Conditions

CO action levels apply to testing under WCD and/or NC.

When an appliance fails spillage or exceeds CO action levels at steady state under WCD, re-test spillage and undiluted CO under NC.

1.
2.

B. SDG&E/SoCalGas Undiluted CO As-Measured Action Levels for Unattended Natural Draft Appliances:

All CO action levels in this table are "as-measured"	If appliance PASSES Spillage under WCD **FAIL** **Remediation Required**	If appliance FAILS Spillage under WCD **FAIL** **Remediation Required**
Forced Air UnitNatural Draft (ND)	> 275 ppm	> 25 ppm
Floor Furnace		
Gravity Furnace		
Vented Room Heater	> 125 ppm	
Wall Furnace		
Storage Water Heater		
Gas-fueled fireplace	> 25 ppm	
Direct-vent Wall Furnace[1]	> 275 ppm	

[1] Spillage testing does not apply to direct-vent appliances.

C. SDG&E/SoCalGas Undiluted CO Action Levels for Attended Appliances

All CO action levels in this table are "as-measured"	**FAIL** **Remediation Required**
Cooktop	> 25 ppm (each burner)
Oven, Broiler with local ventilation	> 225 ppm
Oven, Broiler without local ventilation[2]	> 100 ppm
Gas Clothes Dryer	> 25 ppm

[2] Recommend installation of local ventilation if not present

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Appendix F

Air-Free CO Action Levels for LPG Appliances

A. Air-Free CO Action Levels for LPG Appliances

Appliance Type	BPI 1200 (NFGC Table G.6)[1]
Forced Air Furnace (All)	400 ppm A-F
Gravity Furnace	400 ppm A-F
Wall Furnace (OC)	200 ppm A-F
Wall Furnace (DV)	400 ppm A-F
Floor Furnace	400 ppm A-F
Vented Room Heater (OC)	200 ppm A-F
Water Heater (OC)	200 ppm A-F
Water Heater (DV)	(contact BPI or ANSI)
Gas Log (Gas Fireplace)	400 ppm A-F
Gas Clothes Dryer	400 ppm A-F

B. Air-Free vs. As-Measured CO Action Levels

NFPA 54 is the National Fuel Gas Code (NFGC), also known as ANSI Z223.1.

The NFGC utilizes both "as-measured" and "air-free" carbon monoxide (CO) thresholds—the maximum allowable CO in parts per million (ppm). Air-free CO levels are based on a mathematical calculation, using (a) an equation that factors in the percentage of oxygen (O2), or (b) an equation that factors in carbon dioxide (CO2), which is present in flue gas emissions.

"As-measured" readings are taken directly from the CO sensor in the test instrument.

The flue gas sample used to obtain the reading contains CO *plus* O_2 and CO_2. The actual percentage of flue gas that is CO varies by the percentage of O_2 and CO_2 in the appliance exhaust. The more O_2 present, the smaller the percentage of the flue gas that is CO—and the less accurate the "as-measured" reading is. The only true way to know the actual amount (ppm) of CO in the flue gas is to measure the O_2 and "subtract it out". The result is called "air-free CO," because that is how much CO would be present if there were *no* O_2 in the mix.

When O_2 is 15.7%, the as-measured CO ppm is approximately one-fourth the air-free ppm. Thus, when the as-measured reading is 100 ppm, the air-free calculation would be approximately 400 ppm CO. As-measured readings may be used only when oxygen makes up no more than 20% of the flue gas. A higher percentage exceeds limits of the equation. In that situation, the second equation based on percent of CO_2 must be used to calculate air-free CO. However, most test instruments do not measure CO_2. As a compromise, as-measured readings are accepted for appliances with a high percentage of excess air in the exhaust—such as an oven/broiler, cooktop burner, and gas log.

C. BPI As-Measured vs. SDG&E/SoCalGas As-Measured Action Levels

For CO thresholds, BPI now uses NFGC Table G.6, which lists air-free ppm for appliances other than cooking appliances and gas logs. SDG&E/SoCalGas uses as-measured CO testing for all appliances (as shown in Appendix E).

SDG&E/SoCalGas utilizes a formula from the Gas Engineers' Handbook to determine the actual CO content of an as-measured undiluted flue gas sample. The formula (or correction factor) varies per the type of appliance that is being tested and the amount of actual CO in the as-measured sample. SoCalGas field studies have supported the use of the correction factor in establishing CO action levels for use in SoCalGas operations.

Cooking Appliances – ANSI (Z21.1)

The ANSI method for measuring air-free CO from cooktops and ovens utilizes a capture hood placed above the range. All burners operate simultaneously (with a five-pound pot of water on each cooktop burner). The air-free CO test cannot be easily simulated in the field, so as-measured CO measurements and thresholds are used instead. The ANSI air-free CO Action level for the oven and burners combined is 800 ppm. It is approximated that 400 ppm comes from the oven, and the four cooktop burners account for 100 ppm each (the other half of 800). These values are replaced by as-measured CO thresholds in the NFGC Table G.6.

Cooking Appliances – SDG&E/SoCalGas

SDG&E/SoCalGas considers that a range may consist of an oven, a broiler, and four cooktop burners. Based on the ANSI standard, it was estimated that each cooktop burner could contribute approximately 100 ppm air-free CO, which equates to approximately 25 ppm as-measured CO. Thus, in a policy adopted by SDG&E/SoCalGas, 25 ppm CO as-measured was selected as a relatively conservative threshold for cooktop burners.
For ovens, SDG&E/SoCalGas took a conservative approach and used 300 ppm air-free CO as a basis, which was converted to 225 ppm CO as-measured.

Cooking Appliances – BPI

Previously, BPI did not specify action levels for cook tops and ovens. However, the BPI Technical Standards for Building Analyst Professional now references NFGC Table G.6, which has as-measured CO thresholds for cooktop burners and ovens.

Appendix G

NOx Rod Furnace Identification and Inspection Procedure

A. NOx Rod Furnace General Information

Several models of horizontal furnaces manufactured by Consolidated Industries, Inc. are subject to a Consumer Product Safety Commission (CPSC) recall because of potential fire hazards associated with the burner design.

1. NOx rod furnaces are gas-fired horizontal furnaces equipped with steel NOx rods installed above the burners. The furnaces were sold under various brand names which are listed in the NOx Rod Recall table below:

2.

COMPANY NAME	TRADE NAME	"NOx Rod Furnace" MODEL NUMBERS
Addison Products Co.	Weatherking	GHC
Amana Company	Amana	GSE50DN3X, GSE75DN3X, GSE100DN5X
Arco Comfort Products	ACP, Arcoaire, Northrup	GHB
Bard Manufacturing	Bard	ESG040D36B, ESGO40D36BC, ESG050D36B, ESG050D36BC, ESG060D36B, ESG060D36BC, ESG060D48B, ESGO60D48BC, ESG080D60B, ESGO80D60BC, ESG100D60B, ESG100D60BC, ESG120D60B, ESG120D60BC, ESG140D60B, ESG120D60BC, ESG050D36D, ESG060D48D, ESG075D48D, ESGO80D60D, ESG100D60D, ISGO60D36AX, ISGO80D48AX, ISG100DG60AX, ISG120D60AX
Carrier Corporation	Sunburst by Carrier Southern California	HAC040N(D, E, or F)3RXC, HAC050N(D, E, or F)5RXC, HAC050ND3RXD, HAC060N(D, E, or F)4RXC HACO75N(D, E, OR F)4RXC HAC080N(D, E, OR F)5RSC, HAC100N(D, E OR F)5RXC
Climate Control	Climate Control	GHC
Coleman Company (Evcon Industries)	Coleman	2505-25090B/ 2505-2509C, BGH
Consolidated Industries	Consolidated	HAC/HCC, HBA
DMO industries	Duomatic-Olsen, Olsen, Airco	HCC, HBA
Goettle Air Conditioning, Inc.	American Best, Goettle	HAC040N(D, E, or F)3RCX, HAC040N(D, E, or F)3RXD, HAC050N(D, E, or F)3RCX,HAC050N(D, E, or F)3RXD, HAC040N(D, E, or F)3RXC, HAC050N(D, E, or F)3RXC,

(continued next page)

COMPANY NAME	TRADE NAME	"NOx Rod Furnace" MODEL NUMBERS
Goettle Air Conditioning, Inc.	American Best, Goettle	HAC060N(D, E, or F)4RXC, HAC075N(D, E, or F)4RXC, HAC080N(D, E, or F)5RXC, HAC100N(D, E or F)5RXC, HCC040N(D, E, or F)3RX, HCC050N(D, E, or F)3RX, HCC060N(D, E, or F)4RX, HCC075N(D, E, or F)4RX, HCC100N(D, E, or F)5RX, HBA040N(D, E, or F)3RX, HBA060(D, E, or F)3RX, HBA080N(D, E, or F)4RX, HBA100N(D, E, or F)5RX, HBA120N(D, E, or F)5RX
Goodman Manufacturing Company	Franklin Electric, Goodman, GMC, Hamilton Electric, Janitrol, Johnstone, Liberty	HBA040ND3(X, RX, XC, or RXC) HBA060ND3(X, RX, XC, or RXC) HBA080ND4(X, RX, XC, or RXC) HBA100ND5(X, RX, XC, or RXC) HBA120ND5(X, RX, XC, or RXC) HCA040ND3(X, RX, XC, or RXC) HCA060ND3(X, RX, XC, or RXC) HCA080ND4(X, RX, XC or RXC) HCA100ND5(X, RX, XC, or RXC) HCA120ND5(X, RX, XC or RXC) HCA140ND5(X, RX, XC, or RXC) HCC040ND3(X, RX, XC, or RXC) HCC050ND3(X, RX, XC, or RXC) HCC060ND4(X, RX, XC, or RXC) HCC075ND4(X, RX, XC, or RXC) HCC080ND5(X, RX, XC, or RXC) HCC100ND5(X, RX, XC, or RXC)
Goodman Manufacturing Company	Franklin Electric, Goodman, GMC, Hamilton Electric, Janitrol, Johnstone, Liberty	HBA040ND3(X, RX, XC, or RXC) HBA060ND3(X, RX, XC, or RXC) HBA080ND4(X, RX, XC, or RXC) HBA100ND5(X, RX, XC, or RXC) HBA120ND5(X, RX, XC, or RXC) HCA040ND3(X, RX, XC, or RXC) HCA060ND3(X, RX, XC, or RXC) HCA080ND4(X, RX, XC or RXC) HCA100ND5(X, RX, XC, or RXC) HCA120ND5(X, RX, XC or RXC) HCA140ND5(X, RX, XC, or RXC) HCC040ND3(X, RX, XC, or RXC) HCC050ND3(X, RX, XC, or RXC) HCC060ND4(X, RX, XC, or RXC) HCC075ND4(X, RX, XC, or RXC) HCC080ND5(X, RX, XC, or RXC) HCC100ND5(X, RX, XC, or RXC)

