Building Analyst Field Training Video:
How to Perform a Home Energy Audit

Data Collection Form

Your guide to passing the BPI Building Analyst & Envelope Professional Field Examinations

BuildingScience Tech

Recommended Use:
We recommend that you watch the Building Analyst Field Training Video and follow along with this Data Collection Form. We strongly encourage you to edit this form so the wording makes the most sense to you, especially prior to taking the BPI Building Analyst or Envelope Professional Field Examinations.

The goal is for you to learn the content contained in this video as completely as possible, and to use the form as a place to record information and remind you of steps to take. We also encourage you to never stop asking 'why?'

Key:

Observations/Tests in black	Required for both Building Analyst and Envelope Field exams
Observations/Tests in orange	Required for Envelope Field exam only
Observations/Tests in blue	Not required for either field examination, but still good to do

Disclaimer:

Please note that much of this publication is based on personal experience. Although the author and publisher have made every reasonable attempt to achieve complete accuracy of the content in this Building Analyst Field Training, they assume no responsibility for errors or omissions. Also, you should use this information as you see fit, and at your own risk. Your particular situation may not be exactly suited to the examples illustrated here; in fact, it's likely that they won't be the same, and you should adjust your use of the information and recommendations accordingly.

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Finally, use your head. Nothing in this Training is intended to replace common sense, applicable local codes, legal or other professional advice; it is meant to inform you and prepare you to join the extremely rewarding building science professional industry.

HOMEOWNER INTERVIEW

Q: Why are you getting an energy audit?
Q: Are there any hot or cold rooms, moisture concerns, or indoor air quality issues?
Q: Do you have a copy of your last 12 months worth of utility bills?
Q: Can you give me a quick tour of house and point out problem areas?

NOTES:

