Don Michael Jones
Residential Building Analysis

DIAGNOSTIC REPORT FOR:

The Kloos Home
1166 Westchester Rd.
Napoleon, Ohio 43545
419 599-5313

HOUSE DESCRIPTION:

Newly constructed, wood frame, two story house with a full basement (poured concrete foundation) and an attached garage with a bonus living space attached to the second story. The insulation systems include netted blown insulation on the walls and blown fiberglass across the ceilings. The HVAC systems include a 90%+ gas furnace with whole house air conditioning and two induced draft gas hot water heaters.

PROBLEM DESCRIPTION:

The bonus area above the garage is consistently 5 degrees or more cooler than the remainder of the house during the heating season. It is also more difficult to cool in the summer.

OBSERVATIONS:

A combination of a visual inspection of the house and the accessible parts of the attic, blower door based diagnostics and an Infrared Thermography scan was completed on the Kloos home on February 13, 1997. The results of that inspection and recommendations for correcting the problem stated above is outlined in the report below. In addition a copy of the recorded IR scan is included as a part of this report.

The insulation levels and installation, as best I could determine from a visual inspection along with the photos taken during the construction process would meet or exceed the Model Energy Code Standards for northern Ohio. The lone exception to this is the lack of foundation insulation. A Systems performance energy modeling program, however, shows that the house meets and exceeds Model Energy Code Requirements. The 90%+, 100,000 Btu Input heating unit more than exceeds the heat loss requirements of the building shell (60,000 to 65,000 Btu @ 5 degrees Fahrenheit).

Thermometers placed in various parts of the house, both first and second story rooms, showed consistent 70 to 72 degree temperatures with the thermostat set at around 72 degrees. The exception was the Bonus room area which was at 65 degrees with the door to that area closed. The temperature climbed slightly later after the door was left open.

A measurement of the Relative humidity indicated a reasonable level of moisture in the air given the weather conditions and the house size and tightness:

Relative Humidity- 32% Absolute Humidity- 38 grains/lb air, Dew point- 41 degrees

A test of the overall air leakage of this house using a Minneapolis Model 3 Blower door indicated a structure that was reasonably tight for its size. The results of Blower Door test were:

2443 CFM@ 50 Pascals
170 CFM@ Natural Pressures
.25 Air Changes Per Hour (Nat. Pressures)

In order to get some idea of the amount of air leakage attributable to pathways between the living area and the attic spaces (including that above the bonus area) a zone pressure test was completed. This test measures the pressure drop across the attic/living space boundaries and estimates the amount of air leakage in CFM@50 Pascals.

553 CFM@ 50 Pascals
38 CFM@ Natural Pressures
23 % of House Air Leakage

It was also noted during the inspection of the house with the blower door running, that there was a strong air flow around and under the bonus room door when it was closed. A measurement of the pressure across that door (15 pascals with the house to outside at 50 Pascals) indicated that there were significant air leaks on the bonus room side of the door.

Additional blower door related tests were done to observe the contribution of the duct and recessed lights to the air leakage of the house. With the house to outside pressure at 25 Pascals, the measured pressure across the supply registers (when temporarily covered with a "pressure" pan) was between .8 and 1 pascal. The exception was the Bonus room Supply registers which were between 1.2 and 1.5 Pascals. The Return registers were generally between .1 and .2 Pascals. The exception was the Bonus room return, which was 3.2 Pascals.

The indication here is that the ducts, especially the return in the bonus area has some significant air leaks, probably where the duct is connected to the register boot or where the register boot meets the ceiling surface. In the case of the wall mounted return, the panning on the attic side of the wall could be leaky and should be thoroughly sealed.

The recessed lights that were located in the vaulted section of the ceilings were relatively tight (for recessed lights) as the pressure measurement was 7 pascals across the pan. This leakage could be accounted for by air leaking around a gap where the can meets the drywall. The recessed lights in the flat sections of ceilings (on the second floor) were showing a measurement of 22 pascals across the pan. These are leaking both through the can and around where the can meets the drywall.

A comparative test of the pressures generated by the distribution system fan across the registers (as measured across the "pressure" pan) indicated that the Bonus room air flow was somewhat higher than those pressures measured in the other rooms on the second floor. Most register pressures were in the 12 pascal range, while the bonus room registers were 18-19 pascals. The rear bedroom with the vaulted ceiling had the highest register pressure at 23 pascals. While this method is not readily convertible to a CFM flow, this is best done with a Bolometer or other equipment specifically designed for that purpose, it is effective to evaluate relative flows coming from legs of a distribution system with similar duct and register sizes. The results of this test indicate that the bonus room supply registers are putting out more heated air than the other registers of similar size, with the exception of the one rear bedroom.