COMPANY NAME	TRADE NAME	"NOx Rod Furnace" MODEL NUMBERS
Heat Controller, Inc.	Comfort-Aire	GSH40-T3N-X, GSH50-T3N-X, GSH60-T4N-X, GSH75-T4N-X, GSH80-T5N-X, GSH100-T5N-X
ICG-Keeprite	Keeprite	HAC/HCC, HBA
Johnson Supply	Air Star	SGH
Magic Chef Air Conditioning	Magic Chef	EG, ENG
MLX Refrigeration and Air Conditioning	Heatmaster	HAC/HCC, HBA
Premier Furnace Company	Premier, Sunburst, Sun Glow, PFC, Carrier, Sunbelt	HAC/HCC, HBA
Sears	Kenmore	735
Square D Company	Sundial	GH
The Trane Company	Trane (XE60, XE70, XL80), American Standard	THN050A936A, THN060A948A, THN075A948A, THN100A960A; ALSO THS AND THD
Westbrook Distributing, Inc.	Heatmaster	HAC/HCC
Any company	Any brand	HAC/HCC

3. Additional information may be obtained online at the following websites:

   a. https://furnaceinspect.com/

   b. https://furnaceinspect.com/ModelIdentification/FurnaceInspectionProgram.aspx

   c. https://furnaceinspect.com/ModelIdentification/PressRelease.aspx

   d. http://www.cpsc.gov/en/Recalls/2001/CPSC-Announces-Recall-of-Furnaces-in-California/

1. ## B. NOx Rod Furnace Identification

2. NOx rod furnaces usually have an X at the end of the model number. Either the last character or the next-to-last character is the identifier. There are exceptions to this guideline; the serial number of NOx rod furnaces do not always include an X (Trane, Bard, etc.).

3. NOx Rod recall furnaces were manufactured from the 8th week of 1983 (date code "8308") through the 52nd week of 1994 (date code "9452"). The date code may be found in the first four characters of the
4. serial number. Recall serial numbers will range between 8308 through 9452. There are exceptions to this guideline; the serial number of NOx rod furnaces do not always include a four-digit-date-code

The serial number will contain the lettering or numbering designations listed in the table.

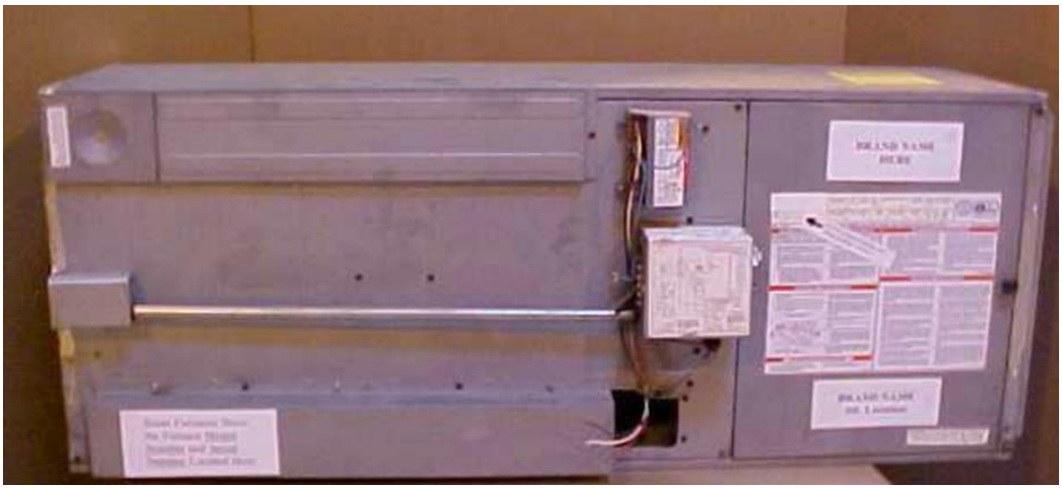
For each horizontal furnace inspection, check the nameplate for any of the following:

a. A Company Name or Trade Name listed in the NOx Rod Recall table

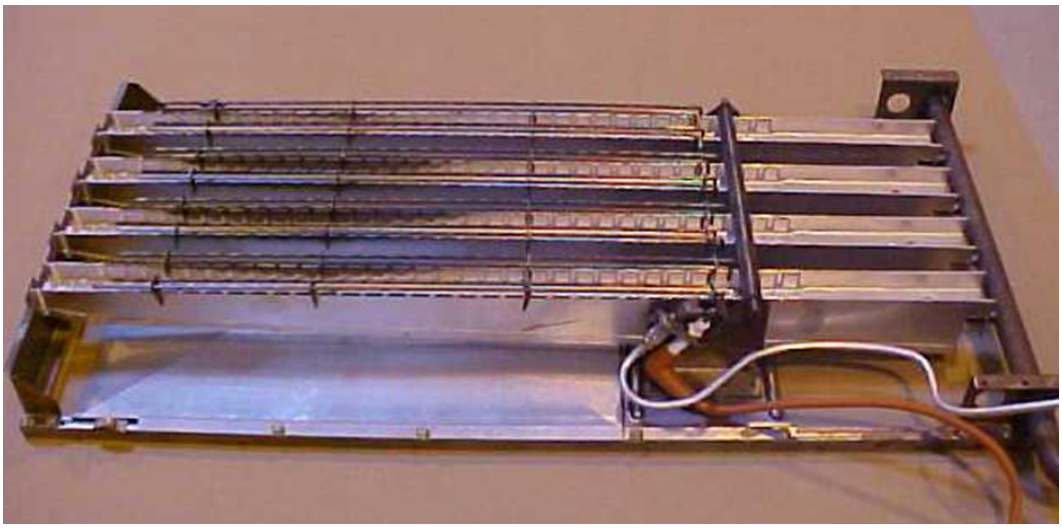
b. Date of manufacture from 1983 thru 1994 (or a date code as described in Item 2 above)

c. A model number containing the lettering or numbering designations listed in the NOX Rod Recall table.

Common NOx Rod Furnace Appearance



NOx Rod Burner Image:



C. Contractor NOx Rod Furnace Testing Non-Feasibility

If the furnace is listed on the CPSC recall list, and does not meet the testing procedure protocols, do not attempt to test or repair the furnace.

Fill out a Notice of Unsatisfactory Condition. Provide a copy of the notice to the homeowner and upload the document to EECP.

Contact the Gas Company to have a GSR service the system.

The GSR will shut the furnace down at the line valve.

Be advised that if the furnace is repaired by a properly licensed (C20) HVAC contractor, and it is serviced at a later date by SDG&E/SoCalGas, the furnace will be shut down at the line valve unless there is a green sticker or tag on the HVAC system. SDG&E/SoCalGas will not attempt to inspect or repair the furnace.

D. Contractor NOx Rod Furnace Testing Procedure

Testing and repairs are allowed when there are no hazardous/unsatisfactory conditions and the furnace has a green sticker or tag indicating a properly licensed C20 HVAC Certified Contractor made the CPSC required repairs.

Verify the NOx rods have been removed.

Perform a thorough examination of the combustion chamber (firebox).

1. a. Inspect the heat exchanger for cracks, excessive rust, and scale that may create debris on top of the burner.
2. b. Inspect the condition of the burner for signs of deterioration or obstruction.
3. c. Observe the burner flame for any signs of disturbance, smothering, or burner flashback (obstruction at the orifice or inside the burner venturi).
   d. Continue to inspect the flame for disturbance after the blower has activated.

Inspect the mounting surface around the furnace for indications of charring, scorching, or excessive heat exposure.

4. Continue inspection in accordance with the Energy Upgrade California Advanced Home Upgrade Inspection Guidelines.
5. Furnace must pass all the above criteria and the standard program requirements pertaining to safety
6. regulations or it will be shut down by the gas utility.
7. Recommend to the customer to have their furnace serviced at least annually or more frequently depending on the usage of the HVAC system.

E. QC Inspection NOx Rod Furnace Testing Non-Feasibility

1. If the furnace is listed on the CPSC recall list, and does not meet the testing procedure protocols, do not
2. attempt to test or operate the furnace.
3. Fill out a Notice of Unsatisfactory Condition. Provide a copy of the notice to the homeowner and upload the document to EECP.
4. Shut down the furnace at the line valve.
5. Advise the homeowner to contact the Gas Company and have GSR service the system. The GSR will confirm that the furnace should be shut down.

In the Application stage the project will go into Appeal status. The unit will have to be capped off for the
1. Incentive Rebate to process.

2. F. QC Inspection NOx Rod Furnace Test Procedure

3. Testing is allowed when there are no hazardous/unsatisfactory conditions and the furnace has a green sticker or tag indicating a properly licensed (C20) HVAC Certified Contractor made the CPSC required repairs.

Verify the NOx rods have been removed.

Perform a thorough examination of the combustion chamber (firebox).

a. Inspect the heat exchanger for cracks, excessive rust, and scale that may create debris on top of the burner.

b. Inspect the condition of the burner for signs of deterioration or obstruction.

c. Observe the burner flame for any signs of disturbance, smothering, or burner flashback (obstruction at the orifice or inside the burner venturi).

d. Continue to inspect the flame for disturbance after the blower has activated.

Inspect the mounting surface around the furnace for indications of charring, scorching, or excessive heat exposure.

Furnace must pass all the above criteria and the standard program requirements that pertain to safety regulations or it will be shut down at the line valve.

4. Advise the customer to have their furnace serviced at least annually or more frequently depending on the usage of the HVAC system.

5.

6.