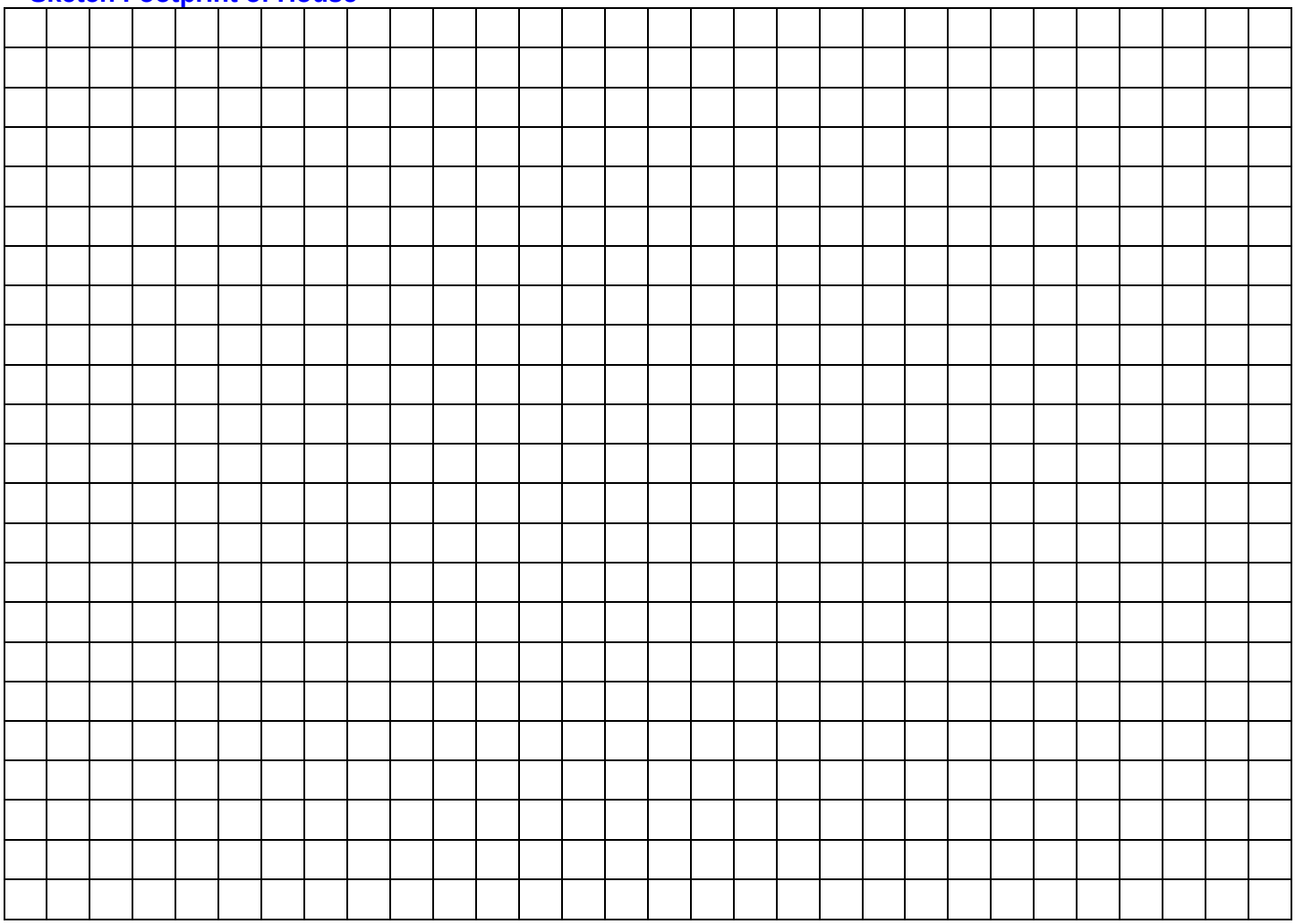
EXTERIOR WALK AROUND – 10 Minutes

Tools: Ambient Carbon Monoxide (CO) Monitor, Combustible Gas Leak Detector, Thermometer

Exterior Inspection - ***Ambient CO Monitor, Gas Leak Detector, Thermometer***

House Type	☐ Single-family ☐ Split-level ☐ Row/Townhome ☐ Condo # of Stories: Estimated year built:
General Condition / Structural issues	Comments:
Record Outdoor Temperature / Weather	☐ Temp: ☐ Weather:
Record Outdoor CO Level	☐ CO Level: ☐ Possible cause (>1ppm):
Bump-Outs / Hidden attics	☐ Bay window ☐ Overhang ☐ Shed ☐ Other:
Foundation	Drainage or grading concerns? ☐ Y ☐ N Comments:
Gutter Condition	☐ Good ☐ Poor ☐ Comments: Downspouts run 5' from house? ☐ Y ☐ N
Roof Condition	☐ Good ☐ Poor ☐ Comments: Flashing concerns:
Chimney Condition, Height	☐ Good ☐ Poor ☐ Comments: Tall enough: ☐ Y ☐ N
Exhaust Vents to Outside	☐ Kitchen ☐ Dryer ☐ # Bathroom: ☐ Other
Roof venting	☐ Soffit ☐ Ridge ☐ Gable ☐ Power Comments:
Window Type / Condition	☐ Single ☐ Double ☐ Triple ☐ Low-e ☐ Storm ☐ Vinyl ☐ Metal ☐ Wood Overall condition: ☐ Good ☐ Poor ☐ Comments:
Sniff Outside Gas Meter & Pipes for Leaks	Beeps from meter? ☐ Y ☐ N Bubbles from soapy mixture? ☐ Y ☐ N Location:
AC / Heat Pump Compressor Inspection	☐ Output (tons): ☐ Age: ☐ Last service visit: Proper clearance? ☐ Y ☐ N Add shading? ☐ Y ☐ N Compressor line insulated? ☐ Y ☐ N Overall condition: ☐ Good ☐ Poor ☐ Comments:

Sketch Footprint of House



Measurements

Square footage of house	
Total above-grade wall area	Perimeter: Avg Height: Wall area:
Foundation wall area	Perimeter: Avg Height: Wall area:
Volume of house	
Window Count	Average size: Quantity: ☐ Total:_____ ☐ Front:_____ ☐ Back:_____ ☐ Right:_____ ☐ Left:_____ Total glazing area:
Attic area	Typical: Other:
Framed floor area	Typical: Other:

INTERIOR WALK THROUGH – 20 Minutes

Tools: Ambient CO Monitor, Combustion Analyzer, Manometer, Gas Leak Detector, Flow Hood (optional), IR Camera (optional), Airflow Meter (optional), Video Inspection Scope (optional),

Observations throughout House

Recommend light bulbs that could be switched out to CFLs/LEDs	☐ Bedroom 1: ☐ Bedroom 2: ☐ Bedroom 3: ☐_____: ☐ Kitchen: ☐ Living Room: ☐ Family Room: ☐ Basement:
Note major electric appliances that should be removed or replaced	☐ Refrigerator ☐ Freezer ☐ Dishwasher ☐ Washing machine/Dryer
Note any health/safety issues	☐ Fire hazards? ☐ Y ☐ N Comments: ☐ VOC pollutants? ☐ Y ☐ N Comments: ☐ Mold? ☐ Y ☐ N Comments: ☐ Additional diagnostic tests needed? ☐ Y ☐ N Comments:
Identify any major fuel-switching opportunities	☐ Water heater ☐ Furnace/Boiler ☐ _____ ☐ _____

Gas Oven Testing - *Combustion Analyzer, Gas Leak Detector, Ambient CO Monitor*

Sniff gas line for leaks of oven and dryer	Beeps from meter? ☐ Y ☐ N Bubbles from soapy mixture? ☐ Y ☐ N Location:
Turn on oven to 500° and test for CO	CO level after 5 minutes of operation: _____ppm
BPI Recommended Action Levels for Gas Ovens	
Always recommend that homeowners install a CO detector in kitchens that contain an unvented range top and oven. Encourage the homeowner to turn on the kitchen range fan whenever the oven or range is in use.	
Level I Action – 100 ppm to 300 ppm *You must install a carbon monoxide detector and make recommendation for service*	***Level II Action – Greater than 300 ppm*** *The unit must be serviced prior to work. If greater than 300 ppm after servicing, exhaust ventilation must be provided with a capacity of 25 CFM continuous or 100 CFM intermittent.*