The Infrared Thermography scan indicated exterior wall and attic insulation that was well installed and is operating in the way that it was intended. There are a number of areas where direct air leakage was identified entering around doors, windows and baseboards. These are typical areas for some minor air leaks to occur, especially with the Blower door depressurizing the house to 20 pascals. For details of the IR scan you will need to review the copy of the videotape that is included with this report, I will, however, summarize those items that are significant to the bonus area problem.

It is important to remember that the IR scan was conducted with the Blower Door depressurizing the house to 20 pascals. This is an exaggerated pressure (stack effect produces a 4-6 pascal pressure difference) and creates a consistent flow of outside air into the living space of the house, in order to more easily identify the role of air leakage in both energy loss, and insulation effectiveness.

There were a number of areas on the second story where air was leaking between the drywall and top plate into the interior partition walls. This is not uncommon in new construction and is not normally a large contributor to the energy loss of a house. The exception to this is when the return system uses unlined drywall cavities for ducts and these leaks can be a pathway for attic air into the returns. There are areas on the scan that indicate this may be occurring.

The junctures where the Northwest corner bedroom (Bedroom #3) and the adjoining hall meet the bonus area is significant to the immediate problem. The interior partition wall joining the bathroom and closet to the bonus area is showing as consistently cooler than the surrounding surfaces. This may be due to air leaks between the drywall and top plate as in other sections of the upstairs walls, however, the cool surfaces are more consistent and extend down the wall further than in other sections of the house. This indicates larger or more consistently distributed air leaks to the attic. I would suspect that there are openings around the mechanical penetrations (wiring, plumbing, etc) that have not been thoroughly sealed. Under normal conditions, this is allowing warm house air to bypass the loose blown insulation in the attic and produce a cool heat loss surface across the interior partition wall.

Looking at that same partition wall in the bonus room, the surface is cooler than the surrounding surfaces and is a part of the heat loss surfaces in that room. It is especially distinct above the doorway and around the return register. Otherwise, the insulation in the exterior walls and attic ceiling spaces appear to be performing well in the bonus area.

A significant amount of air leakage is occurring at the baseboard/carpet joint along the three outside walls of the area. It appears especially dark and cool along the wall that connects the bonus room to the attic above the one car garage. Air leakage can also be seen around the west window casing.

CONCLUSIONS:

The construction of the house, the insulation and the air sealing completed on the house have created an energy efficient and, for the most part, comfortable home. The bonus room is having problems maintaining the same air temperature as the remainder of the house due to a combination of factors.

1. It is bounded by five surfaces that are exposed to either the outside or an unheated zone. These surfaces are effectively insulated, but are nevertheless heat loss surfaces. In addition there are conductive weak points in the wall system, ie, three sizable windows, and the ceiling system, ie, a number of recessed lights and spots where the vaulted ceilings meet the eaves (5-10 degrees cooler).

2. The interior partition wall that joins the bonus room to the main living spaces has a collection of air leakage sites that are connecting that wall to the

attic. It is thus a surface of the room that is loosing heat to the attic.

3. The area where the rear wall sole plate meets the subfloor is a significant air leakage source and is cooling the outer edge of the floor and wall surfaces (4-8 degrees).

4. Significant air leakage at the supply and return registers.

5. The heated volume of space in the Bonus room is roughly the same as the Master suite (3712 cu.ft vs 3920 cu.ft.). The bonus room, however, has two supply registers while the Master suite has four supply registers. Two of those registers are in the bedroom, which is a little over half the volume of the bonus area. The homeowner normally keeps one of those registers closed and still maintains a steady 70 degree temperature.

   The heat loss surface of the Master suite is considerably less since the floor is over the heated 1st floor and two of the wall surfaces border heated spaces. Orientation also could play a part since the master suite is located at the southeast corner of the house and benefits from solar gain, while the bonus room is on the northwest corner and realizes very little solar gain in the winter but instead picks up the prevailing winter winds creating cold air infiltration into that area.

There is most likely no one of these situations that can be called the primary culprit. The air flow to the bonus area has been increased and dampers have been added to the main plenum takeoffs to increase the air flow to the upstairs. The problem still exists, however. The recommendations listed in the next section represent a way to address the majority of the factors listed above and should be applied as a balanced approach to eliminating the temperature difference between the bonus area and the remainder of the house.

RECOMMENDATIONS:

1. Air Seal the penetrations into the interior partition wall between the bonus area and the main body of the house.

Openings in the Partition Wall:

Air leakage through the major openings in the partition wall such as wiring knockouts, plumbing stacks or gaps between the top plate and drywall should be sealed using latex mastic, silicone caulk or urethane foam sealant.

Plumbing walls:

Major air leakage can occur along the top of plumbing walls. The openings in the interior wall framing or framed chaseways connects all the plumbing in the house including the basement to the unheated attic. Large openings (ie, open wall cavities in drop soffits or double walls) should be covered with a rigid material (Insulation board, drywall, etc) fastened down to the framing and the seams thoroughly sealed with silicone caulk, latex mastic or urethane foam sealant. Penetrations through the top plate of simple plumbing walls should be sealed thoroughly with a combination or packing materials and a high performance caulk or a urethane foam sealant.

