Home Performance with ENERGY STAR®

Sample Audit Data Collection Form

For Minneapolis Blower Door and DG-700

CONTRACTOR INFORMATION

Contractor Name:_____ Date:_____

Company Name:_____ Phone:_____

PROPERTY INFORMATION

Owner's Name: _____ Year Built / Age: _____

Property Address: _____

City, State, Zip _____ Phone No:_____

Email: _____

HOUSE TYPE *(Check One)*

Single Family Mobile Home Duplex Multi-family Condo

Townhouse, end unit Townhouse, inside unit Apt., end unit Apt., inside unit

UTILITY INFORMATION

Electric Provider Name: _____ Copy of 1 year of electric bills? Yes / No

Heating Fuel Provider Name:_____ Copy of 1 year of fuel bills? Yes / No

CUSTOMER CONCERNS / NOTES:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

EXTERIOR WALK AROUND

House Diagram

	Basement	First Floor	Mid-Level	Second Floor	Other	Totals
Living Floor (ft2):						
Ceiling Height (ft):						
Volume (ft3):						

Exterior Observations

Drainage/Grading Concerns? Y / N

Roof condition: Good / Poor
Flashing issues? Y / N

Maintenance / Durability
Concerns:_____

Bathroom exhaust fans: 1 2 3 4 5 or more

Outdoor CO level:_____

Natural Gas leaks? Y / N
If yes, location:_____

Window Types: single, double paned
wood, vinyl, metal
high-efficiency

Average window size:_____

Windows: East side:_____
South side:_____
West side:_____
North side:_____

Glass doors: East side:_____
South side:_____
West side:_____
North side:_____

INTERIOR WALK THROUGH

Insulation Levels

	Insulation Type	Insulation Depth (Inches)	Nominal R-Value See BPI Pg 7	Effective R-Value See BPI Pg 7	Comments / Thermal bypasses / Envelope Alignment Issues
Attic					
Frame Walls					
Foundation Walls					
Other					

Duct System

Location:

Open crawl space Enclosed crawl space Conditioned crawl space Unconditioned Basement

Conditioned basement Attic, under insulation Attic, exposed Conditioned space

Number of Return Registers: _____ Insulation R-value: _____

Percent supply ducts in unconditioned space: _____ Percent return ducts in unconditioned space: _____

Rooms with > 2.5 Pa pressure differential: _____

Mechanical System

Central Heating System: (if home has multiple heating systems, include information on reverse side of this sheet)

System Type: _____ Fuel Type: _____

Manufacturer / Model #: _____ Seasonal Efficiency: _____AFUE

Input (kBtuh): _____ Output (kBtuh): _____ Estimated Age: _____

Setpoint (F): _____ Automatic Thermostat? Yes No

Location: Conditioned area Attic Unconditioned basement/enclosed crawl space Garage/open crawl space

Central Cooling System: (if home has multiple cooling systems, include information on reverse side of this sheet)

System Type: _____ Fuel Type: _____

Manufacturer / Model #: _____ Output (tons): _____

Seasonal Efficiency: ____ SEER Load Served: _____ % Estimated Age:_____

Performance Adjustment (%): _____ Setpoint (F): _____ Automatic Thermostat? Yes No

Domestic Hot Water Heater

Type: _____ Fuel Type: _____ Fuel Switch Opportunity?: ☐ Yes ☐ No

Manufacturer / Model #: _____ Size (gallons): _____ Energy Factor: _____ EF

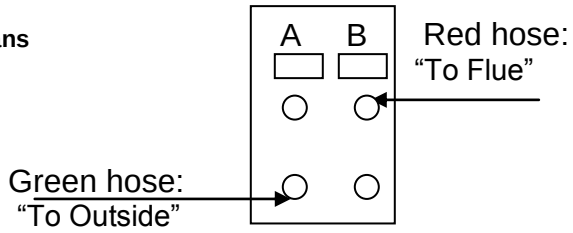
Extra Tank Insulation: _____ Estimated Age: _____ Location: _____

COMBUSTION SAFETY TESTING

Preparing House for Worst Case Testing

TEST	Pre test	Post test
Test Date		
Ambient CO		
Outdoor Temperature		

1. Take control of combustion appliances: turn them off at the thermostat or to pilot
2. Zero CO detector (Follow manufacturer's instructions)
3. **Record house ambient CO level**
4. **Record outdoor temperature**
5. Put house in winter condition (Including latching or locking windows), open interior doors
6. Install green hose; CAZ WRT (with respect to) Outside
7. Check furnace filter; replace if dirty when possible
8. Close all operable vents (Example -- Fireplace damper)
9. **Turn off all HVAC equipment, exhaust fans, including attic exhaust fans**
10. Inspect flue for proper slope (1/4" per foot) & safety issues rust on equipment, staining, soot, loose connections, etc.
11. Check all accessible gas lines for leaks