Above-Grade Floor(s) Observations – *Flow Hood (optional), IR Camera (optional)*

Wall details (typical)	Framing: ☐ Wood ☐ Metal ☐ Masonry ☐ Other: Insulation: ☐ Fiberglass ☐ Cellulose ☐ Foam R-value: Comments:
Wall details (other)	Framing: ☐ Wood ☐ Metal ☐ Masonry ☐ Other: Insulation: ☐ Fiberglass ☐ Cellulose ☐ Foam R-value: Comments:
Framed Floors (typical)	☐ Over crawlspace ☐ Over basement ☐ Joist Depth: Insulation type: ☐ Batt ☐ Loose Fill ☐ Foam ☐ Material: R-value: Comments:
Framed Floors (other)	☐ Over crawlspace ☐ Over basement ☐ Joist Depth: Insulation type: ☐ Batt ☐ Loose Fill ☐ Foam ☐ Material: R-value: Comments:
Cathedral Ceilings	Insulation adequate? ☐ Y ☐ N Comments: Recessed lights? ☐ Y ☐ N Comments:
Any differences in ceiling heights on top floor (bump outs)?	☐ Y ☐ N Comments:
Compare exhaust fans inside to vents to outside	☐ Kitchen ☐ Dryer ☐ # Bathroom: ☐ Other Any vents not to outside? ☐ Y ☐ N Comments:
Test bathroom fans for proper airflow: toilet paper test or cfm reading	☐ Bathroom 1: ☐ Bathroom 2: ☐ Bathroom 3 :

Basement/Crawlspace Observations

Foundation wall details (typical)	Insulation: ☐ Fiberglass ☐ Cellulose ☐ Spray Foam ☐ Rigid R-value: Comments:
Foundation wall details (other)	Insulation: ☐ Fiberglass ☐ Cellulose ☐ Spray Foam ☐ Rigid R-value: Comments:
Rim Joist	Insulation type: ☐ Batt ☐ Foam ☐ Other: R-value: Comments:
Air leakage	Unsealed rim joists? ☐ Y ☐ N Comments: Chaseways to the attic? ☐ Y ☐ N Comments:
Ceiling	See Framed Floors in *Above Grade Floors* section
Are there any parts of the house to bring inside thermal envelope?	☐ Y ☐ N Comments:
Are any asbestos-like materials present?	☐ Y ☐ N Comments:
Any signs of moisture problems caused by poor grading/drainage/gutters?	☐ Y ☐ N Comments:
Is the crawlspace floor properly sealed from ground moisture with 6-mil poly sheets?	☐ Y ☐ N Comments:

Attic Inspection

Note health/safety issues	☐ Mold ☐ Live Knob & Tube ☐ Vermiculite ☐ Other:
Any improper clearance around flues?	☐ Y ☐ N Comments:
Insulation (typical)	Type: ☐ Fiberglass Batt ☐ FG Loosefill ☐ Cellulose ☐ Other: Installation quality: ☐ Good ☐ Fair ☐ Poor Nominal R-value: Effective R-value: Comments:
Insulation (other)	Type: ☐ Fiberglass Batt ☐ FG Loosefill ☐ Cellulose ☐ Other: Installation quality: ☐ Good ☐ Fair ☐ Poor Nominal R-value: Effective R-value: Comments:
Do any baffles need to be installed or repaired?	For fire protection? ☐ Y ☐ N Comments: To prevent wind-washing? ☐ Y ☐ N Comments:
Air leakage	Top plates sealed? ☐ Y ☐ N Comments: Chaseways to the basement? ☐ Y ☐ N Comments:
Attic kneewalls	Location: Insulation type: ☐ Fiberglass Batt ☐ Spray Foam ☐ Other: Properly blocked if fiberglass batts? ☐ Y ☐ N Comments:
Attic access hatch	Properly insulated? ☐ Y ☐ N Comments: Adequately weatherstripped? ☐ Y ☐ N Comments:

Hydronic - Steam Distribution Inspection

Locate supply and return pipes	Comments:
R-value of pipes	R-value: Comments:
Leaks present?	☐ Y ☐ N Comments:

Duct System Inspection – *Manometer, Flow Hood (optional), Airflow Meter, Duct Leakage Tester*

