

IES GREEN REVIEW

INTELLIGENT ENERGY SOLUTIONS LLC

WHY IS MY SECOND FLOOR SO HOT?

A building science review of safety, indoor air quality, and energy efficiency

If you have had multiple contractors to your home in an attempt to determine why your second floor is much warmer in the summer only to be told "your system is working fine but "a new system might help" or "we are not sure" and "that's just how some houses are," then please read on.

The temperature imbalance that you are experiencing between the first and second floor is occurring for one of two reasons or maybe a little of both; **it is either excess heat gain or lack of heat removal.** It is really that straight forward. Either heat is bleeding into the second floor through poor air sealing, insulation or windows or your HVAC system is not capable of removing the heat.

How do you find out exactly what the problem is; **testing**. If you measure the air flow at the supply and return vents, use an infrared camera and blower door or other testing equipment then you will be able to identify the exact problem. Anything other than

testing is guess work. As we are fond of saying;

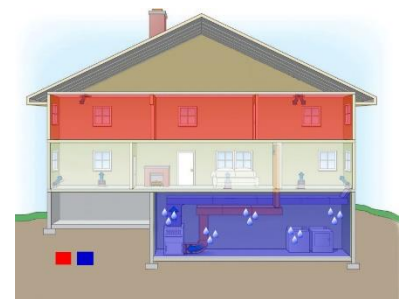
"if you don't test, you don't know."

What does testing reveal;

- A lot of the time; poor air flow at return vents.
- Sometimes; poor air flow at supply vents.
- Air exchanging between the attic and house.
- Lack of attic ventilation
- Lack of insulation
- Occasionally windows are the issue.

Issue: Let's begin with air flow at the return vents. Before we get ahead of ourselves we need to review an important concept about how an air conditioner works. You're A/C system works by removing heat from the air. Air pulled from the return vents passes over the A-coil which is cold, the BTU's of heat in the air are absorbed by the coil and the air that has passed through the coil now as fewer BTU's of heat, thus cold air. Now back to the return vents. If most of the heat is on the second floor and the return vents on the second floor are

not working properly then the system has a limited capability of removing heat from the second floor. Pulling air from the first floor and basement where there is less heat causes the system to work inefficiently.



Solution: Depending on the location of the system and type of duct work the resolution may be easy or it may require a little more work. Either way if the duct work does not function properly then your HVAC system isn't really a system, it's just a box with a fan making noise in the basement.

If you have a home built prior to 2010 then chances are the duct work is not sealed and you may even have paned returns meaning the stud bays and floor joist cavities are used to move air. This must be addressed. Sealing the Duct

work is step one. There are several ways to go about it, depending on the situation. The bottom line is that it must be done. Retesting the air flow, after sealing, at the supply and return vents will verify how effective the duct sealing has been and if the room has sufficient return and supply air flow.

Options for sealing duct work;

- For accessible duct work, Mastic and UL approved foil backed tape.
- Removing paneled returns and installing solid metal or flex ducts.
***this may require some drywall repairs which is still cheaper than a new system that has not solved the problem.**
- Aeroseal is great for some duct work but has limitations and can't seal up larger holes.

The goal is balanced air flow in each room. For every CFM of supply air, you should have a CFM of return air. Many times, we find ample supply air and inadequate return air. Example, a room has 80 CFM of supply air and 20 CFM of return air, moving a total of 100 CFM's of air. If the return was working properly the room would have 160 CFM of air movement. Additionally, imbalanced air flow can cause positive and negative pressures leading to poor indoor air quality, condensation, and even safety

concerns when combustion appliances are nearby.

Once the supply and return ducts are sealed, balancing may be required to provide the needed amount of air flow to a room or even the entire second floor. Adjusting the dampers off the main trunk line is the best way to accomplish this but may require seasonal adjustment. Another approach is to install Zoning dampers that are automatically controlled by additional thermostats. This is a more expensive upgrade but can deliver the comfort you are looking for.

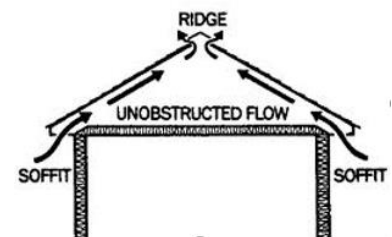
For situations where the air conditioner is located in the attic; we may have multiple opportunities. Keep in mind the attic is outside the thermal and air boundary of the house. It is cold in the winter and hot in the summer. Begin with sealing the duct work and installing insulation around the duct work. We have tested systems without air sealing and consistently find leakage amounts between 200 and 500 cfm. That is the equivalent of having 2 to 5 open registers in the attic. Secondly the HVAC unit needs to be in a conditioned space, meaning build an enclosure. You can get carried away with framing, insulation and drywall or use something as simple as minimal

framing and 2" foil faced foam board.