Worst Case Depressurization Test

1. Baseline test (Interior doors open, furnace off, exhaust appliances off) *Turn on monometer (don't push any buttons).* ***Record pressure.***

2. Turn on all exhaust appliances in home (bathroom fans, dryer, kitchen fans – but *not the furnace air handler*). ***Record pressure.***

3. Turn on air handler. ***Record pressure***.

4. Close interior doors - as you close doors measure the pressure difference between the extended CAZ and the room you are closing off (If negative leave door OPEN – If positive keep door CLOSED). Start with door farthest away from the CAZ and work back to the CAZ. *Test all rooms w/ registers, exhaust fans, or attic hatches.* ***Record pressure.*** *If pressure more positive than step 2 or 3, go back to the most negative situation*

5. Calculate the worst case depressurization (the most negative of Line #2, #3 or #4 minus #1 = worst case) (e.g. if #1 = -0.5 and #4 = -1.2 then -1.2 – [-0.5] = -0.7) ***Record worst case depressurization.***

6. Compare with CAZ Depressurization Limits in Table A. Record dominant force(s) causing depressurization. *If it is more negative than depressurization limit (Table A), it 'fails'. Recommend solutions to minimize depressurization*.
   For example: If worse case above = - 2.5 and the setup is orphan water heater, the CAZ Depressurization test fails because -2.5 is more negative than -2 from the table below (more air is drawn from the CAZ than is safe).

Note: If value on Line #5 is between -2 and -5 Pa, require installation of spill switch or alarm on natural draft water heater.

7. Maintaining the house under **Worst** case conditions, proceed to testing. ***If furnace fan is running, leave it on!***

Table A: 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

I. Water Heater Testing

1. Drill holes in the flue, where appropriate. *The draft/efficiency 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 <u>not</u> drill holes in double-walled flues (Type B venting), or for power vented or for sealed combustion/direct vented units (with PVC venting). If a unit has this venting set-up, the only necessary step is to record CO at the exterior outlet of the flue. Skip steps 2 & 3.

2. Turn on the appliance and test for spillage, ½" below and ½" outside lip of draft hood. *Record the amount of time it takes to stop spilling.*
    a. If the appliance stops spilling within 60 seconds = **PASS –** continue testing
    b. If it takes more than 60 seconds to stop spilling = **FAIL** – GO TO STEP 7 – consider recommendations

3. With the appliance on and at steady state (wait up to 5 minutes) test for draft (in Pascals), using either a digital manometer or select combustion analyzers. *Compare the draft to the Minimum Acceptable Draft Test Range (Table C).*
    a. If the appliance is drafting at a pressure more negative than the Minimum Acceptable Draft Test Range = **PASS** – continue testing and SKIP STEP 7
    b. If the draft is less negative than the Minimum Acceptable Draft Test Range = **FAIL** - GO TO STEP 7 – check ambient CO level, and consider recommendations.

4. Measure the CO in undiluted flue gases at steady state, at least 1 inch into the throat of the water heater and on both sides of the turbulator, using a combustion analyzer.
    a. Compare the CO levels to the Table B: Combustion Safety Test Action Levels
    b. Measure efficiency of the appliance at the same location

6. Turn water heater control to pilot setting (or the thermostat completely down)

7. **WATER HEATER FAILS UNDER WORST CASE DEPRESSURIZATION** - Immediately turn the appliance to pilot (or thermostat down), turn off the exhaust fans, open all interior doors, and **Go back to Step 2 and re-test spillage, draft, 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.*

8. Check the water heater to verify that it has a pressure and temperature relief valve and a safety discharge pipe to within 6" of the floor. Recommend installation of a relief valve and discharge pipe if none exists.
    a. Consider adding tank insulation and/or pipe insulation.

II. Furnace/Boiler Testing

Do not drill holes in double walled flues (b-vents), or for power vented or sealed combustion units. If a unit has this venting set-up, the only necessary step is to record CO at the exterior flue outlet.

1. Drill holes in the flue, where appropriate. *The draft/efficiency test location should be about 1 foot downstream of the appliance draft diverter and about 1 foot away from any elbows.*

2. Light the smoke pencil and turn on the appliance Test for spillage approximate ½" below and ½" in front of the draft diverter. *Record the amount of time it takes to stop spilling.*
    a. If the appliance stops spilling in less than 60 seconds = **PASS** – Continue testing
    b. If it takes longer than 60 seconds to stop spilling = **FAILS** – GO TO STEP 6 - consider recommendations

3. With the appliance on and at steady state (wait up to 5 minutes) test for draft (in PA) using either a digital manometer or select combustion analyzers. *Compare the draft to the Minimum Acceptable Draft Test Range (see chart below).*
    a. If the draft pressure is more negative than the Minimum Acceptable Draft Test Range = **PASS** – continue testing and SKIP STEP 6
    b. If the draft is more positive than the Minimum Acceptable Draft Test Range, = **FAILS** – GO TO STEP 6, check ambient CO level, and consider recommendations.