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Appendix H

Notice of Unsatisfactory Condition Form

A. Notice of Unsatisfactory Conditions (NOUC)

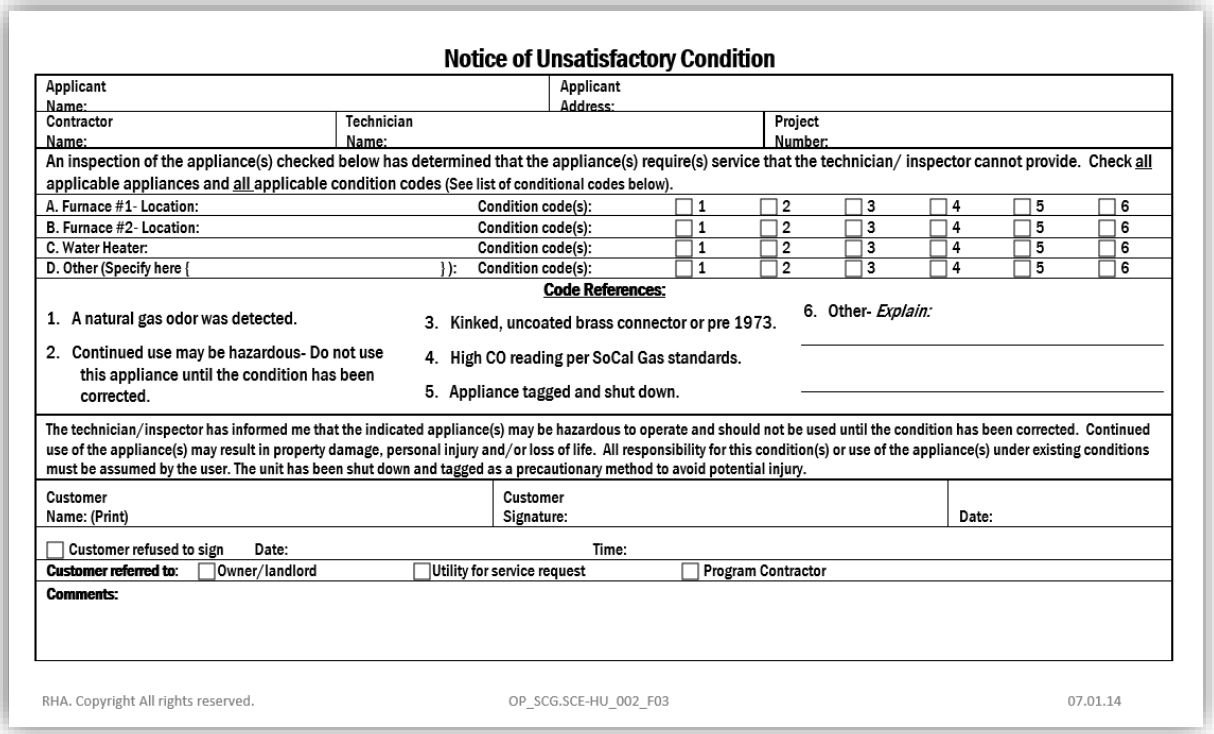
The NOUC (shown below) pertains to safety-related items. The NOUC is to be filled out by the contractor or RHA staff for any conditions listed in the Processing Guidelines.

The NOUC must be signed by the homeowner or their designated representative.

A copy must be left with the homeowner or their designated representative.

The NOUC must be uploaded to Vision or the Vision web application.

1.
2. For more detail, please reference the Home Upgrade Processing Guidelines located on Home Upgrade
3. contractor portal.
4. If the customer refuses to sign the NOUC, notate that in the document and enter a note in Vision.
5.



Notice of Unsatisfactory Condition

Applicant Name:		Applicant Address:
Contractor Name:	Technician Name:	Project Number:

An inspection of the appliance(s) checked below has determined that the appliance(s) require(s) service that the technician/ inspector cannot provide. Check all applicable appliances and all applicable condition codes (See list of conditional codes below).

A. Furnace #1- Location:	Condition code(s):	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
B. Furnace #2- Location:	Condition code(s):	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
C. Water Heater:	Condition code(s):	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
D. Other (Specify here { }):	Condition code(s):	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Code References:

1. A natural gas odor was detected.
2. Continued use may be hazardous- Do not use this appliance until the condition has been corrected.
3. Kinked, uncoated brass connector or pre 1973.
4. High CO reading per SoCal Gas standards.
5. Appliance tagged and shut down.
6. Other- *Explain:*

The technician/inspector has informed me that the indicated appliance(s) may be hazardous to operate and should not be used until the condition has been corrected. Continued use of the appliance(s) may result in property damage, personal injury and/or loss of life. All responsibility for this condition(s) or use of the appliance(s) under existing conditions must be assumed by the user. The unit has been shut down and tagged as a precautionary method to avoid potential injury.

Customer Name: (Print)	Customer Signature:	Date:

☐ Customer refused to sign Date: Time:

Customer referred to: ☐ Owner/landlord ☐ Utility for service request ☐ Program Contractor

Comments:

 OP_SCG.SCE-HU_002_F03 07.01.14

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Appendix I
Notice of Survey by Electrical Contractor

A. Purpose

Before ceiling insulation that will encapsulate knob-and-tube (K&T) wiring is installed, the wiring system must be inspected by a C-10 Electrical Contractor and determined safe to cover (encapsulate) with insulation. The C-10 must complete a "Notice of Survey by Electrical Contractor", which provides a written report indicating one of the following findings:

1. The knob-and-tube wiring is:
    a. In good condition with proper overcurrent protection, or
    b. In poor condition, but was brought up to acceptable standards and may now be encapsulated, or
    c. Abandoned, totally disconnected, and not energized, or
    d. In poor condition, is not suitable to be brought up to acceptable standards, and may not be encapsulated.

If ceiling insulation will be installed over the K&T wiring:

2. a. Condition a., b., or c. above must exist.
    b. The C-10 must explain to the customer the possibility of nuisance tripping.
    c. The customer must understand the "Client Acknowledgement" statements in the Notice and sign the form giving consent to modify the wiring and encapsulate it.
    d. The C-10 must complete and sign the "Electrical Contractor Certification" portion of the Notice, give a copy to the customer, and provide a copy to the Home Upgrade contractor.
    e. The Home Upgrade contractor must provide a copy of the completed/signed Notice to the local jurisdiction (if required) in conjunction with obtaining and finalizing a building permit for ceiling insulation
    f. A copy of the Notice must be placed in a visible location (e.g., next to the Warning Placard) inside the attic near the primary entrance.

B. Notice of Survey by Electrical Contractor for Knob and Tube Wiring Form

An image of the "Notice of Survey by Electrical Contractor for Knob and Tube Wiring" is on the next page.

NOTICE OF SURVEY BY ELECTRICAL CONTRACTOR FOR KNOB-AND-TUBE WIRING

This is a verification that the existing knob-and-tube wiring was surveyed at this address:

Number _____ Street _____ City _____ ZIP _____

THIS EXISTING KNOB-AND-TUBE WIRING WAS FOUND TO BE:

(A) ☐ In GOOD condition with:
- ☐ No evidence of deterioration
- ☐ No improper connections or splices
- ☐ No evidence of improper overcurrent protection

OR

☐ In POOR condition and was brought up to acceptable standards by:
- ☐ Installing tamperproof overcurrent protection with fuses
- ☐ Installing new service panel with breakers
- ☐ Other: _____

OR

☐ ABANDONED; totally disconnected, not energized and safe to cover with insulation

(B) ☐ Existing wiring is in POOR condition, and not suitable to be brought up to acceptable standards because of:
- ☐ Evidence of deterioration
- ☐ Evidence of improper connections or splices
- ☐ Evidence of improper overcurrent protection
- ☐ Other: _____

*When not possible to bring knob-and-tube wiring to an acceptable standard, installing any type of insulation is **not** feasible.*

ELECTRICAL CONTRACTOR CERTIFICATION

☐ A copy of this certificate will be filed with the local code-enforcement authority, if required by local jurisdiction.

☐ Prior to installation of new overcurrent devices, their effects on usage habits was explained to the occupant(s) and permission to install them was obtained.

Electrical Contractor Signature _____ Date _____

License Number _____ Company Name _____

CUSTOMER ACKNOWLEDGMENT: This electrical survey is required before insulation is installed by the Energy Upgrade California® Home Upgrade Program Participating Contractor when knob-and-tube wiring is present.

You are advised that if tamper-proof overcurrent protection devices are installed to protect the wiring system, your electrical usage habits may require modification to avoid "nuisance" tripping of electrical circuits. Prior to installing overcurrent protection, the electrical contractor performing this Survey is required to explain the difficulties you may experience after the devices are installed.