Options for sealing duct work in the attic;

- For metal duct work, 2" closed cell spray foam is an all in one solution; air sealing and insulation.
- Mastic and UL approved foil backed tape.
- Foil faced R-8 or better fiberglass insulation wrap.
- Aeroseal

Issue: The two most likely sources of excess heat on the second floor is warm air rising, not heat, only warm air, and your attic. As the air in the attic is heated by the sun the air expands. If the attic is not vented properly to allow for the heated air to be vented then the expanding air will push its way into the house via penetrations such as, open chases, electrical conduit, and access hatches.



Solution: Step one in addressing the attic is to determine the amount of proper ventilation. Building code requirements of 1 square foot of **Net Free Ventilation (NFA)** for every 300 square feet of ceiling area is a good place to start but keep in mind this is

only the minimum. You cannot over ventilate the attic. Proper ventilation must also be balanced between the upper and lower vents.

The size of the roof vents must closely equal the size of the soffit vents and baffles. If calculated and installed correctly, passive ventilation will be sufficient. Many people ask about powered attic fans. Please refer to our article titled "Attic Fans" for all the details. In summary if the attic is properly vented, air sealed and insulated then a powered attic fan is not necessary and you will enjoy all the benefits of the added insulation and air sealing in the winter.

Air Sealing the attic is step two, having conducted before and after testing on more than 1000 homes we can confidently tell you that at least 20% of your homes overall air leakage comes from the attic. Air sealing requires some grunt work. Dig through the existing insulation and seal up every penetration, can light, top

plate, dropped soffit, open chase, open joist ends...

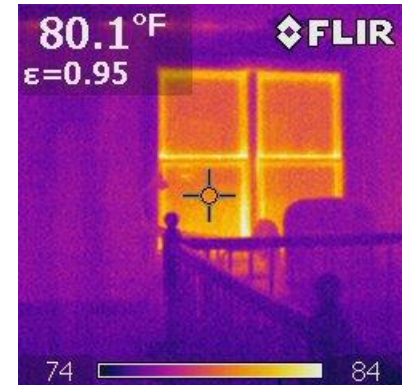


After ventilation and air sealing are complete the final step is to add insulation. Current code is R-49 and we prefer Cellulose over fiberglass. Either choice will work. Additionally, ensure any access hatches are insulated to the same level as the attic with 5 layers of 2" foam board and weather stripping at the edges.

If you have a whole house fan, especially the older units with metal dampers that do nothing to prevent air movement or provide any insulation value, remove it. If you feel the need to have a whole house fan we suggest replacing the older unit with a newer model that has tight sealing, insulated dampers. If you must keep the

old fan then build and insulated box for the fan that will seal it off from the attic when not in use.

Windows are typically the weakest link in your homes thermal boundary and can account for significant heat gain depending on their exposure to the sun.



Solution: Block the sun's rays. New windows offer many options for LowE coatings that will reduce the amount of heat generating ultraviolet rays that enter your home. The down side is cost. Other solutions include heavy sun blocking screens which work remarkably well but will reduce visibility. Awnings and canopies are an option but cost can quickly escalate.

Additional Recourses:

<http://www.greenbuildingadvisor.com/blogs/dept/musings/return-air-problems>

<http://www.greenbuildingadvisor.com/blogs/dept/musings/keeping-cool-two-story-house>

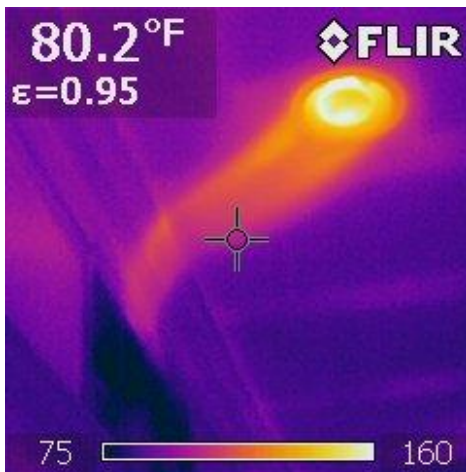
<http://www.greenbuildingadvisor.com/blogs/dept/green-communities/return-sender-hvac-return-pathway-options>

