Diagnostic Energy Auditors, Western Pennsylvania
www.DEAWP.org

Case Study of Etna Neighborhood Home

A Weatherization Project completed by Comfy House Conservation Services Inc.
As part of the ReEnergize Pittsburgh healthy Homes Incentive Program
Summer 2014

Comfy House Project Team:

Tom Branch
Brian Keech
Ray Frazier
Oliver Branch
Marvin Manker

Scenario:

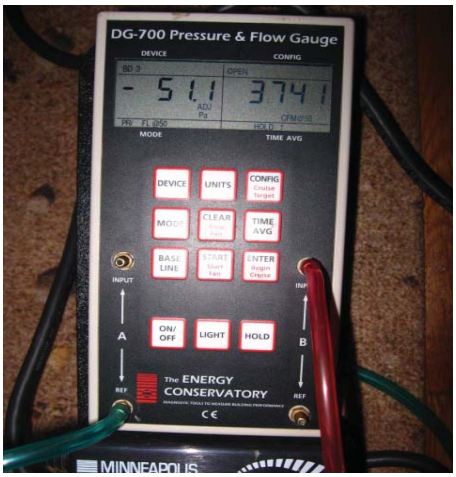
The owners of a single family residence in the Shaler neighborhood requested an audit to solve comfort and energy issues at their home. The audit was conducted as part of the ReEnergize Pittsburgh Healthy Homes Incentive Program, a program which provides financial incentives for homeowners in Allegheny County willing to invest over $5,000 in whole-home energy effficiency improvements. The homeowners were wanting to resolve the following issues:

- **The house is dry in the winter: warm air leaking out through air gaps in the building envelope is being replaced by cold, dry outdoor air.**
- **There were drafts in a few rooms, especially at the second floor.**
- **The Second Floor is extremely cold in the winter; conditioned air does not reach the second floor. This floor is also uncomfortably hot in the summer.**
- **There were moisture issues at the Basement: Evidence of moisture intrusion was found at the lower part of the basement masonry walls.**
- **High Utility Bills, especially during the past winter.**

Audit Findings:

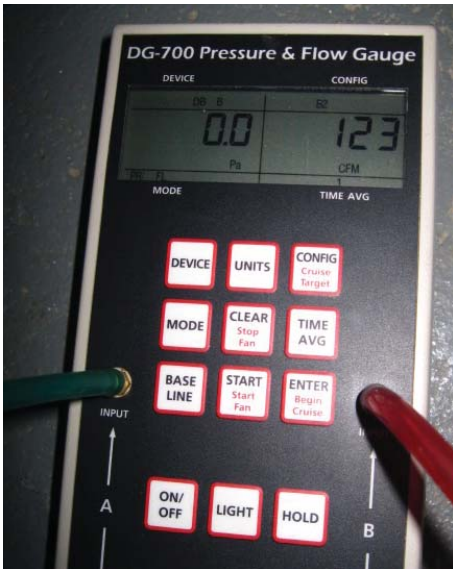
Diagnostic Energy Auditors, Western Pennsylvania
www.DEAWP.org

Blower Door Test:
A blower door test was conducted at the house to measure overall air leakage. The blower door reading was **3,741 cubic feet per minute (CFM)** air flow needed to reach -50 Pascals of depressurization. When compared to the overall volume of the house, this equates to **10.6 air changes per hour (ACH)**. Presently, the code required ACH for new homes is 7 ACH, which means there was room for plenty of improvement in your house in terms of air sealing.



Blower Door Test-In Reading

Duct Blast Test:
During the audit, a duct blaster test was conducted at the house to measure the air leakage in the ducts. The duct blaster reading was **123 cubic feet per minute (CFM)** air flow needed to reach 25 Pascals of pressurization in the ducts with relation to outside. The higher the CFM, the leakier the ductwork. This CFM number, while not extremely high, can still be improved upon with proper air sealing of the ducts.



Duct Blaster Test-In Reading

Combustion Safety Testing:

The Gas Furnace and Hot Water Heater, both located in the basement, were tested for combustion safety, in addition, there was a gas range in the kitchen, which was tested for carbon monoxide levels. The following information was found:

1) Gas Furnace: The gas furnace is a sealed combustion unit; no combustion air/gases are exposed to the basement. The gas lines leading into the furnace and exhaust pipes leading out were inspected for gas leaks, and were found to have no gas leaks.

2) Gas Hot Water Heater: The gas hot water heater was tested for gas leaks (no problems) and for combustion safety in a worst case depressurization test, where the house was set up for maximum worst case "pull" of air against the water heater flue draft, so that if the test passes, you know that the equipment is operating safely at all times. In the worst depressurization test for combustion safety, we found that the water heater passes spillage (exhaust gases do not roll out from the draft hood), has adequate draft pressure at the flue, and the carbon monoxide level, both ambient (inside the basement) at the draft hood, and in the exhaust flue are well within safety limits. In addition, the exhaust flue is adequately sloped upward away from the water heater and directly to the outside.