4. Measure the CO in undiluted flue gases at steady state in each exhaust chamber.
    a. Compare the CO levels to Table B: Combustion Safety Test Action Levels
    b. Test for efficiency at the same locations using the combustion analyzer.

6. **FAILS** - Immediately turn off the appliance, turn off the exhaust fans, and open all interior doors, and **Go back to Step 2 and re-test spillage, draft, and carbon monoxide under natural conditions**. *There is no need to test the draft of CO under **worst case depressurization** if the appliance fails spillage.*

III. Combined Test

Do this test when the water heater and furnace/boiler are commonly vented into the same flue.

1. With the furnace still on, turn on the water heater.
    a. Test the water heater for spillage; *record the time it takes to stop spilling.*
    b. Test water heater for draft; *record draft reading.*

IV. Heat Exchanger Inspection

Forced warm air furnaces must be inspected for flame interference. Visually inspect the burner as the blower fan comes on. If the flames burn differently when the blower comes on, a complete analysis needs to be done to find the source of the flame interference.

Appropriate inspection techniques include visual inspections using a mirror and flashlight or tracer gas tests when the problem is not visually apparent. This problem must be referred to a heating system service contractor for repairs. A cracked heat exchanger cannot effectively be repaired and must be replaced.

When testing is completed, turn off the furnace and set water heater to pilot (or turn the thermostat completely down).

Table C: Minimum Acceptable Draft Test Readings for Outdoor Air Temperature Ranges						
Degrees F	<10	11-30	31-50	51-70	71-90	>90
Pascals (Pa)	-2.5	-2.25*	-1.75*	-1.25*	-0.75*	-0.5

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

Backdraft and CO testing results of atmospherically vented appliances

Appliance	Spillage (Pass or Fail)				Draft Test (Pascals)				Carbon Monoxide (PPM - As measured before diverter)	
	Stand Alone Test		Combined Test		Stand Alone Test		Combined Test		Stand Alone Test	
	Worst Case	Norm Cond	Worst Case	Norm Cond	Pre	Post	Pre	Post	Pre	Post
Water Heater										
Heating System										
Other										

Combusting Efficiency

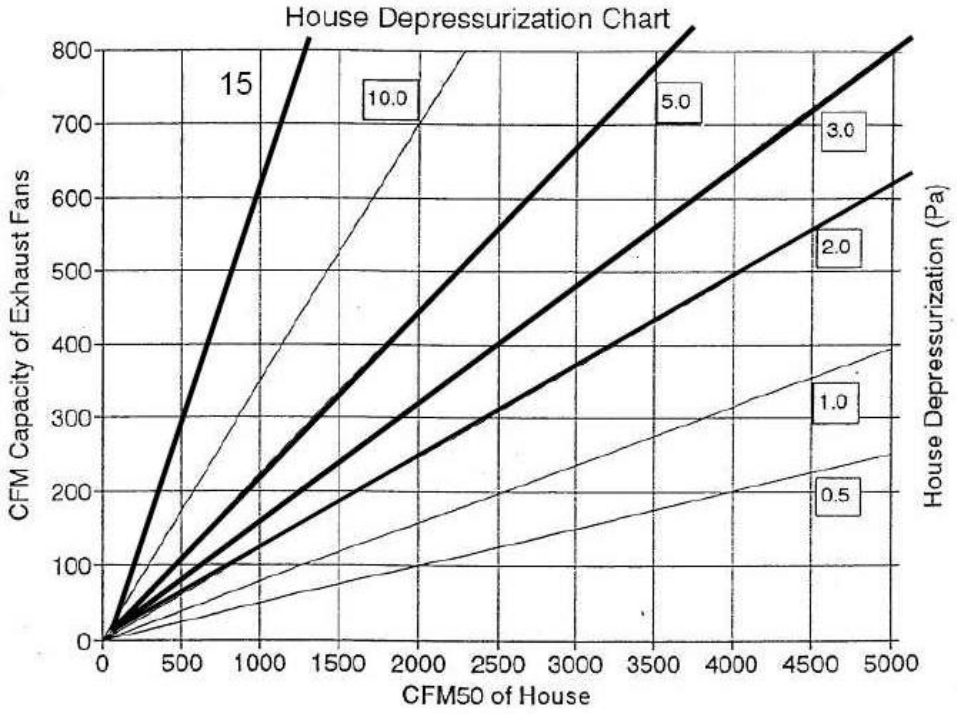
Water Heater: _____
(75% Eff or ↓: Recommend tune-up or change out)