Turn on the air handler fan, consider turning on heat or a/c if season appropriate	
Air leak inspection	Leaks in unconditioned space? ☐ Y ☐ N Comments: Leaks in conditioned space? ☐ Y ☐ N Comments: Seal with: ☐ UL-181 tape ☐ Mastic ☐ Aeroseal
R-value of ducts in unconditioned space	Is it at least R-6? ☐ Y ☐ N Comments:
Supplies and returns inspection (central return or one in each room)	Quantity of return grills: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ #
Are there any glaring sizing or installation issues with ducts?	Sizing: ☐ Y ☐ N Comments: Installation: ☐ Y ☐ N Comments:
Rooms where there is Δp > 2.5 pa	☐ _____: ___(pa) ☐ _____: ___(pa) ☐ _____: ___(pa) ☐ _____: ___(pa) ☐ _____: ___(pa) ☐ _____: ___(pa) Comments:
With furnace or a/c on, tests supply air of any rooms with comfort problems	☐ _____: ____CFM 1 ___ Temp 1 ____CFM 2 ___ Temp 2 ☐ _____: ____CFM 1 ___ Temp 1 ____CFM 2 ___ Temp 2 ☐ _____: ____CFM 1 ___ Temp 1 ____CFM 2 ___ Temp 2 ☐ _____: ____CFM 1 ___ Temp 1 ____CFM 2 ___ Temp 2 ☐ _____: ____CFM 1 ___ Temp 1 ____CFM 2 ___ Temp 2 Comments:

Total Duct Leakage Pressurization Test using Retrotec Model Q32

This test quantifies the total leakage of a duct system.
Other devices require slight deviations to the use of the manometer.

Step	Action	
1	Turn off HVAC unit. a. Remove the filter	
2	Position the duc-tester near a central return.	
3	Install the mid-range nozzle. a. For very tight duct systems, install low flow nozzle. b. For very leaky duct systems, remove both nozzles and leave it open.	
4	Attach flange to central return, keeping it in place with duct mask or tape. a. Make sure there are no air leaks.	
5	Attach the flex duct to the flange. a. Firmly tighten with Velcro strap.	
6	Seal off all supply and return registers with duct mask. Do not seal to wall or ceiling. a. Install red tube in a supply register.	
7	Open all interior doors that have a supply or return register. a. Open a window or exterior door.	
8	Connect all hoses and cords to corresponding nipples or portals of manometer and fan, except: a. Connect red hose to blue nipple on DM-2	
9	Turn on DM-2. a. Press 'Device' button until 'Duc-Tester DU200' or the appropriate model name appears in bottom right part of display.	
10	Create 25 pa pressure in ducts. a. Press 'Set Pressure' button. b. Push '2' button, '5' button, and then 'Enter' button.	
11	If 25 pa pressure cannot be achieved, adjust nozzle. a. If 25 pa cannot be achieved, remove nozzle and retest on 'open'. b. If 'Flow' displays 'Too Low', add small 1" nozzle and retest	
12	Record flow. Let the system run for 15 seconds until it is stable and record fan flow in CFM	CFM

COMBUSTION SAFETY TESTING – 60 Minutes

Tools: Ambient CO Monitor, Combustion Analyzer, Manometer, Gas Leak Detector, Smoke Pen

Water Heater Inspection

Fuel Source	☐ Electric ☐ Natural Gas ☐ Propane ☐ Other:
Overall condition	Rust: ☐ Y ☐ N Comments: Burns: ☐ Y ☐ N Comments:
Equipment Details	Manunfacturer: Date Manufactured: Size: Comments:
Flue Inspection	Proper slope (1/4" per foot)? ☐ Y ☐ N Comments: Safety issues? ☐ Y ☐ N Comments: Flue type: ☐ Single Wall ☐ B-vent ☐ PVC
Is there a temperature/pressure relief valve present with discharge pipe to floor?	T/P relief valve? ☐ Y ☐ N Comments: Discharge pipe? ☐ Y ☐ N Comments:
Could tank use blanket wrap?	☐ Y ☐ N Comments:
Are pipes properly insulated?	Cold water pipes (5 feet): ☐ Y ☐ N Comments: Hot water pipes (all accessible): ☐ Y ☐ N Comments:
Sniff gas line for leaks	Beeps from meter? ☐ Y ☐ N Bubbles from soapy mixture? ☐ Y ☐ N Location:

Furnace/Boiler Inspection

Fuel Source	☐ Electric ☐ Natural Gas ☐ Propane ☐ Oil ☐ Other:
Distribution System	☐ Forced Air ☐ Hot Water ☐ Steam
Overall condition	Rust: ☐ Y ☐ N Comments: Burns: ☐ Y ☐ N Comments:
Equipment Details	Manunfacturer: Date Manufactured: Size: Comments:
Flue Inspection	Proper slope (1/4" per foot)? ☐ Y ☐ N Comments: Safety issues? ☐ Y ☐ N Comments: Flue type: ☐ Single Wall ☐ B-vent ☐ PVC
Filter inspection	Present? ☐ Y ☐ N Comments: Clean? ☐ Y ☐ N Comments: Properly sized? ☐ Y ☐ N Comments: Filter door properly sealed? ☐ Y ☐ N Comments:
Sniff gas line for leaks	Beeps from meter? ☐ Y ☐ N Bubbles from soapy mixture? ☐ Y ☐ N Location:

Prepare House for Worst Case Testing - *Ambient CO Monitor, Thermometer*

Step	Action		
1	Turn water heater to pilot; turn furnace/boiler off; turn off all exhaust fans		
2	Record ambient CO level in combustion appliance zone (CAZ)	CO Level:	
3	Record outdoor temperature	Temperature:	
4	Make sure house is in winter condition: close exterior doors, latch or lock windows, open interior doors		
5	Close all operable vents (ie: fireplace damper)		
6	Replace or remove furnace filter if dirty		
7	Install hose from combustion appliance zone (CAZ) to outdoors; plug into manometer, CAZ with respect to outside (red nipple of DM-2, bottom left corner of DG-700)		

Create Worst Case Depressurization Conditions – *Manometer*

We are trying to determine if the exhaust fans in the house can create enough competition for air to back-draft the heater or hot water heater. If the appliance vents sufficiently in worst case conditions, they should also vent under natural conditions.

Green house goes to outside; red to flue or under door.

Record pressure (CAZ with respect to outside) after each step.

Step	Action	Pressure (Pa)
1	Baseline test. Keeping the house in winter conditions, turn on monometer.	
2	Turn on all exhausting fans and appliances (bathroom fans, kitchen fans, dryer, etc). *Do not turn on air handler*. a. If there is a fireplace that is regularly used, turn on blower door to exhaust at 300cfm to simulate fireplace.	
3	Unplug manometer from hose to outside. Attach short hose to manometer. a. Turn on air handler (but not heat source) b. Starting with room furthest from CAZ, test pressure under each interior door. Keep your back to the CAZ. Measure the pressure between the main body of the house (where you should be standing) and the room you are closing off. Test every door except for closets. c. If the pressure is negative, leave the door open. If it is positive or zero, keep it closed. *If it blows on your nose, keep it closed.* d. Unplug the short hose, replug in the hose to outdoors	
4	If pressure in Step 3 is unchanged or more negative than in Step 2, skip to Step 5. a. If pressure is more positive now than in step 2, turn off air handler. b. Next, unplug long hose from manometer, reattach short hose to manometer and test pressure under door closing off CAZ to rest of house with manometer and short hose. c. If pressure is negative, leave open, if positive, keep it closed. d. Unplug the short hose, replug in the hose to outdoors	
5	You have now created worst case conditions. *Record Pressure one last time.*	
6	Calculate worst case depressurization (Step #5 minus Step #1 = worst case).	
7	Compare worst case depressurization (#6) with *CAZ Depressurization Limits* Table. a. If it is more negative than depressurization limit (Table A), it 'fails', and you must make recommendations to alleviate depressurization.	

Dominate force(s) causing depressurization?	☐ Duct Leaks ☐ Kitchen Exhaust ☐ Other:
Recommendations to alleviate depressurization	☐ Seal Duct Leaks ☐ Remove Exhaust Fan ☐ Add Supply Air to CAZ ☐ Add Jumper Ducts ☐ Upgrade to Sealed Combustion Unit

BPI Combustion Appliance Zone (CAZ) Depressurization Limits (Pa.)

Venting Conditions	Limits (Pascals)
Orphan natural draft water heater (including outside chimneys)	-2
Natural draft boiler or furnace commonly vented with water heater	-3
Natural draft boiler or furnace with vent damper commonly vented with water heater	-5
Individual natural draft boiler or furnace	-5
Mechanically assisted draft boiler or furnace commonly vented with water heater	-5
Mechanically assisted draft boiler or furnace alone, or fan assisted DHW alone	-15
Exhaust chimney-top draft inducer (fan at chimney top); high static pressure flame-retention-head oil burner; and sealed combustion appliances	-50

Combustion Appliance Testing – ***Manometer, Ambient CO Monitor, Combustion Analyzer, Smoke Pen, Drill***
Maintaining the house in worst case conditions, proceed to test the lower BTU appliance first (usually the water heater).