☐ **I HEREBY GIVE PERMISSION TO INSTALL TAMPER-PROOF OVERCURRENT PROTECTION DEVICES IF APPLICABLE.**

☐ **I CERTIFY THAT I HAVE READ AND UNDERSTAND ITEM A OR B ABOVE.**

Customer Signature _____ Date _____

NOTICE OF SURVEY BY ELECTRICAL CONTRACTOR FOR KNOB-AND-TUBE WIRING Updated 11/30/17

Appendix J

Knob-and-Tube Warning Placard

A. Purpose

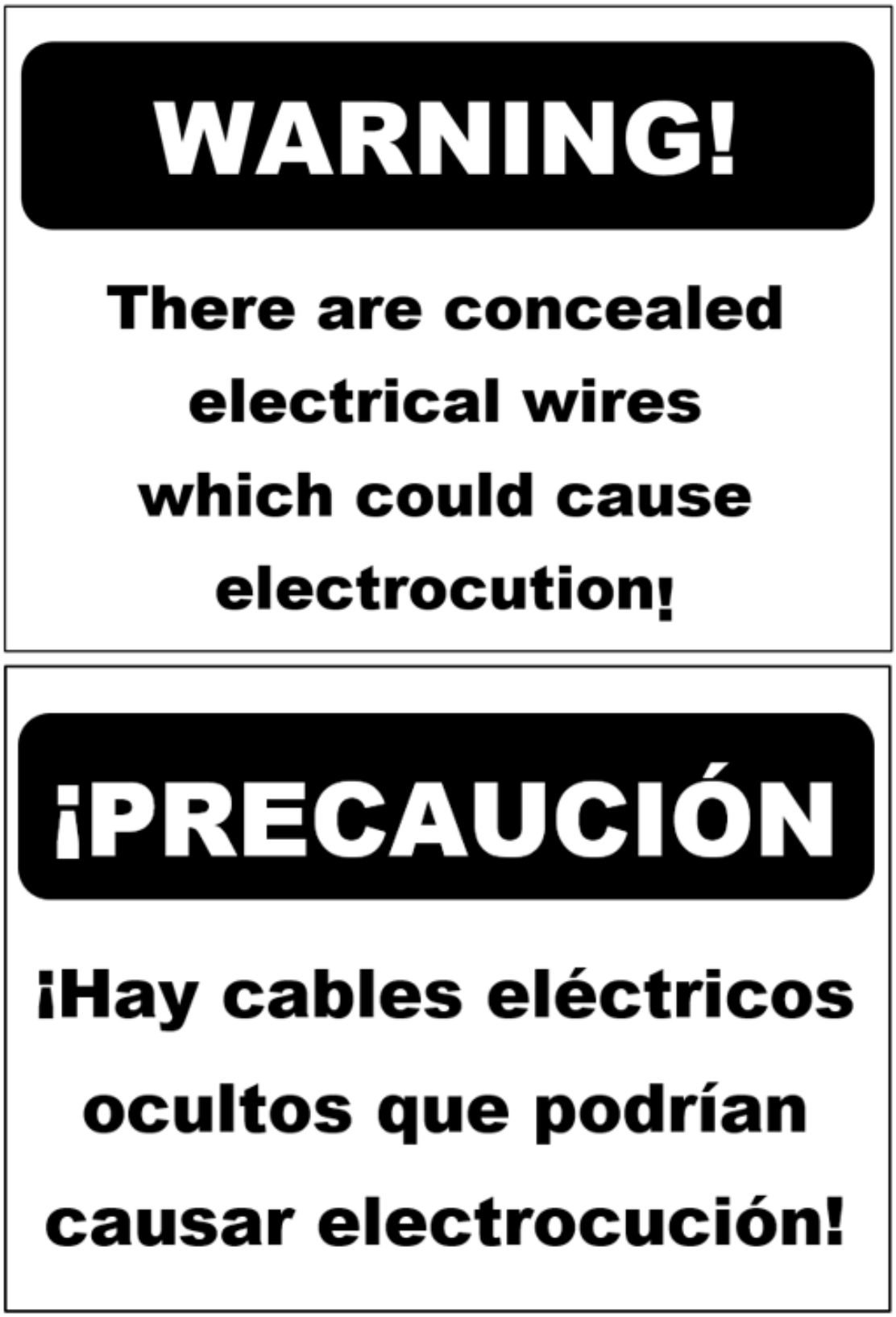
When ceiling insulation is installed in an attic containing energized knob-and-tube wiring, and the wiring is encapsulated by retrofit insulation, the knob-and-tube wiring "Warning Placard" must be posted.

A copy of the Placard must be placed at each openable entrance to the attic, basement entrance and/or crawlspace, in a visible location where it will be observed by persons entering the space.

1.

2. ## B. Warning Placard Graphic

A reproducible copy of the "Warning Placard" is on the next page.


WARNING!
There are concealed electrical wires which could cause electrocution!
¡PRECAUCIÓN
¡Hay cables eléctricos ocultos que podrían causar electrocución!

Appendix L
BPI Guidance on Pre-Installation Duct Testing

Building Performance Institute, Inc.

GUIDANCE ON PRE-INSTALLATION DUCT TESTING
Issued July 2011

Question: When performing a duct blaster test on a system, if you are unable to pressurize the system due to a duct break, should the duct break be repaired before performing the test.

BPI Standard Reference: BUILDING PERFORMANCE INSTITUTE TECHNICAL STANDARDS FOR THE HEATING PROFESSIONAL, v11/20/07mda

Response: A technician *should not* repair the duct break before performing a pre-installation duct leakage test.

Page 10 of Heating Professional Standard: Duct Leakage

> *When quantifying duct leakage, an appropriate type of measurement system shall be used, which includes a metered and calibrated duct pressurization device. Pre-and post installation duct leakage shall be measured any time that duct sealing is part of the work scope to verify the success of the installation.*
>
> *Duct leakage areas must be diagnosed using appropriate duct leakage testing equipment and/or pressure pan tests to prioritize leakage areas (treating the largest leaks and the highest-pressure areas first) anytime duct sealing is installed.*

If the work (duct break repair) was performed before the duct leakage test, the test would not be considered "pre-installation."

According the checklist directly below, a duct break (disconnected duct, missing end-caps and other catastrophic holes) is a duct leak. Once duct sealing becomes part of the work scope, pre and post installation duct leakage testing must be performed. A technician will not know if the ducts can or cannot be pressurized due to duct leakage unless they perform the test. If the technician is unable to (de)pressurize the duct system to a full 25 pa when performing a pre installation duct leakage test, the technician must document what the actual pressure and CFM flow was at the time of testing. The pressure and flow may be zero, if there is a catastrophic break.

Page 11 of Heating:

> *Use the following checklist as a guide for prioritizing duct sealing installations:*
>
> ✓ Seal the largest leaks first. These include: **disconnected ducts, missing end-caps, and other catastrophic holes**

- ✓ Seal the areas of highest pressure. These included all the connections near the air handler cabinet and supply and return plenums, flexible canvas plenum connectors, and filter slot covers.
- ✓ Seal all return leaks which may be contributing to negative pressures in the combustion appliance zone.
- ✓ Seal all accessible connections between duct sections, at branches, and where take-offs connect to main trunk lines.
- ✓ Seal take-off connections to register boots and boot connections to floors, walls, and ceilings.

CONCLUSION:

When evaluating duct work, a pre-installation duct leakage test must be conducted any time duct sealing is part of the work scope. Please use the checklist directly above to prioritize duct sealing measures. A post installation duct leakage test must be conducted to verify the success of the installation.

If you have any additional questions now or in the future, please do not hesitate to contact BPI with an email via the Ask an Expert tab on the BPI.org website:

http://bpi.org/tools_contact.aspx?submissionType=ASK

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Appendix K

BPI Clarification on Blower Door Testing in the Presence of ACM*

CLARIFICATION ON BLOWER DOOR TESTING IN THE PRESENCE OF ASBESTOS CONTAINING MATERIALS

Question: Do the BPI Standards allow blower door testing when asbestos containing materials are present?

BPI Standard Reference: BUILDING PERFORMANCE INSTITUTE TECHNICAL STANDARDS FOR THE BUILDING ANALYST PROFESSIONAL, v2/28/05mda, Page 1 of 17, states:

HEALTH AND SAFETY:

> Where the presence of asbestos, lead, mold and/or other potentially hazardous material is known or suspected, all **relevant state and federal (EPA) guidelines must be followed to ensure technician and occupant safety**. Blower door depressurization tests may not be performed in homes ***where there is a risk of asbestos becoming airborne and being drawn into the dwelling***. (Emphasis added).

Response: Although the standards do not specifically prohibit pressurization, the emphasis is on the risk of asbestos becoming airborne. Blower door activities in the presence of damaged ACM (friable asbestos) pose a risk of causing the fibers to become airborne. Both the safety of the technician and occupant are paramount. Proper precautions should be taking to avoid risk of causing asbestos particles to become airborne, thus it is recommended that no blower door activity take place where friable asbestos is present. Once the material is properly repaired, sealed, or removed by a properly licensed and qualified professional, then blower door testing may proceed.

Per the EPA website: www.epa.gov/ASBESTOSwww.epa.gov/ASBESTOS

Asbestos is a mineral fiber that has been used commonly in a variety of building construction materials for insulation and as a fire-retardant. Because of its fiber strength and heat resistant properties, asbestos has been used for a wide range of manufactured goods, mostly in building materials (roofing shingles, ceiling and floor tiles, paper products, and asbestos cement products), friction products (automobile clutch, brake, and transmission parts), heat-resistant fabrics, packaging, gaskets, and coatings.

When asbestos-containing materials are damaged or disturbed by repair, remodeling or demolition activities, microscopic fibers become airborne and can be inhaled into the lungs, where they can cause significant health problems.

MOST COMMON SOURCES OF ASBESTOS EXPOSURE:

Workplace exposure to people that work in industries that mine, make or use asbestos products and those living near these industries, including:

- **the construction industry (particularly building demolition and renovation activities),**
- the manufacture of asbestos products (such as textiles, friction products, insulation, and other building materials), and
- during automotive brake and clutch repair work
- **Deteriorating, damaged, or disturbed asbestos-containing products such as insulation, fireproofing, acoustical materials, and floor tiles.**

OSHA also has guidance on employee exposure. See

https://www.osha.gov/Publications/OSHA3507.pdf

BPI's draft standards for Quality Assurance Inspector provide additional guidance:

4.5.8 Asbestos

Inspector shall determine the potential asbestos hazard, especially in homes built after 1930 and before the 1970s. Inspector shall follow the assessment protocols in the EPA Healthy Indoor Environment Protocols for Home Energy Upgrades.

4.5.6.1 If suspected asbestos-containing material (ACM) is found, **Inspector shall not conduct a blower door test or otherwise conduct any testing that may disturb the ACM**.

4.5.6.2 If ACM is found, Inspector shall document the finding on the Inspector Checklist (Appendix E) and shall also document if any of the measures in the scope of work may have affected the ACM.

4.5.6.3 If ACM is damaged, the Inspector shall notify the Contractor that a professional with proper licensing and credentials must be contacted for abatement or repair.

This guidance is similar to that found in EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades:

https://www.epa.gov/sites/production/files/2014-12/documents/epa_retrofit_protocols.pdf

CONCLUSION:

Unless you have the ability to monitor and determine that particles caused to be airborne by blower door testing are below the permissible exposure limit, it is advisable not to conduct blower door testing in the

presence of damaged or deteriorating ACM.

If you have any additional questions now or in the future, please do not hesitate to contact BPI with an email via the Ask an Expert tab on the BPI.org website:
http://bpi.org/tools_contact.aspx?submissionType=ASK

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Appendix L

BPI Guidance on Fireplaces and Blower Door Testing

GUIDANCE ON FIREPLACES AND BLOWER DOOR TESTING
June 2011

Question: Should you tape off and seal the fireplace for the test-in and test-out?

BPI Standard Reference: BPI Standard Reference: **BUILDING PERFORMANCE INSTITUTE TECHNICAL STANDARDS FOR THE BUILDING ANALYST PROFESSIONAL,** v2/28/05mda, page 6

BUILDING AIRFLOW

Fires in woodstoves and/or fireplaces must be fully extinguished prior to performing a blower door test.

Response:
No, the fireplace should not be taped off during blower door testing. The fireplace is an existing condition. Pressurization tests are not recommended when there is a fire or hot embers, due to the fire safety risks. The following procedures should be performed prior to conducting a blower door test when a fireplace or woodstove exists:

a) Make sure there are no active embers and that the fireplace and chimney are cold.
b) Close the damper (if a damper is present and operable); if the damper cannot be closed (e.g., wired open due to code requirements), then that is the natural condition.
c) Clear the base of the chimney of ashes and or debris
d) Place damp newspapers or damp towels at the base of the chimney (to catch/contain ash, dust or other debris)
e) Close the glass doors of the actual fireplace opening (if doors are present and operable).
f) Advise the homeowner that ash, dust or other debris may be circulated throughout the home even with the procedures performed above.