Combustion Safety Testing

3) Gas Range: The range was tested for gas leaks and none were found. The range did NOT have direct exhaust to outside, but there was a carbon monoxide detector installed nearby. The oven was turned on to 500 degrees and was tested for carbon monoxide levels: at ambient (in the kitchen right next to the range), the carbon monoxide level was well within safety limits.

Specific Air Sealing issues found in the house, leading to the relatively high blower door reading were:

1) The side attic knee walls were not adequately air sealed, and had no attic side air barrier.

2) The side attic floors (including wall top plates, plumbing and electrical penetrations) were not adequately air sealed.

3) Chimney at the north side attic - there were air gaps between the chimney and the attic floor.

4) The four side attic access doors were not weatherstripped.

5) The upper attic was, at the time of the audit, inaccessible; an access hatch/panel was needed in order to air seal and insulate at the upper attic.

6) The upper attic floors (including wall top plates, plumbing and electrical penetrations) were not adequately air sealed.

7) The basement rim joists were neither air sealed or insulated.

In addition, the following Insulation issues were found at the house:

Attics:
8) There was fiberglass BATT insulation installed between roof rafters; which was the wrong place. This insulation was also blocking ventilation air to the upper attic, which is not a good thing, since air flow to the upper attic ridge vent is important.

9) The side attic knee walls were not insulated.

10) The side attic and upper attic floors were insulated with fiberglass BATTS to an effective R-value of 15. The code requirement for attic floor insulation is R-38.

11) The four existing attic access panels were not insulated.

12) Except for the fiberglass BATTs at the rafters that block air flow to the upper attics, the attics were properly ventilated, with gaps in the side attic soffits and both roof and gable vents at the upper attic.

Knee walls - no insulation and no attic side air barrier. Also, insulation was installed at the rafters, where it should not be.

Wall top plates were not air sealed

Basement Rim Joists were unsealed and uninsulated

Basement:

13) The basement band and rim joists were not insulated.

14) The basement masonry walls were not insulated.

15) There was mild staining at the bottom 2' of the basement masonry walls, behind what appeared to be a recent coat of paint, indicating a moisture issues.

Specific Air Sealing issues found at the duct work, leading to the somewhat high duct blaster reading were:

16) The HVAC supply ducts at the basement were not air sealed: the metal supply ducts had gaps at the joints and around the duct boots.

17) The return air plenums in the basement (running between the floor joists) had air gaps along the bottom and top joints.

18) The flexible HVAC ducts at the side attics were not air sealed at the joints.

19) All return air grilles were located at interior walls; there were no return air grilles located at exterior walls. This is good in that the conditioned duct air in the interior wall cavities are never exposed to outdoor/unconditioned air.

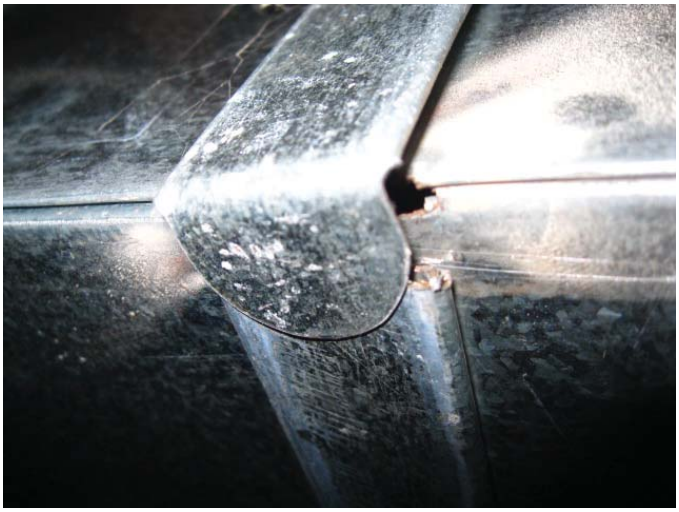
Other Findings from the Audit:

20) The living room fireplace had no damper, leaving air free to escape through the fireplace and out the chimney at all times.

21) The house did not have any exhaust fans installed at the time of the audit. Exhaust fans are important to properly ventilate the kitchen and bathrooms (along with the rest of the house), especially in a house with a gas range.

22) The house has a radon reduction system installed in the basement.

Basement Walls were uninsulated



Gap at basement supply duct

Gaps at basement return air plenum

DEAWP Diagnostic Energy Auditors, Western Pennsylvania
www.DEAWP.org

Recommended Weatherization Improvements:

Comfy House met with the homeowners and presented the audit report, complete with audit findings and recommended improvements. As a certified PA Home Improvement Contractor, Comfy House was chosen to complete the weatherization work. The scope of work, which was completed in late summer, was as follows:

Side Attics:

1) The fiberglass BATT insulation installed between the roof rafters, which was the wrong place, was removed.

2) The side attic knee walls were air sealed with spray foam, then insulated with R-13 fiberglass BATTs.