I. Water Heater Testing

1. Drill holes in the flue, where appropriate, and possibly the draft diverter. *The draft test location should be about 1 foot downstream of the appliance draft diverter and about 1 foot away from any elbows. You may also need to drill a hole in the draft hood to perform the CO test with undiluted flue gases.* a. Do not drill holes in double walled flues (b-vents), or for sealed combustion units. If a unit has this venting set-up, the only necessary step is to record CO at the exterior outlet of the flue if accessible. Skip to step 4.	
2. Turn on the appliance, observing the flames as it turns on, and test for spillage, ½" below and ½" outside lip of draft hood. *Note the amount of time it takes to stop spilling.* a. If the appliance stops spilling within 60 seconds, proceed to draft test. b. If it takes more than 60 seconds to stop spilling, it fails. In this case immediately turn off the appliance, and put house into winter conditions (turn off the exhaust fans, open all interior doors) and test the spillage, draft test, and carbon monoxide under natural conditions. *There is no need to test the draft or CO under worst case depressurization if the appliance fails spillage.*	Flame roll out? ☐ Y ☐ N Spillage Time (sec) Worst Case / Natural
3. Wait up to 5 minutes and test for draft (in Pascals), using either a digital manometer or select combustion analyzers. *Compare the draft to Minimum Acceptable Draft Test Readings Table.* a. If the appliance is drafting at a pressure more negative than the Minimum Acceptable Draft Test Range, proceed to test the CO. b. If the draft is less negative (closer to zero) than the Minimum Acceptable Draft Test Range, the appliance fails this test. In this case immediately turn off the appliance, and put house into winter conditions (turn off the exhaust fans, open all interior doors) and test the spillage, draft test, and carbon monoxide under natural conditions. *There is no need to test the CO under worst case depressurization if the appliance fails spillage.*	Draft (Pa) Worst Case / Natural
4. Measure the CO in undiluted flue gases at steady state, at least 1 inch inside the throat of the water heater, on both sides of the turbulator, using a combustion analyzer. a. Compare the CO levels, spillage, and draft results to the *BPI Combustion Safety Test Action Levels Table*	Carbon Monoxide (ppm) Left / Right
Extra Credit. Using combustion analyzer, record combusting efficiency in same spot as CO. a. Steady state efficiency should be at least 75%	Efficiency (%)
Turn the water heater to pilot, and proceed to test Furnace/Boiler.	

II. Furnace/Boiler Testing

	1. Drill holes in the flue, where appropriate. *The draft test location should be about 1 foot downstream of the appliance draft diverter and about 1 foot away from any elbows. You may also need to drill a hole in the draft hood to perform the CO test with undiluted flue gases.* a. Do not drill holes in double walled flues (b-vents), or for sealed combustion units. If a unit has this venting set-up, the only necessary step is to record CO at the exterior outlet of the flue if accessible. Skip to step 5.	
	2. Forced air furnaces must be inspected for flame interference. Turn on furnace and visually inspect the burner as the blower fan comes on. *Do this and Spillage (Step 3) at the same time* a. If the flames burn differently when the blower comes on, this is a symptom of a cracked heat exchanger. A cracked heat exchanger cannot effectively be repaired and must be replaced. If time permits, take ambient CO monitor and check CO levels at a couple supply registers around house. If you get any CO reading from supply registers, this is another symptom of cracked heat exchanger.	Cracked Heat Exchanger? ☐ Y ☐ N CO at Supplies? ☐ Y ☐ N Comments:
	*3.* Turn on the appliance (if it's not already on) and test for spillage where the flue gases meet the ambient air. This test is not required for mechanically assisted units. *Note the amount of time it takes to stop spilling.* a. If the appliance stops spilling within 60 seconds, proceed to draft test. b. If it takes more than 60 seconds to stop spilling, it fails. In this case immediately turn off the appliance, and put house into winter conditions (turn off the exhaust fans, open all interior doors) and test the spillage, draft test, and carbon monoxide under natural conditions. *There is no need to test the draft or CO under worst case depressurization if the appliance fails spillage.*	Spillage Time (sec) Worst Case | Natural
	4. Wait up to 5 minutes and test for draft (in Pascals), using either a digital manometer or select combustion analyzers. *Compare the draft to Minimum Acceptable Draft Test Readings Table.* a. If the appliance is drafting at a pressure more negative than the Minimum Acceptable Draft Test Range, proceed to test the CO. b. If the draft is less negative (closer to zero) than the Minimum Acceptable Draft Test Range, the appliance fails this test. In this case immediately turn off the appliance, and put house into winter conditions (turn off the exhaust fans, open all interior doors) and test the spillage, draft test, and carbon monoxide under natural conditions. *There is no need to test the CO under worst case depressurization if the appliance fails spillage.*	Draft (Pa) Worst Case | Natural
	5. Measure the CO in undiluted flue gases at steady state in each chamber. If no chambers are accessible, test in same hole as draft test. a. Compare the CO levels, spillage, and draft results to the *BPI Combustion Safety Test Action Levels Table*	CO (ppm) Highest CO reading
	Extra Credit. Test for efficiency at the same location in the flue as for CO using combustion analyzer. a. Steady state efficiency should be at least 80%.	Efficiency (%)

III. Combined Water Heater and Furnace/Boiler Test

Perform this test when the water heater and furnace/boiler are going into the same flue.