Additionally, when performing Worst Case Combustion Air Zone (CAZ) depressurization testing, the fireplace damper should be in the closed position (if present and operable), or let if in its natural condition if not operable. The fireplace is treated just as any other opening such as windows and doors which lead to the exterior.

The sole reason taping off the fireplace during blower door testing would be necessary would be to evaluate the cost-effectiveness of installing a permanent plug or sealed damper to eliminate that source of infiltration. If you have any additional questions now or in the future, please do not hesitate to contact:

Tony Peters
National Manager of Quality Assurance for Affiliates
Building Performance Institute, Inc (BPI)
518-899-2727 x 303 (office)
877-274-1274 (toll-free)

If you have any additional questions now or in the future, please do not hesitate to contact BPI with an email via the Ask an Expert tab on the BPI.org website:
http://bpi.org/tools_contact.aspx?submissionType=ASK

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Appendix M

BPI Guidance on Standards Conflicts with Local Program Rules, Law or Code

GUIDANCE ON BPI STANDARDS CONFLICTS WITH LOCAL PROGRAM RULES, LAW, OR CODE
Released February 3, 2012

Question: When a Contractor is working in an area where there is a conflict between local code, law, or program rules, and the BPI Standards, what standard should be applied for Quality Assurance purposes?

BPI STANDARD REFERENCE:

- **The BUILDING PERFORMANCE INSTITUTE HOME ENERGY AUDITING STANDARDS (BPI-1100-T-2010 [formerly known as BPI-101], August 3, 2010), p.2**

Program requirements (including conditions for incentives), laws or regulations, and applicable building codes or ordinances may take precedence over these standards in setting requirements for energy audits, work scopes and Energy Conservation Measures (ECMs). Consumers and third-party funding sources often require an accounting of ECM costs and savings, energy savings, demand savings, and/or emissions reductions. Additionally, regional climate, housing types and market conditions vary.

Response: The situation must be evaluated on a case-by-case basis. If local code, law or program requirements prohibit actions required by BPI Standards, or permits actions prohibited by BPI Standards, then the local authority has jurisdiction and the law must be followed.

For Quality Assurance purposes, whether being conducted as part of the BPI Quality Assurance (QA) Program for Accredited Contractors, or by a third-party as part of a local program, the Contractor will not be penalized for complying with the law.

When QA is performed on a completed project in a program relying on BPI Standards, the QA inspector should be knowledgeable of not only the standards, but also applicable laws in the jurisdiction where they are conducting QA. The program should be notified of the discrepancy, and measures taken by implementers, utilities, program designers, etc. to remedy the deficiency in the local law. The contractor should not be penalized, issuing a violation or required to make correction that would require conducting an illegal activity, putting his business license, contractor's license, or company at risk. The QA inspector should also be BPI Certified in all areas of work that may be inspected (e.g., if inspecting air sealing and insulation installations, the QA inspector should be a BPI Certified Envelope Professional).

The contractor should annotate the customer file with a copy of the applicable rule, law, or code. The QA Provider should be informed of the situation and work with the local program to remedy the official stance. The QA provider should not issue a site violation per BPI standards and no correction should be required.

This is not an all-inclusive list, but some examples follow.

- Drilling holes in venting for combustion safety testing. The program implementer follows BPI standards which require draft testing by drilling a hole in the vent pipe. The state does not allow the drilling of the vent pipe so the contractor does not drill one. The contractor annotates the customer file with the local code or guidance document from the local building official. No violation is issued for failing to follow BPI Standards.
- Insulating over Knob-and-Tube Wiring. BPI 104 Envelope Professional Standard (LR: 8/2010) states in the section "Minimum Health and Safety Requirements" (Envelope Professional), page 3: "Insulation may not be installed where live knob and tube wiring exists." The California Electrical Code, for instance, allows insulation to be in contact with knob-and-tube wiring, if certain conditions are met. The code would take precedence over BPI standards. The contractor annotates the customer file with a copy of the local code, and all required documentation to show the conditions were met. In this case, providing all local code requirements are met, insulating over knob-and-tube would not be addressed as a BPI Standards violation.
- A contractor complies with all laws, follows the BPI Standards, makes appropriate recommendations, and the customer refuses to have certain actions taken or items installed (e.g., refuses to have venting repaired that is not drafting properly), the contractor is not required to walk away from the job (although it is permissible). The contractor should obtain a signed statement from the customer that certain portions of the work order have been refused, that the contractor has explained and the customer understands the risks of refusing to have that portion of the work completed, and the customer wishes the remaining work scope to be completed, assuming all risk related to the incomplete items. In this case, providing proper documentation was included in the file, failure to complete the entire recommended scope would not be addressed as a BPI Standards violation.

CONCLUSION:

All BPI certified professionals conducting any work must use professional judgment to evaluate the conditions, rules, laws, codes, and program requirements governing their work. Although every effort should be made to follow the BPI Standards, BPI Certified Professionals will not be forced to engage in illegal activities. The BPI Standards are subordinate to contradictory local law, no matter how misguided. QA Providers, implementers, program designers, contractor organizations, and BPI should be notified of such challenges, and work together to educate local officials and fix the conflict so that local customers can have all the advantages of professional building science being practiced and home performance services being offered in their jurisdiction.

If you have any additional questions now or in the future, please do not hesitate to contact BPI with an email via the Ask an Expert tab on the BPI.org website:
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Appendix N
Test Instrument Calibrations

A. CO Analyzers

Maintenance

a. Contractors and the QC vendor are responsible for performing routine maintenance on all CO analyzers used in this program.

1. b. Maintenance includes mandatory calibrations, performed:
   1) In-field Calibration
      a) By the contractor, following manufacturer's instructions and using:
         - Instrument manufacturer's Calibration Kit, and
         - CO calibration gas that is appropriate for the CO ppm levels being measured *and* is traceable to a NIST certification.
   2) Factory Calibration
      a) By the instrument manufacturer or authorized calibration facility that provides NIST certification.

c. Contractors are responsible for purchasing all items and services necessary to comply with these requirements.

2. Calibration and Calibration Logs

a. All instruments must be calibrated:
   1) Every 30 days, or at intervals recommended by the manufacturer, and in accordance with manufacturer's recommended maintenance protocol.
   2) After the instrument has been dropped or otherwise damaged.
   3) After the instrument has been subject to repeated exposure to ≥ 1,000 ppm CO A-M.
   4) When readings appear abnormal or inconsistent.

b. In-Field and Factory Calibrations
   1) In-field calibrations must be performed with the CO analyzer manufacturer's calibration kit *and* calibration gas that is in conformance with A.2.d below.
   2) Factory calibrations are those performed by the instrument manufacturer or an authorized calibration facility.
   3) Each CO analyzer must be factory calibrated at least once per year.

c. Each CO analyzer must have a unique identification, including but not limited to the manufacturer's serial number.

d. Each instrument calibration must be recorded in a Calibration log that shows, at a minimum, the following information:
   1) Date of calibration
   2) Name of person *and* company performing the calibration
   3) ID of the instrument being calibrated (e.g., serial number or company ID)

4) ID of calibration Kit (e.g., serial number or company ID)
5) Calibration gas information:
   a) Manufacturer of the gas, and pertinent identification information from the cylinder;
   b) CO ppm concentration of the calibration gas;
   c) Expiration date of the gas cylinder;
   d) ID traceable to NIST certification (see A.3 below).
6) CO reading before calibration, while calibration gas is being fed to the instrument, prior to any adjustments being made.
7) CO reading after calibration, while calibration gas is still being fed to the instrument (should be the same as the calibration gas concentration).

e. Calibration Label Requirements
   1) A calibration label must be attached to the instrument, verifying a successful calibration.
   2) The label must:
      a) Be attached securely with strong adhesive,
      b) Be resistant to altering (e.g., covered with clear tape), and
      c) Include the date of calibration and the entity who performed the calibration.

f. All calibration logs and accompanying NIST compliance verifications must be kept in a Calibration log file.

3. NIST Certification

a. CO calibration gas must be shown to have a lot number traceable to NIST.

b. Written verification must be obtained and included in the Calibration log file.

c. When calibration gas is not available that is verified to be NIST certified, a factory calibration must be performed by a facility capable of providing the required certification.

1. ## B. Digital Manometers

Maintenance

a. Contractors and the QC vendor are responsible for performing routine maintenance on all digital manometers used in this program.

2. b. Instruments must be properly maintained and calibrated.

c. Contractors are responsible for purchasing all items necessary to comply with these requirements.

All instruments must be calibrated:

3. a. Every 6 months, or at intervals recommended by the manufacturer, and in accordance with manufacturer's recommended maintenance protocol.

b. After the instrument has been dropped or otherwise damaged.

c. When readings appear abnormal or inconsistent.

Each instrument must have a unique identification, including but not limited to the manufacturer's serial number.

Each instrument calibration must be recorded in a calibration Log log that identifies the instrument and shows, at a minimum, the following information:

a. Date of calibration

b. Name of person/company performing the calibration

4. c. ID of the instrument being calibrated (e.g., serial number or company ID)

d. Method used (e.g., manufacturer's calibration kit).

Calibrations must be recorded in a calibration log and kept in a calibration log file.

C. Duct Testers and Blower Doors

5. Maintenance

a. Contractors are responsible for performing routine maintenance on duct test and blower boor equipment used in this program.

1. b. Maintenance procedures are as described by the equipment manufacturer.

c. Contractors are responsible for purchasing all items necessary to comply with these requirements.

Calibrations must be recorded in a calibration log and kept in a calibration log file.

2.

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Appendix O
Health and Safety

A. Health and Safety Guidelines

Requirements

a. Requirements apply to all participating contractors and auditors.

b. Contractors must abide by BPI Health and Safety standards and have all the necessary personal safety equipment required by all applicable federal, state and local laws, including, but not limited to, the Occupational Safety and Health (OSHA) and Cal/OSHA Standards.

1.

Safety Equipment and Training

a. Required safety equipment includes, but is not limited to:

2.

1) Canister-type respirators
2) Gloves
3) Protective clothing or overalls
4) Elbow and knee pads
5) Safety glasses
6) Hard hats
7) First aid kit
8) Fall arrestors

b. Technicians and installers must be trained on the proper use and applicability of these safety devices and adhere to all OSHA regulations when performing diagnostics or work at the site.

c. All tools and machinery must be used in a safe manner and be properly maintained and or calibrated per manufacturer's recommendations.