3) Three inch diameter tubes were installed at the sloped ceiling rafter cavities between the side attics and upper attic. The tubes serve to provide air ventilation flow from side attics to the upper attic & its ridge vent.

4) An air-sealed attic side air barrier was then installed. The air barrier used at most locations was an extruded polystyrene (XPS) rigid insulation, adding additional R-value to the knee wall assembly. ThermoPly was used at a few locations in lieu of XPS. After the air barrier was installed, it was air sealed with spray foam at all gaps and joints.

5) The side attic floors, including wall top plates, plumbing and electrical penetrations, were air sealed with spray foam, and rigid material was used to seal large attic floor gaps.

6) Gaps around the chimney at north side attic were sealed with fireproof spray foam.

7) Weatherstripping was installed at the four side attic access doors, and rigid insulation was applied to the attic side of each door.

Note: since the homeowner requested that the side attics be accessible, with floorboards throughout, no additional side attic floor insulation was installed.

Newly installed tubes used for ventilation between lower and upper attics

New air barrier at side attic knee walls

New rigid insulation at side attic doors

Upper Attic:

8) An insulated, weatherstripped attic access panel and frame was installed at the second floor ceiling leading to the upper attic.

9) The upper attic floors were air sealed w/spray foam.

10) After air sealing was complete, the upper attic floors were insulated with blown-in loose fill fiberglass insulation above the existing fiberglass BATTs, bringing the overall R- value of R-38.

Basement:

11) The Basement band and rim joists were air sealed with spray foam and R-10 rigid foam insulation was installed at all rim joist bays and along the entire length of all band joists.

12) Extruded polystyrene (XPS) rigid insulation was installed along the upper 4' of the basement walls, terminating at 3'-4" above the basement floor. The purpose of this was to prevent moisture at the basement walls from being trapped behind the insulation, leaving any moisture free to dry to the inside.

Ducts:

13) The basement HVAC supply ducts, including duct boots, were air sealed with duct mastic.

14) All of the joints and gaps at the basement return air plenums were air sealed with duct mastic.

15) All of the joints at the side attic flex ducts were sealed with duct mastic.

Other Improvement Measures:

16) A chimney balloon was installed at the living room fireplace chimney. This device will keep conditioned air from flowing out of the chimney, saving great amounts of energy both in the winter and the summer.

17) Exhaust fans were installed at the Kitchen, firrst floor Bathroom, and basement Bathroom. The fan at the basement Bathroom was equipped with a humidity sensor and automatic switch to remove excess condensation at the basement.

New upper attic access panel

New air sealing and insulation at rim joists

New rigid insulation at basement walls

Diagnostic Energy Auditors, Western Pennsylvania
www.DEAWP.org

Final Test-Out:

Blower Door Test:
After weatherization measures were completed, a final test-out blower door test was conducted at the house. The reading on the blower door test-out was **1,933 cubic feet per minute (CFM)** air flow needed to reach -50 Pascals of depressurization. When compared to the overall volume of the house, this equated to **5.5 air changes per hour (ACH)**. This represented a **48% reduction in overall air leakage** in the home.

Duct Blast Test:
After duct sealing was completed, a final test-out duct blaster test was conducted. The test-out duct blaster reading was **90 cubic feet per minute (CFM)** air flow needed to reach 25 Pascals of pressurization in the ducts with relation to outside. This represented a **27% reduction in duct air leakge to the outside.**

Energy Model:

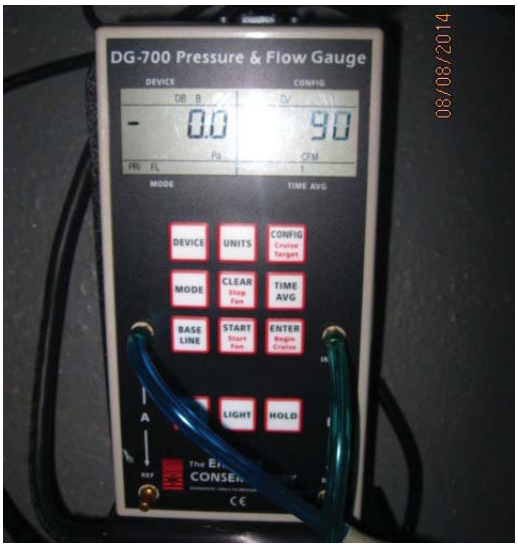
The weatherization upgrades, and all the measurements and characteristics of the house, were input into an energy modeling software. The energy model determined an estimated energy cost savings of $1,010 per year.

Summary:

The weatherization improvements were completed at the house over the course of 6 summer days. After the work was completed, the homeowners spoke of a noticeable improvement in the temperature and comfort level at the second floor. The air sealing, knee wall air barriers, and added insulation, should have even more noticeable effect during the extreme temperatures of the winter, as drafts will be minimized, and heat loss will be drastically reduced.

Newly air sealed ducts at basement

Final Blower Door Test-Out Reading



Final Blower Door Test-Out Reading