<https://www.askthebuilder.com/hvac-return-air-ducting/>

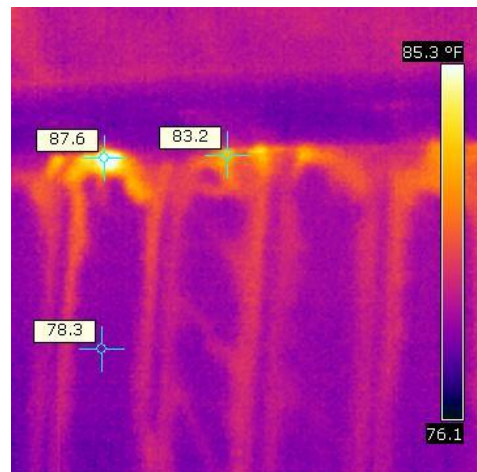
Facts + Experience = Your Solution

Our Services

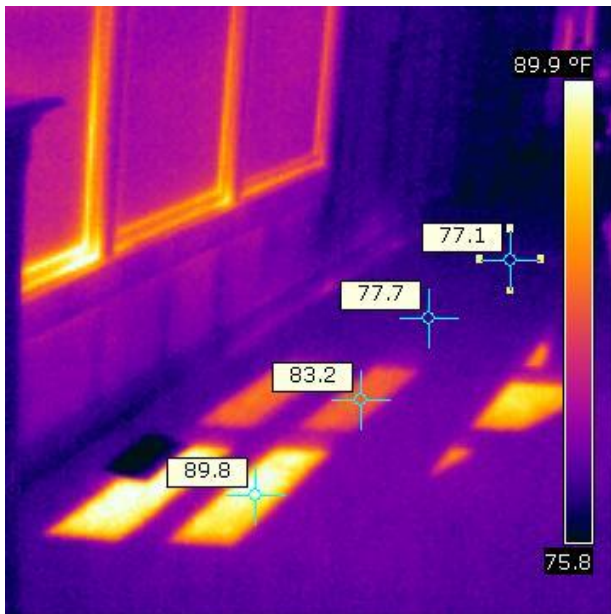
- Testing; Infrared Camera, Blower Door, Duct tightness, Supply and Return Air Flows, Combustion safety
- Reports from testing with prioritized action plan.
- Energy Modeling using REMRate software. Heating/cooling load calculations ACCA Manual J & S
- Duct sealing, new duct work installation, balancing
- Attic HVAC system enclosures.
- Air sealing, insulation and ventilation.
- Cellulose, Foam and Fiberglass insulation
- Bath fan upgrades and venting.
- Drop down stairs to attic with properly insulated and sealed covers
- Crawl space upgrades and encapsulation
- Window upgrade and replacement
- Solar Screens



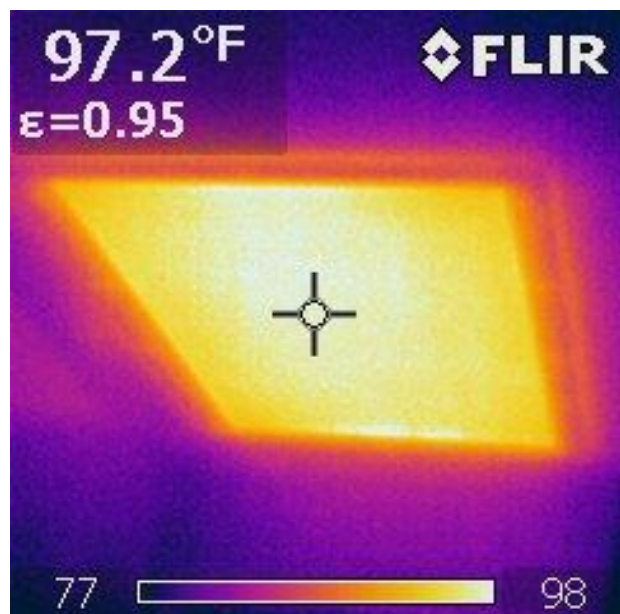
Return air duct pulling hot air from the attic through an unsealed can light



Fiberglass batt insulation at exterior wall with air infiltration



Left to right – No screen, standard screen, sun block heavy screen. The sun blocking screen stops nearly all the UV rays causing heat in the room



Uninsulated attic access hatch.

Comfort / Energy Efficiency									
Testing Conducted in mode									
Loc #	Room/Location	Cooling Supply	Heating Return	Fan On % Difference	Temp	Duct Location/Notes	Rm Pressure WRT0*	Notes	Thermal Deficiency
	Standard			+/- 15%	+/- 5		+/- 0.5		
	First Fl								
	Living Rm	66			86	Un Conditioned Crawl Space			y
	Dining Rm	136	90	-41%					y
	Total supply for Fltn	202	90	-77%					
	Family Rom	156	240						
	Dinette	186	217		95	Conditioned Space			
		165	30		95				
	Total supply for Fltn	507	487	-4%					
	Second Fl								
	Master Bath	114					-5.6	Over gar - 2 fans	
		110							
	Master Closet	120							
	Master Bed	59	80	-30%					y
	Total supply for Fltn	403	80	-134%			-8.9	over gar and overhangs	
	Upper hall way	91	141	-43%					
	Bed #2	136	200	-38%			-3.5	over gar	
	Bed #3	62	126	-68%			-6	Old part of house	
	office	78	157	-67%	82	Attic	-2.3		
	Basement						-5	windows	
	Garage (> -48)						-45.5		
	Total system CFM	1479	1281	-14%					

Testing reveals air flow imbalances, temperature difference, air leakage and thermal deficiencies. Solid data, that will identify why your home is experiencing inconsistent temperatures.