3.

4.

Safety Data Sheets and Occupant Safety

All applicable safety data sheets must be present for all materials brought on job site, including but is not limited to those for:

a. Diagnostic smoke

5.

b. Caulking and adhesives

c. Insulation and air-sealing materials

Hazard Removal

a. Training and certification in the identification, removal, disposal, abatement and remediation of hazardous materials is outside of the scope of the Program.

b. If any hazardous materials are encountered during the course of a project, only those Participating Contractors that have the necessary training and required certification(s) may remove, dispose, abate and/or remediate hazardous materials discovered on a job site.

c. Participating Contractors are solely responsible for the identification, removal, disposal, abatement and/or remediation of hazardous materials encountered on a job site.

d. RHA and Energy Upgrade California® will assume no liability arising out of, resulting from, or regarding a Participating Contractor's detection, identification, inspection, removal, disposal, abatement, and/or remediation of hazardous materials.

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Appendix P

Acronyms and Definitions

A. Acronyms

ACCA	Air Conditioning Contractors of America
ACHn	Air Changes per Hour (at Natural Pressure)
A-F (CO ppm)	Air-free (CO ppm) (Example: 100 ppm A-F = 100 ppm CO Air-free)
AFUE	Annual Fuel Utilization Efficiency
ACM	Asbestos-Containing Material (also see "PACM" below and in the Definitions)
AGA	American Gas Association
AHRI (ARI)	Air Conditioning, Heating, and Refrigeration Institute (formerly ARI)
A-M (CO ppm)	As-Measured CO ppm
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG, awg	American Wire Gage
Btu	British Thermal Unit
Btuh (Btu/hr)	Btu per Hour (also see kBtuh)
Cal/OSHA	California Occupational Safety and Health Administration
CAS	Combustion Appliance Safety
CAZ	Combustion Appliance Zone
CBC	California Building Code
CCR	California Code of Regulations
CEC	California Energy Commission *and* California Electrical Code
CFL	Compact Fluorescent Lamp
CFM, cfm	Cubic Feet per Minute
CFM_{25}	Cubic Feet per Minute of Air Flow at 25 Pascals of Pressure
CFM_{50}	Cubic Feet per Minute of Air Flow at 50 Pascals of Pressure
CFR	Code of Federal Regulations

CMC	California Mechanical Code
CO	Carbon Monoxide
COP	Coefficient of Performance
CPC	California Plumbing Code
CPSC	Consumer Products Safety Commission
CSD	California Department of Community Services and Development
CVA	Combustion and Ventilation Air
DHW	Domestic Hot Water Heater
DOE	(United States) Department of Energy
DV (Appliances)	Direct Vent Appliances (see Definitions)
EER	Energy Efficiency Ratio
EPA	Environmental Protection Agency
FAU	Forced Air Unit
fpm	Feet per Minute
FVIR	Flammable Vapor Ignition Resistant
GFCI	Ground Fault Circuit Interrupter
HCD	(California Department of) Housing and Community Development
HPD	Heat Producing Device
HUD	(U.S. Department of) Housing and Urban Development
HVAC	Heating Ventilation and Air Conditioning
HVACR	Heating, Ventilation, Air Conditioning, and Refrigeration
HSPF	Heating Seasonal Performance Factor
Hz	Hertz (equivalent to cycles per second) *(not related to the car rental company)*
ICBO	International Conference of Building Officials
ICC	International Code Council
ID	Inside Diameter
ID (Appliances)	Induced Draft Appliances (see Definitions)
IM	Infiltration Measures (same as IRM)
IRM	Infiltration-Reduction Measures (Same as IM)
IWC, iwc	Inches of Water Column (Same as IWG, Inches of Water Gauge)
kBtuh	Thousand Btu per hour (also see Btuh above)
kHz	Kilohertz (see Hz, Hertz above)
NC	Natural Conditions (in the CAZ)

ND (Appliances)	Natural Draft Appliances (see Definitions)
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NFVA	Net Free Ventilation Area
NOx	Generic term for a group of gases containing nitrogen and oxygen (e.g., NO and NO_2).
OC (Appliances)	Open Combustion Appliances (see Definitions)
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
Pa	Pascal (see definitions)
PACM	Possible Asbestos-Containing Material (see Definitions)
PPM, ppm	Parts Per Million
psf	Pounds per Square Foot
psi	Pounds per Square Inch
PTAC	Packaged Terminal Air Conditioner
RTV	Room Temperature Vulcanization (e.g., RTV Silicone)
SC (Appliances)	Sealed Combustion Appliances (see Definitions)
SEER	Seasonal Energy Efficiency Ratio
T&P Valve	Temperature and Pressure Relief Valve
UBC	Uniform Building Code (CBC in California)
UL	Underwriters Laboratories
UV	Ultraviolet
WCD	Worst Case Depressurization
WRT	With reference to

B. Definitions

Abandoned Appliance	A natural gas combustion appliance which is no longer used and has been removed from service, by the following actions: a. Flexible gas connector has been removed, *and* b. Gas shutoff valve has been capped, or the valve has been removed and the pipe capped.
Affecting the Living Space	See "Combustion Appliances Affecting the Living Space" and "Combustion Appliances **Not** Affecting the Living Space"
Air Changes per Hour Natural (ACHn)	ACHn is the air infiltration rate of a building at natural (atmospheric) pressure. a. ACH is the percentage of building volume exchanged per hour—or the number of times per hour an amount of air equivalent to the entire volume of a building will pass through the shell as infiltration and exfiltration. b. If a 4,000-cubic foot dwelling had infiltration at natural pressure equivalent to 1,000 cubic feet per hour, the air infiltration rate would be 0.25 ACHn (1,000 ÷ 4,000 = 0.25). c. In other words, during each hour, one-fourth of the air in the dwelling would be replaced (changed) by fresh outdoor air. d. ACHn = air change per hour (percent of building volume exchanged per hour under natural pressure)
Air-free (A-F) CO	A CO measurement taken with a test instrument that calculates the amount of CO ppm without the presence of excess air. The amount of oxygen in the combustion gas is considered, by adjusting theas-measured CO ppm value to simulate oxygen-free conditions in the combustion gases.
Appliance Line Valve (Appliance Shutoff Valve)	A manual gas shutoff valve, installed between the gas supply pipe and the flexible gas connector for an appliance. It must be located within 6 feet of the appliance it serves. The flexible gas connector must be completely in the same room as the appliance to which it is connected.
As-Measured (A-M) CO	The measured CO ppm from a sample of combustion gases with no regard for excess air diluting the CO concentration. The test instrument does not perform a calculation to account for oxygen in the combustion gases.
Attic Venting	Screened and/or louvered vents installed to provide attic ventilation. a. Low vents typically are eave and soffit vents, but they can also be a roof jack/eyebrow installed low on the roof, or a gable vent installed low on the gable wall. b. High vents typically are roof jacks, eyebrow vents, dormer vents, and wind turbines.

Automatic Gas Shutoff Valve	An automatic safety device that is installed on some gas water heaters to protect against overheating by shutting off the gas supply when water in the tank reaches a preset level, typically 210 °F. a. It shuts off gas to the water heater and prevents the burner from lighting. b. Code requires that a separate pressure relief valve also be installed somewhere in the cold-water supply line. c. An automatic gas shutoff valve (such as a "Watts-210") may be used on water heaters instead of a temperature and pressure (T&P) relief valve. This is done in locations where a gravity drain line to outdoors cannot be installed (e.g., interior locations and basements).
Backdrafting	a. The reverse flow of combustion gases down the vent pipe and out the draft hood of a natural draft open combustion gas appliance (also see "spillage"). b. Intermittent backdrafting can be caused by wind gusts. c. Ongoing backdrafting can be the result of a negative pressure in the (CAZ) caused by: • Return duct leaks near the appliance, • Blockage of the vent pipe or cap, and/or • The excessive interference of mechanical systems exhausting air from the structure (kitchen, bathroom, and utility room exhaust fans, clothes dryer, built-in vacuum system, etc.).
Bellyboard	See "Rodent Barrier".
Belly-Cavity Return (In Mobile Homes)	The belly cavity (in the floor of a mobile home) used as an un-ducted return is called a "belly-cavity return." It is a source of catastrophic duct leakage, because there are many air leaks (bypasses) in the belly cavity. When feasible, a belly-cavity return, should be abandoned (by removing floor registers and filling/sealing the holes), and replaced by a ducted central return.
Btu, Btuh (Btu/hr), kBtuh	a. Btu is short for British thermal unit. Btuh (or Btu/hr) is the Btu-per-hour input rating of a combustion appliance, a measure of the quantity of energy from fuel that is consumed by the burner. • For simplicity, large Btu ratings are referred to as "kBtuh," which is "thousand Btuh" (1,000 Btuh = 1 kBtuh). • Thus, the rating of a 90,000 Btuh input furnace can be expressed as "90 kBtuh." b. Btuh can also be used to express the *output* of a furnace. Btuh input times the AFUE equals the Btuh output. • A 100 kBtuh input 80% AFUE furnace has an 80 kBtuh output.
Carbon Monoxide (CO)	A gas produced as a byproduct of the combustion process. CO is toxic to humans and animals, because it "steals" oxygen atoms in the blood-stream and "starves" the body of oxygen.

Climate Zone (CZ)	There are 16 CEC climate zones (CZ), based on energy use, weather, temperature, and other factors.
Closed Combustion (Appliance)	Has a sealed combustion chamber with gasketed access door. Does not have a draft hood. Combustion air is brought in through a pipe/tube directly to the combustion chamber. If the air pipe/tube extends to outdoors, it is a "direct vent" appliance, and CVA is not an issue. If the air pipe terminates in the CAZ, CVA evaluation is required.
CO	See "Carbon Monoxide (CO)" above. Also, see "A-F" and "A-M" CO ppm.
Combustion Appliances Affecting the Living Space	a. All space heating appliances, **and** b. Other combustion appliances in the following locations: • Partially or entirely within the living space (including closets located within the envelope but accessed from outdoors). • An outdoor location/enclosure where any part of the appliance is within 4' of an openable door or window, or a gravity air inlet, leading into the living space. • Attic or basement, or in a location that communicates with the attic or basement. • Attached garage. • A location where combustion products from the appliance could infiltrate the duct system (e.g., through return leaks). Also, see "Combustion Appliances Not Affecting the Living Space."
Combustion Appliances Not Affecting the Living Space	Combustion appliances in all locations other than those listed above, including: a. Detached garage, and b. An outdoor enclosure more than 4 feet from an openable door or window, or a gravity air inlet, leading into the living space.
Combustion Appliance	Appliances that burn fuel. They include those using natural gas, propane (LP gas), fuel oil, wood, wood pellets, coal, or any other flammable liquid (e.g., kerosene) or combustible material.
Combustion Appliance Safety (CAS) Fail	An unsafe (non-conforming) condition associated with the operation of a gas appliance.
Combustion Appliance Safety (CAS) Hazard	A health-threatening condition associated with the operation of a gas appliance, such as spillage and CO ppm above the action level.