1. With the furnace still on, turn on the water heater.	
2. Test the water heater for spillage; *note time it takes to stop spilling.*	Spillage Time (sec)
3. Test water heater for draft; *record draft reading*	Draft (Pa)

Minimum Acceptable Draft Test Readings

BPI Minimum Acceptable Draft Test Readings at Outdoor Air Temperature Ranges									
Degrees F	<19	20s	30s	40s	50s	60s	70s	80s	>90
Pascals (Pa)	-2.5*	-2.25*	-2*	-1.75*	-1.5*	-1.25*	-1*	-0.75*	-0.5*

** Actual equation is (T_out/40)-2.75*

Combustion Safety Test Action Levels

CO Test Result*	And/Or	Spillage and Draft Test Results	Retrofit Action
0 – 25 ppm	*And*	**Passes**	Proceed with work
26 – 100 ppm	*And*	**Passes**	Recommend that the CO problem be fixed
26 – 100 ppm	*And*	**Fails at worst case only**	Recommend a service call for the appliance and/or repairs to the home to correct the problem
100 – 400 ppm	*Or*	**Fails under natural conditions**	Stop Work: Work may not proceed until the system is serviced and the problem is corrected
> 400 ppm	*And*	**Passes**	Stop Work: Work may not proceed until the system is serviced and the problem is corrected
> 400 ppm	*And*	**Fails under any condition**	Emergency: Shut off fuel to the appliance and have the homeowner to call for service immediately

****CO measurements for undiluted flue gases at steady state***

BLOWER DOOR TESTING – 30 Minutes

Tools: Blower door, Pressure Pan (optional), IR camera (optional), Calculator

Calculate Minimum Building Airflow Standard (BAS)

Go to page 5 of BPI Building Analyst Standards to determine the LBL 'N' Factors for your region.

Step 1: Calculate Ventilation Required for Building
Airflow (cfm) = 0.35 x *Volume* / 60
= 0.35 x _____/60 =_____cfm

Step 2: Calculate Ventilation Required for People
Airflow (cfm) = 15 x *occupants* (occupants = bedrooms +1)
= 15 x _____ = _____cfm

Step 3: Using Higher Airflow Requirement, Convert to CFM50
Minimum CFM50 = Airflow (cfm) x N
= _____ x ____ = _____CFM50

Step 4: Multiply Step 3's BAS x 0.7 for Acceptable Range
BAS x .7 = _____ CFM50

'N' Factors for Washington, DC	
# Stories	N Factor
1	20
1.5	17.8
2	16.2
2.5	15.2
3	14.4

BAS Range: ____ to _____
70% **100%**

Prepare House for Blower Door Testing

Step	Action
1	Turn water heater to pilot; turn HVAC completely off; turn off exhaust fans
2	Close exterior doors, latch or lock windows, lock attic/crawlspace hatches
3	Close all operable vents (ie: fireplace damper)
4	Open all interior doors, including closets with windows or hatches
5	Locate any potential IAQ issues that could become airborne if blower door depressurization test is performed, such as vermiculite (asbestos) in attic, or mold. *Do not perform blower door test if there is an IAQ concern.*
6	Make sure all fires are out, and that ashes are removed or covered
7	Secure all pets and children

Blower Door Set-Up *- Blower door*

Step	Action
1	Select a central location to install blower door (but not a sliding door)
2	Set up frame snugly into door jam a. If using frame with nylon cover, fix bottom first, sides second, and top last in door frame b. Do not pop cams at this point
3	Remove the frame from door jam, and install canvas covering frame a. Stretch canvas tightly to top so fan fits more easily through the hole
4	Reinstall the frame into the door jam a. Pop cams. Shake frame to ensure tight fit. b. Install 5th piece directly above hole for fan
5	Install hose to outdoors, and throw end at least 5' to the side of the door
6	Install fan into frame, hang from 5th piece
7	Install all hoses into manometer, fan, and outlet a. For Retrotec, plug colored hoses and cords into corresponding nipples b. For Minneapolis BD, install hose to outside to bottom left nipple, and hose to fan to top right corner

Run Test – Using Retrotec Blower Door

Step	Action
1	With fan cover still on, turn on DM-2 Manometer
2	Set up for baseline. a. Push the 'Mode' button once. b. Push 'Device' button until it says 'Retrotec 2000'. Make sure it matches the name that is on the red canvas of the blower door frame. c. Verify that the configuration is 'open'. d. Push 'Baseline' button. e. Wait 20 seconds or until reading has stabilized, push 'Enter' button.
3	Remove fan cover.
4	Bring house depressurization to 25 pa. a. Push 'Mode' button until it reads 'Flow(pa)'. b. Push 'Set Pressure' button. c. Push '2' button, '5' button, and then 'Enter' button.
5	Walk around house and make sure there are no problems.
6	Increase house depressurization to 50 pa. a. Push 'Set Pressure' button. b. Push '5' button, '0' button, and then 'Enter' button.
7	If manometer blinks 'Low', the house is too small or tight, so turn off the fan, a. Install the largest ring (ring A) onto the fan. b. Push 'Range Config' button until it says 'Ring A'. c. Repeat step 6. d. If it still blinks 'Low', repeat Step 7 except with ring B.
8	Record CFM50 number displayed on the right side of the gauge.
9	Compare the CFM50 reading to the calculated BAS to determine potential for air sealing/mechanical ventilation.