Recessed Lights:

Recessed lights can be significant air leakage points into the attic. If standard I.C. rated lights are used, air sealing the can is possible. There is, however, the possibility that lighting fixtures with a <u>tight</u> lens covering will occasionally click off. Light fixtures that are open at the bottom seldom exhibit this problem, since the heat of the bulb has an easy means of escape.

The light can be sealed on the attic side by applying latex based mastic or silicone caulk to seal all the openings in the top of the light can housing. Fiberglass mesh is used to bridge the larger openings prior to sealing. Foam sealants or caulk can be used to seal the fixture/ceiling joints after installation.

The light can be sealed in a similar fashion on the living area side using silicone caulk to cover and fill the various penetrations in the light can, bridging the larger ones with fiberglass mesh prior to caulking. The drywall can joint is sealed with caulk as well.

2. Seal the air leaks between the attic and the distribution system, especially in the bonus area.

Supply Duct Leaks:

Duct leakage into the attic from unsealed supply ducts should be sealed thoroughly with a latex based duct mastic. A close attention to detail is required due to the mechanically driven pressures of the air leakage, which exaggerates the significance of seemingly small gaps. Fiberglass mesh should be used to bridge gaps over 1/8" wide. In order to locate the leakage sites, turn on the air handler and identify leakage points using a smoke generator.

- Seal duct/trunk line connections.
- Seal duct/register boot connections.
- Seal register boot/ceiling material connections.

Return Duct Leaks:

Duct leakage from unsealed return ducts should be sealed thoroughly with a latex based duct mastic. A close attention to detail is required due to the mechanically driven pressures of the air leakage, which exaggerates the significance of seemingly small gaps. Fiberglass mesh should be used to bridge gaps over 1/8" wide. In order to locate the leakage sites, turn on the air handler and identify leakage points using a smoke generator.

- Seal duct section joints.
- Seal return panning/stud and stud/wall joints.
- Seal duct collar/panning joints.
- Seal top plate/drywall connections of interior partition walls containing returns runs without a sheet metal duct.

3. Seal the direct air leaks, especially the baseboard/subfloor leaks in the bonus area.

Baseboard leaks along Garage attic:

Use a high quality sealant and an air infiltration barrier, if needed, to close any openings along the garage attic/ bonus room floor joint. Latex mastic, silicone or Urethane caulk, or Urethane foam sealant can all be used to seal the gaps. If openings exist, an air barrier material such as foam insulation board, waxed cardboard, drywall, polyethylene or other rigid or flexible barriers can be used along with the sealants to close and seal the air leak.

Baseboard leaks along outside walls:

This requires pulling back the carpet at the edge of the floors and sealing the gaps between the subfloor and sole plate with a high quality sealant such as silicone or siliconized latex caulk. If the sole plate cannot be reached then the baseboard should be sealed at both the bottom edge and along the wall/ baseboard joint with a paintable siliconized latex caulk.

4. Provide protection from soffit venting for the insulation out at the eave edge.

Soffit vents should have a chute material also known as baffle boards, cardboard or foam, installed across the rafter down to the outer top plate edge to divert outside air into the attic and keep it out of the outer layers of insulation where it can degrade its performance. If the soffit venting is continuous all rafters should be baffled, if the soffit vents are individually installed, a baffle per rafter cavity is usually sufficient.

If the baffle boards cannot be successfully installed, soffit vents should not be installed.

5. **Increase the supply air volume to the bonus area and improve its distribution by adding at least one additional register.**

The large volume of the bonus room space, including the vaulted ceiling in combination with its large areas of heat loss and orientation, will necessitate adding additional air flow into the room. Thusfar, increasing the flow of the existing registers have not corrected the problem. Adding one or two registers to the vaulted ceiling sections towards the rear wall and diverting air flow from the remainder of the upstairs rooms would seem to be the next step towards bringing the temperature of this area closer to that of the remainder of the second story.

Adding dampers into the ducts that feed the other rooms in order to divert flow to the bonus area and balance the air distribution should also be a part of this process. The fact, however, that the ducts are mostly buried under loose blown fiberglass make this process problematic. While it may not be practical to install and access dampers to all the runs, installing them on runs that have a high flow rate and are reasonably accessible would be a reasonable compromise.

If additional supply air flows are added to the bonus room, additional return area is required as well. The system as it is now, is running the room at a slight positive pressure (1 Pa). This will increase if additional supply is added. The existing return could be modified or a transfer grill could be added to the wall above the door to satisfy the return requirements of the room after the supply air flow has been increased.

I appreciate your business and if you have any questions please do not hesitate to contact me.

Thank you,

Don Michael Jones

2/19/97