Combustion Appliance Zone (CAZ)	The room or space in which one or more combustion appliances are located. The area is subject to pressurization or depressurization that can affect proper operation of the appliance(s). a. Depressurization (negative pressure) in the CAZ is of greatest concern for natural draft appliances—typically a furnace, water heater, wood burning stove, or fireplace drawing combustion air from the living space. b. The CAZ could be a living room containing a wood burning stove, a kitchen or utility porch containing a water heater, or an appliance enclosure containing a furnace and/or water heater. c. Excessive depressurization of the CAZ can cause spillage of CO out of the draft hood and into the living space.
Combustion Ventilation Air (CVA)	a. The total amount of air provided to the space (CAZ) containing fuel-burning equipment. • It may be obtained entirely from indoors (based on room volume), or from outdoors (based on NFVA of the CVA vents or ducts). • It can also be a combination of indoor and outdoor air, when the CAZ is not conditioned space. • See "Confined Space" below. b. Primary and secondary combustion air enter the burner and combustion chamber to support proper burning of the fuel. • Ventilation (dilution) air enters the draft hood to support proper up-flow of combustion gases in the vent pipe (draft). • The "lower" CVA vent primarily provides combustion air to the burner. • The "upper" CVA vent primarily provides dilution air for natural draft appliances, *and* it serves to ventilate heat and combustion byproducts up and out of the enclosure. CVA requirements for room volume and vent/duct size are explained in Chapter 4.
Conditioned Space	An area, room, or space normally occupied and being heated or cooled by any equipment for human habitation. (CMC, §205.0.)
Confined Space	a. A room or space having a volume < 50 cu. ft. per 1,000 Btuh of total input rating of fuel burning appliances installed in that space. (See CMC Chapter 7.) • Total input includes space and water heating appliances in all homes, plus cooking appliances for homes built in 2008 or later. • It is not a confined space when the volume is ≥50 cubic feet per 1,000 Btuh. b. 50 cu. ft. of room volume is the "standard" method of evaluating CVA, and it assumes air infiltration rate is ≥0.40 ACHn. • When ACHn is *known* to be < 0.40, the "Known Air Infiltration Rate Method" must be used, as described in Chapter 4.

Conventional Home	A site-built home, in contrast with a "manufactured" home. See "Mobile Home" and "Modular Home."
Dilution Air	Air that enters through the draft hood opening, mixes with flue gases, and assists the movement of combustion byproducts up the vent pipe (draft) and out into the atmosphere.
Direct Vent (DV) Appliances	A closed combustion appliance into which combustion air is ducted (piped) directly into the combustion chamber from outdoors. CVA is not an issue with DV appliances. All DV appliances are closed combustion—however: a. A closed combustion appliance (e.g., 90+ condensing FAU), with the combustion air intake pipe terminating in the CAZ (not extended outdoors), is not DV. b. In that case, CVA (room volume or combination indoor and outdoor air) must be calculated for the appliance, and it must be adequate.
Draft Hood and Draft Diverter	a. Part of a natural draft appliance, located between the flue terminal (exhaust port on a furnace, center tube on a water heater) and the vent connector (or vent pipe). It has a fixed opening and is intended to do the following: • Allow intake of dilution air to facilitate flow of flue gases up the vent pipe, and prevent the upflow from affecting the combustion chamber. and • Allow flue gases to escape (rather than enter the combustion chamber) if there is inadequate draft, backdrafting, or stoppage beyond the draft hood. b. There is a baffle (diverter) within the draft hood that diverts backdraft gases outward through the draft hood opening, rather than downward into the combustion chamber.
Drawband	A device which encircles a duct and mechanically secures the core-to-fitting attachment—a synthetic duct tie ("zip tie") or a worm-drive stainless steel clamp.
Duct Closure System	The components utilized to secure and seal a duct system joint or seam against air leakage (e.g., pressure sensitive tape, or heat activated tape, or mastic with fiberglass mesh reinforcement). In addition, mechanical fasteners (e.g., drawbands) are required for non-metallic flexible duct connections.
Duct System	All ducts, fittings, plenums, and fans assembled to form a continuous passageway for distribution of air. (CMC, §206.0.)
FAU (Forced Air Unit)	That portion of a central heating and/or air conditioning (A/C) system which contains the air handler (blower section). In a "Split System," it is the furnace. In a "Package Unit," the combination heating or A/C unit may be referred to as the FAU.

Flue	Flue is the portion of a combustion appliance that conveys undiluted flue gases from the combustion chamber to the point where they exit the appliance. a. In a natural draft furnace, the flue(s) terminate at the exhaust port(s) below the draft hood. b. In a water heater, the flue is the center tube, which terminates at the top of the tank. (Also see Vent.)
FVIR Water Heater	a. Open combustion water heaters installed in CA must be "Flammable Vapor Ignition Resistant." • FVIR units have a sealed combustion chamber access and a combustion air inlet system that prevents flames from escaping downward and igniting flammable vapors below (e.g., gasoline fumes in a garage). • If combustion air inlets become obstructed (by dust, lint, etc.) and temperature inside the combustion chamber becomes elevated, the unit will automatically shut down. b. 18-inch elevation above the garage floor is not required for FVIR water heaters.
Gas Shutoff Valve	See "Automatic Gas Shutoff Valve" and "Appliance Line (Shutoff) Valve."
Heat Activated Tape (UL "181A-H")	Metallic duct-sealing tape with an adhesive coating that is activated and cured by the application of heat and pressure. Heat activated tape is used only to seal joints in rigid fiberglass duct systems.
High-Efficacy, High-Efficacy Lighting	Title 24 specifies that new and replacement lights in bathrooms, garages, laundry rooms and outside on the front porch generally must provide "high-efficacy" lighting—which requires that the fixtures be "pin-based" rather than "thread-based"—so efficient lamps cannot be removed and replaced with standard bulbs.
Inaccessible Appliance	A combustion appliance that cannot be accessed for CAS testing, such as: a. Floor furnace in a crawlspace within adequate clearance. b. Floor furnace may also be inaccessible because it has been turned off and covered over by plywood or attached floor covering (e.g., wall-to-wall carpet or vinyl). c. Floor or wall furnace may be inaccessible because it has been turned off and blocked by heavy furniture (hutch, cabinet, etc.).
Induced Draft (Appliance)	An open combustion appliance with an "inducer fan" in the vent system, instead of a draft hood. The combustion chamber is open to the CAZ. It draws combustion air from the CAZ, so CVA must be adequate, based on Btuh input.

Infiltration Measure (IM)	a. Measure(s) installed in or applied to dwellings to reduce or stop infiltration • Infiltration is the uncontrolled flow of conditioned air out of the dwelling, **and** flow of outside air into the living space. b. IM are: • All "shell sealing" (envelope tightening) measures, and • Duct sealing (because duct leaks affect the pressure dynamics of the living space).
kBtuh, kBtu/hr	See "Btu, Btuh (Btu/hr), kBtuh" above.
Lead De Minimis (DPH)	California Department of Public Health (DPH) requires that, in homes built before 1978, contractors are required to *know and follow* lead-safe practices for containment, clean-up, and certification.
Lead De Minimis (EPA RRP)	Environmental Protection Agency Renovation, Repair and Painting (RRP) Rule: a. Applies to housing constructed prior to 1978, ***except*** • Housing for the elderly or persons with disabilities (unless any child who is less than six years of age resides or is expected to reside in such housing), and • 0-bedroom dwellings. b. De minimis (minimum action) levels are activities that will disturb: • > 6 sq. ft. of painted surfaces on the interior of a building (per room), or • > 20 square feet total on the exterior.
Lead De Minimis (HUD)	U.S. Department of Housing & Urban Development (HUD) Lead-Safe Housing Rule: a. It is required for all HUD Public Housing and Section 8 "Rental Assistance" clients when HUD's de minimis (minimum action) levels are exceeded, which are: • 2 square feet of paint disturbance per interior room; or, • 20 square feet on exterior surfaces. • 10 percent of the surface area of small building components (i.e., trim, window sill, or baseboard) is disturbed. b. When calculating the di minimis level, the entire surface of the component must be included in the computation. • For example, when replacing a 2 x 3 foot window, the di minimis level would be 6 sq. ft., which exceeds the maximum allowance for interior surfaces. • The unit would therefore be subject to HUD Regulation.
Lead-Free, Certified	Residential property that has been determined by a California Certified Inspector/Risk Assessor Contractor to be absent from the presence of lead-based paint

Lead-Safe, Certified	Residential property in which lead-painted surfaces are intact and/or have been treated with measures to stabilize and eliminate lead-paint hazards, and therefore the paint poses no immediate threat to the occupants, as determined by a California Certified Inspector/Risk Assessor Contractor.
Listed, Listing (e.g., "UL Listed")	Equipment or materials included in a list published by a nationally recognized testing agency (e.g., UL, CSA, ITS, ETL, Warnock Hersey, etc.) that maintains periodic inspection of the production of listed equipment or materials. a. Listing indicates compliance with nationally recognized standards. Listed appliances and components must be installed in a manner which complies with the "terms of the listing" (i.e., in accordance with manufacturer's instructions). b. Also, known as "Labeled" and "UL Classified" (see definitions at the end of this table).
Luminaire	A complete lighting **fixture**. A luminaire includes the light source/lamp, the reflector for directing the light, an aperture/opening (with or without a lens/diffuser), the outer shell/housing, an electrical ballast (if required), and connection to a power source.
Manufactured Home	See "Mobile Home" and "Modular Home".
Mechanical Draft (Appliance)	A combustion appliance (open or closed/sealed) with induced draft (under non-positive pressure) or forced draft (under positive pressure). The vent system removes flue or vent gases by mechanical means.
Mini Split Air Conditioner or Heat Pump	Mini-split units' condition air like a central HVAC system, but are much smaller and without ducts (they are "ductless"). They are called "mini splits" because they are very small split systems. a. The outdoor condenser unit is relatively small, and the refrigerant lines and wiring come through the wall in a small-diameter conduit. b. The indoor air-handling unit is mounted on a wall in front of the conduit. The indoor unit looks like a wall-mount air conditioner or a PTAC, but it is surface-mounted rather than extending through the wall, and it does not contain a condensing unit. c. Some mini split systems have several indoor units to condition multiple rooms (zones) in the home.
Mobile Home (Manufactured Home)	A mobile or "manufactured home" is regulated by HUD and is built on a trailer chassis and designed for highway delivery to a permanent location. a. It can be a single-, double- or triple-wide home. b. It is licensed by the Department of Motor Vehicles