Heating System: _____
(80% Eff or ↓: Recommend tune-up or change out)

Table B: 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 (unofficially 'Or')*	**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: Upgrade work may not proceed until the system is serviced and the problem is corrected
> 400 ppm	*And*	**Passes**	Stop Work: Upgrade 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

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



V. Oven Testing

*** Do not test at worst case *** Test for CO after 5 minutes of operation.
You should always recommend that homeowners install a CO detector in kitchens that contain an unvented range top and oven. You should also recommend that the homeowner turn on the kitchen range fan or kitchen exhaust 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.

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

Blower Door Set-up/Operation Procedure

Calculate Minimum Building Airflow Standard (BAS):

'N' Factors for Virginia	
# Stories	N Factor
1	21.5
1.5	19.1
2	17.4
2.5	16.3
3	15.5

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

Step 2: 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 BAS x 0.7 for Acceptable Range
BAS x .7 = _____ CFM50

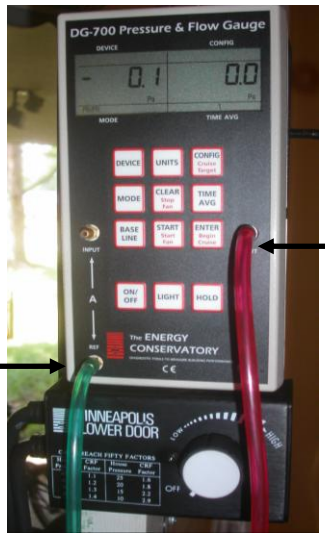
BAS Range: ____ to _____
70% **100%**

House Set-Up

- Turn off combustion appliances and electric heat/cool systems (leave keys)
  - Water heater to pilot (or thermostat completely down)
  - Furnace emergency switch to off (or turn off at thermostat)
  - Electric Heat – thermostat mode to off
- Make sure fires are out, cover or remove ashes, and close dampers and screens
- Turn off exhaust fans, including clothes dryer
- Close and latch all exterior openings
  - windows, storm windows
  - attic and crawlspace hatches, kneewall attic doors, attic stair doors
  - exterior doors
- Open all interior doors, including:
  - basement door
  - bedroom doors
  - closets with windows, hatches, or registers
- Check attic for vermiculite (asbestos) and/or excessive mold
- Check other areas for other potential Indoor Air Quality (IAQ) problems (mold, asbestos)
- Do not perform the blower door test if there is an IAQ concern
- Secure all pets and children

Blower Door Set-Up

1. Select a central location to install blower door
2. Set up frame firmly into door jam
   - If using expanding frame, spread wide first and up second in door frame
   - Do not engage camlocks at this point
3. Remove the blower frame from door frame and install the shroud covering the frame
   - Stretch shroud tightly to top so fan fits more easily through the hole.
4. Install hoses
   - The green hose to outside goes to **ref**erence tap on bottom left side of DG-700 manometer.
   - The red hose to fan goes to **input** tap on top right side of DG-700 manometer.



Green hose to outside – red hose to the fan

Run Test

1. With fan cover still on, turn on DG-700 Manometer
2. Perform Baseline correction
   a. Push the **'Mode'** button twice to display PR/FL@50 in lower left corner of DG700
   b. Push the **'Baseline'** button
   c. Push the **'Start'** button. A clock will start recording time on the right hand side of gauge
   d. Wait 20 seconds or until reading has stabilized, then push the **'Enter'** button
3. Remove fan cover, start the fan and increase house pressure to 25 pa.
   a. Walk around house and make sure there are no problems, especially at the fireplace(s).
4. Increase house pressure to 50 pa or full fan speed (whichever is less).
5. Note CFM50 number displayed on the right side of the gauge.
   a. Compare this number to the calculated BAS to determine potential for air sealing.

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

While the blower door is operating, walk through the house identifying and documenting the leaks as you go. Check recessed lights, windows & doors, window and door frames, attic hatches, electrical outlets and penetrations, plumbing penetrations, basement sill plates and rim joists, etc. Use a smoke device (smoke pen) and/or infrared scanner to help identify and document air leakage.

Air Leakage Sites *(check all that apply)*:

Chimneys	Soil Stacks	Void Around Stairwell	Sill Plate
Electrical Penetrations	Pocket Doors	Porch Ceiling	Duct system
Plumbing Penetrations	Band Joist	Recessed Lights ____#	Drop Soffits
Mechanical Chase	Windows	Partition Wall at Top Plate	Bathroom fans