Run Test – Using Minneapolis Blower Door

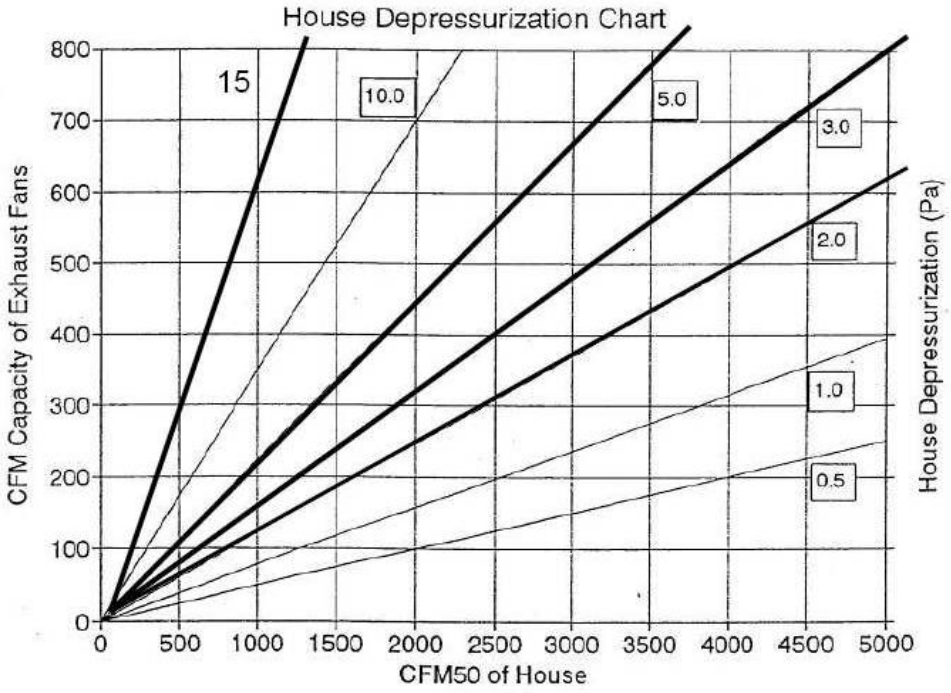
Step	Action
1	With fan cover still on, turn on DG 700 Manometer.
2	Set up for baseline. a. Push the 'Mode' button twice to display PR/FL@50 in lower left corner for digital gauges. b. Push 'Baseline' button. c. Push 'Start' button. A clock will start recording time on the right hand side of gauge. d. Wait 20 seconds or until reading has stabilized, push 'Enter' button.
3	Remove fan cover.
4	Manually turn on fan with dial and bring house depressurization to 25 pa. b. Walk around house and make sure there are no problems.
5	Increase house depressurization to 50 pa or full fan speed (whichever is lower).
6	If manometer blinks 'Low', the house is too small or tight, so turn off the fan, b. Install the largest ring (ring A) c. Press the 'Device' button once until 'A' appears on the top right corner of the manometer. d. Repeat Step 5. e. If it still blinks 'Low', repeat Step 6 except with ring B.
7	Record CFM50 number displayed on the right side of the gauge.
8	Compare the CFM50 reading to the calculated BAS to determine potential for air sealing/mechanical ventilation.

Blower Door Number:_____ CFM50 BAS Range: _____CFM50 to _____CFM50

Need mechanical ventilation due to tight house? □ Y □ N Comments:

Inspect House for Air Leaks - ***Pressure Pan (optional),Manometer (optional), IR camera (optional),***
Walk through the house, looking for significant air leakage. Start at top of the house, and work your way down. Before entering a room, close the door to feel for the cumulative air leaks of that space.

Significant air leakage locations	Windows: □ Y □ N Comments: Doors: □ Y □ N Comments: Recessed Lights: □ Y □ N Comments: Attic Hatch: □ Y □ N Comments: Supply Registers: □ Y □ N Comments: Return Registers: □ Y □ N Comments: Band Joists: □ Y □ N Comments: Bypasses: □ Y □ N Comments:
Pressure pan (looking for Δp<2pa) Note areas of concern	Supply Ducts: ____(pa) Comments: _____: ____(pa) Comments: Return Ducts: ____(pa) Comments: _____: ____(pa) Comments: Recessed Lights: ____(pa) Comments: _____: ____(pa) Comments: Bath Fans: ____(pa) Comments: Switches/Outlets: ____(pa) Comments:
Zone to house pressure test (looking for Δp>48pa)	Attached Garage to House: ____(pa) Comments: Attic to House: ____(pa) Comments:
Air barrier and insulation in same place?	□ Y □ N Comments:
Estimate post air sealing CFM50	_____(CFM50)
Worst case pressure problem after air sealing?	Using the chart below, estimate the ΔP after air sealing is performed. Does this change HVAC recommendation? □ Y □ N Comments:



Recommendations
Create a work scope that details the most cost-effective recommendations for air sealing and insulating the ducts and the envelope, and addresses the homes durability, health and safety issues.
Prioritize recommendations, specify materials and techniques, and list any additional diagnostic tests to be performed. Include need for post-work blower door and combustion safety testing if appropriate.