Modular Home (Factory-Built Housing)	In California, "modular homes" are called "factory-built housing" and are subject to Title 24 and the CA Residential Code—*not* the HUD code. a. Alteration permits are issued/inspected by the local building department, not HCD. b. A modular home has framing characteristics like a conventional home, and is built for permanent installation on a foundation. It is not built on a trailer chassis, it does not have axles, wheels or license plate, and it is transported on a dolly or trailer.
Natural Conditions (NC)	The condition in which air pressures within the home and each CAZ are in their "natural" state—without the depressurizing influence of fans, the air handler, and closed doors. Interior room doors are open, air handler and exhaust fans/devices are off. Also see "Worst-Case" Depressurization (WCD) below.
Natural Draft (Appliance)	An open combustion appliance with a draft hood located between the flue (center tube on a DHW) and the vent connector. Dilution air enters through the draft hood and assists the upflow of combustion byproducts through the vent pipe to outdoors. It draws combustion air from the CAZ, so CVA must be adequate, based on Btuh input.
NFVA, Net Free Ventilating Area	It is the net (open) amount of venting area provided by a vent, after the blocking effect of mesh and/or louvers has been subtracted from the gross area of the vent opening. (See Chapter 4.)
Nonconforming	An appliance or component that does not meet code or is not installed in accordance with manufacturer's instructions. Examples include: a. An unlisted or improperly-vented gas appliance, b. A vent pipe with improper termination or inadequate clearance to combustibles, c. An improper gas line valve and/or flexible connector, and d. An appliance that has been improperly modified.
Occupancy Sensor, *and* Vacancy Sensor	a. An **Occupancy** Sensor is an electronic device that detects presence of a person in the room where a light fixture is located and *automatically* operates the fixture circuit (turns it on and off). • Occupancy sensors are typically used in commercial/industrial applications, such as offices and restrooms. b. A *Vacancy* Sensor is turned on *manually* (does not come on automatically when a person enters the room). It keeps the light on when occupancy is detected, and it automatically turns *off* the circuit after occupancy is no longer detected. • Title 24 requires Vacancy Sensors in *residential* applications (and does *not* allow Occupancy Sensors). • An Occupancy Sensor will needlessly turn on lights when a person enters a room during the day. (Units with photocell to prevent day-time activation do not meet Title 24 standards as written.)

Open Combustion (Appliance)	An appliance with combustion chamber that is open to the CAZ. It draws combustion air from the CAZ, so CVA must be adequate, based on Btuh input. It can be natural draft (atmospheric) with a draft hood, or induced draft with an inducer fan in place of a draft hood.
Overcurrent Protection	An electrical protection device (circuit breaker or fuse) designed to break (disconnect) the circuit if current exceeds the amount for which the wiring and other components are designed. a. Tamper-proof overcurrent protection (required when insulating over Knob-and-Tube wiring), is a circuit breaker or a special "S-type Fuse." b. An S-type Fuse fits into a special threaded adapter permanently installed in the fuse socket. The adapter will accept *only* a fuse with the correct amperage rating.
Package Unit	An air conditioner, or a combination heating and air conditioning system, contained within one housing unit, which is installed outdoors (on the roof or on a slab next to the house). It may also be called a "Dual Pack". (Also see "Split System.")
Pascal (Pa)	a. A small unit of pressure equal to 0.004 inches of water column (IWC). • 1 Pa = 0.004 IWC, and 1 IWC = 250 Pa. • 25 Pa (0.1 IWC) is the pressure typically used for duct testing. • 50 Pa (0.2 IWC), is the pressure typically used blower door testing. b. Conversion equations: [Pa = IWC ÷ 0.004] and [IWC = Pa x 0.004]
Plenum	An air compartment or chamber or building cavity to which one or more ducts are connected. (CMC, §218). a. The plenum forms part of either the supply-air or return-air system. b. FAUs in garages and hallway closets often rest on a "platform" building cavity that constitutes the return plenum, referred to as a "platform return". c. Unlined platform returns are catastrophic leakage sources that should always be sealed.
Possible Asbestos-Containing Material (PACM)	Material that *may* contain asbestos. a. Lab testing is required to determine if asbestos is present in the material. If so, it is an "asbestos-containing material" (ACM). b. PACM is most commonly found in older duct sealing and insulating materials, in "popcorn" ceilings, and in some vermiculite insulation. c. See Appendix M regarding ACM and blower door testing.

Pressure Sensitive Tape (UL "181A-P" & "181B-FX")	Duct tape with a tacky adhesive coating (butyl, acrylic, etc.), which will adhere to a surface with the application of pressure (heat not required). Title 24 requires that duct tapes be listed and marked per UL 181A-P (for rigid fiberglass ducts), and 181B-FX (for flexible ducts). Either can be used to seal rigid metal ducts.
PTAC **Package Terminal Air Conditioner**	A self-contained, non-ducted air conditioning/heating unit that is normally mounted through an outside wall. It is usually larger than a typical wall-mount air conditioner and is most commonly seen in motel rooms and apartments.
Rodent Barrier	A thin rigid or flexible material attached to the bottom of the floor supports (joists) of a mobile home to keep rodents out of the insulation and underfloor area. (Also called the "bellyboard".)
Sealed Combustion (Appliance)	See "Closed Combustion (Appliance)" above.
Solid Fuel Heating Appliance	A combustion appliance that burns solid fuel—wood, wood pellets, or coal. It can be a free-standing stove, fireplace insert, or a fireplace.
Spillage	In an open combustion, *natural draft* appliance, spillage is the unwanted outflow of combustion gases through the draft hood. (Also see "Backdrafting.") a. Spillage occurs when the vent system draft is not adequate to carry combustion gases up through the vent pipe and outdoors. b. *Brief* spillage occurs when combustion first begins in a cold appliance, because cold air in the vent pipe impedes exhaust flow. c. *Occasional* spillage may be caused by wind gusts creating pressure at the vent termination. d. *Continuous* spillage (a hazardous condition) may result when (a) the vent pipe is blocked by an obstruction or is improperly constructed (too short, too many elbows, improper slope or diameter, etc.), or (b) excessive negative pressure is in the CAZ.
Spillage Test	A test for spillage is performed along the *entire* draft hood opening. a. Most commonly, a mirror is used to detect hot moisture (which will cause it to "fog up"). b. Smoke (e.g., from a "smoke pen") may also be applied (which will be blown away from the draft hood by spillage).
Split System	A heating and cooling system in which the: a. Air conditioning evaporator coil (the "inside" coil) is attached to the furnace (typically in the garage, attic, basement, or interior closet), **and** b. Condenser unit (with "outside" coil, compressor, and fan) installed outdoors, usually on a slab next to the house. c. Also, see "Mini Split" and "Package Unit."

T&P Valve	A safety valve required on water heaters, which releases water (and thus relieves pressure) if either the temperature or pressure in the tank gets too high. a. Temperature relief is typically set at 210°F, and pressure relief at 125 to 150 psi. b. T&P valves must have a gravity drain line to outdoors. (When a drain line cannot be installed, an "automatic gas shutoff valve" may be used.)
Thermostatic Shut-off Valve (TSV)	A valve installed in a shower that reduces water flow to a trickle when water temperature reaches a preset level. Manual activation restores water flow. a. A TSV reduces energy waste when a person turns on the shower to warm up and leaves it unattended beyond the time required for hot water to reach the showerhead. b. It can be a separate component or built into the showerhead.
Threshold Risers and Elevators/Shims	a. Threshold Risers are installed on top of the threshold to increase its total height (profile). b. Elevators and shims are placed underneath the threshold to raise it up, so its top surface is higher above the floor. c. The topmost surface of the threshold or riser must not extend above the interior finished floor more than 1″ (1/2″ if any occupant uses a wheelchair or walker).
Trickle Valve	One name for a valve that reduces flow into a showerhead to just a trickle. It can be a separate valve that attaches to the shower arm ahead of the showerhead, or it can be included in the showerhead assembly. (Also see "Thermostatic Shut-off Valve.")

UL Classified, **UL Labeled** **UL Listed,** **UL Recognized**	a. **UL Classified** means that UL testing was limited to examination of one potential hazard. b. **UL Labeled** means that a product is either UL Listed or UL Classified. c. **UL Listed** means that UL testing included examination of all foreseeable hazards. • Note that a product can be certified and "listed" without involving UL. Other accredited laboratories (e.g., CSA International, ITS Intertek Services, ETL SEMKO, Warnock Hersey, etc.) can test products and certify conformance with established standards. • Such products can thus be "listed and labeled" without reference to UL. d. **UL Recognized** means that a component (such as a motor) is approved for use in a UL Listed product (such as an evaporative cooler). • The complete cooler is UL Listed, but the tested and approved components used in it are “UL Recognized” components. • Each UL Recognized component is tested to a UL standard applicable to that component, and it is “recognized” for use in a UL Listed product.
Vacancy Sensor	See “Occupancy Sensor and Vacancy Sensor.”
Vent Pipe (Vent System)	The vent pipe extends beyond the top of the appliance or draft hood. a. Single-wall pipe between the draft hood and the double-wall vent pipe is the “vent connector.” b. Vent pipe extending beyond a wall or ceiling must be double-wall (e.g., Type B). c. When double-wall pipe starts at the appliance or the draft hood and extends all the way to the vent termination, it is all “vent pipe” (there is no vent connector). d. Also, see “Flue” above.
“Worst-Case” Depressurization (WCD)	The condition in which negative pressure in the CAZ is the greatest (most negative). a. CAZ depressurization is affected by a variety of conditions including positions of interior doors, exhaust fans/devices, the FAU air handler, duct leakage, obstructed return airflow, etc. b. See Chapter 5, Part 1: Preparation for CAS testing. c. Also, see “Natural Conditions (NC)” above.

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