Alaska Building Science News

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The purpose of *Alaska Building Science News* is to bring timely building science information to Alaskans in order to improve the quality and durability of the housing stock in Alaska as well as save energy and maintenance expenses for home owners.

We hope that ABSN Newsletter will become a mainstay in your information menu in the future. If you would like to receive ABSN's newsletter electronically, please let us know by email and we will save cutting the trees and using the paper. This newsletter can be found on our website: http://www.uaf.edu/coop-ext/faculty/seifert

MOVING TOWARD A ZERO-NET-ENERGY HOUSE IN HOMER

My long term friend George Matz has moved to Homer and constructed a beautiful new home off East End Road on 9 acres of timber. He has incorporated many of the most recent strides toward minimizing his energy needs from local fossil fuel resources. George took the "Integration of Solar Design into Homes" course that was given in Homer this March, and that's how I rekindled my acquaintance with him. He invited me to his house and I took the photographs that are included with this article.

Figure 1. An interior view of the Matz-Woodring home in Homer, Alaska.

George took me on a tour of his house and showed me all the details. He has a wonderful humidistat-controlled ventilation system, which was locally installed in Homer. The house has a mostly log façade, but many of the logs are actually only cosmetic round logs on the outside with a layer of Styrofoam in between two such "cosmetic" wall surfaces. It is a sort of structural insulated panel using as the exterior sheathing, a false log façade. George has

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optimized windows and uses inslab heat in the basement. The basement walls are constructed with insulated concrete forms.

Figure 2. The heat recovery ventilation (HRV) system in the Homer house.

The septic system is a "mounded" type system because the soils in Homer often aren't very well drained. A very common impermeable clay layer at about 4 feet deep makes water absorption a problem. George has cleared on the south side of the house both for purposes of removing hazard trees and for providing garden space. It's on this southern exposure, suspended from the second floor deck, that he wants to place active solar thermal collectors on the south wall to add a supplementary heat source for both hot water and space heating needs.

Perhaps the most remarkable and up-to-date aspect of the technology of George's house is that he has managed to heat the entire house with only a propane water heater. This will be a new feature in the heating chapter of our latest building science manual now in progress, which we plan to use next year in workshops on cold climate and marine climate homebuilding.

Figure 3. The water heater (using propane) heats the house using an in-floor heating system. There is no boiler or furnace.

Figure 4. A view of the heating distribution system, viewed from under the first floor. A loop of polyethylene PEX® pipe is backed by an aluminum heat transfer surface/plate, which is stapled to the underside of the wood floor. The aluminum plate aids in heat transfer.

So is heating with only a water heater the way to go? We think so. Once the house is designed to use as little energy as possible (approaching the zero-net-energy concept, something like a specification of R-30 walls and R-40 ceilings), then the heat loss with good windows and possible addition of shutters is so much smaller a portion of the total heat requirements that the hot water load becomes the dominant load in the house. Since that water heater is only servicing the house with hot water about two hours out of the 24, the remaining capacity for the hot water heater is perfectly ample to heat the house. George has actually shown this to be quite true, and has all the heat to his house supplied through floor heat transfer with panel heating. He not only finds it very comfortable (although he does supplement with a woodstove in the main floor area of his house) he has all the energy consumption data: electrical, wood, and propane for the entire duration of the house's operation.

You can see from the house photos that it's a beautiful, spacious, very pleasant modern house—very comfortable to be in. I was there on a morning when it was zero degrees (F) in early March, but it soon warmed up as it commonly does when the sun rises. The fresh snow reflects light onto the south facing surfaces and east facing windows. George's home represents a direction we should all strive toward in minimizing our energy loads and using less money for heating equipment. George has managed to heat his entire home without having a boiler or furnace. Everything is done by the water heater.

Thanks George for the visit, for the data, and for the example you give to us all to strive in this direction in housing.

HERE ARE SOME ACTUAL FUEL USE MEASUREMENTS

More results on the house retrofit

Last quarter in this newsletter I described my house retrofit. Here are some reports on its subsequent performance this winter for the months of Sept.-Dec. for both 2004 and 2005, before and after the retrofit, I now know the fuel oil comparisons and the heating degree-day (HDD) comparisons. Here they are:

For fuel oil, I used 39% less in 2005 compared to 2004 (this from actual fuel delivery records)

HDD for 2004 Sept.--Dec. = 6078
HDD for 2005 Sept.--Dec. = 5725
Difference = 353 more HDD in 2004
which is ~ 6% colder in 2004

Figure 5. A finished view of the "superwindow" in Sept. 2005.

My conclusion from this early data is I'm saving somewhere between 40-44% of my fuel use. Since January has been unusually cold, I'll be interested to see how this month works out. There is a complication too, since I heat hot water with the oil boiler, and that's difficult to disaggregate. This result is fairly rewarding now at 30 below. I attribute the actual savings as higher than 39% because the water use fraction (oil used to heat hot water) is likely in the range of 30-40% of total heating fuel use. So my actual space heating savings could be 50 to 60%, since I actually more than doubled wall and window R-values.

In addition to the basic fuel savings from my retrofit, I had the opportunity to do some serious research on the performance of the super window with the help of my collaborative friends at UAF, Professor Doug Goering of the Mechanical Engineering Dept. and Jack Schmid, Energy Technician also with the Energy Center and the Dept. of Engineering. Doug Goering loaned me a Campbell Data Logger with Omega thin film heat flux sensors (model HFS-4). These devices enabled me to measure the heat flow at the center of glass of the large fixed pane glazing of the super-window at my house.

The test was done from 6:30 pm January 30th 2006 until 36 hours later at about 7:30 am on February 1st. The outside air temperature was 14.5 degrees F below zero at the start of the test and minus 24.5 degrees F at the end of the test. Outdoor conditions varied between those temperatures over the 36 hours of the test. The test was done with most of the equipment in the living room of my house. I measured the surface temperature of the window, the outdoor temperature right outside the window (not in the shelter of the window but on the north wall of the house) as well as the interior air temperature on the floor of the living room, where the window is located. The results turned out to be remarkable.

Long-term readers of the newsletter might recall that in the autumn edition of the newsletter, I printed the specifications for performance of this window from the Southwall.com website. At that time, I was suspicious of the actual claim of the performance of the window. Performance claims were made with a simulated University of California Berkeley, Lawrence Berkeley Laboratory window simulation computer program, predicting that the window system that I have should perform with an overall R-value of 12.5. I was highly skeptical of the ultimate performance of the window because I had never known of a window that could possibly perform at that level. This predicted insulation value is higher than the walls of my house before the retrofit. They would typically be about R-11 with the sheathing and the 3½ inches of fiberglass in a standard 2 x 4 wall. These walls were typical of those built in 1975.

When I analyzed the data with the help of Dr. Goering it was clear that over the period of 36 hours of the test at very cold temperatures (our third coldest January ever in Fairbanks), that the window performed with an average R-value over those 36 hours of 13.25. Not only did the window exceed the specification listed on the computer simulation from the commercial website of Southwall, but it did so fairly consistently and outperformed even that specification. So I feel extremely good about the window. The performance claim was valid even though it was a prediction rather than a real measurement.

It can be seen from the data that the cycles of the furnace are very evident. There is a large curtain covering the window, and the effects of the convective heater at the base of the window are quite evident from the data. Every time the furnace comes on, the indication in the data is that the R-value drops because the surface becomes heated and increases the heat flow across the window as the heat flows up between the curtain and the window. This flow is aided by the location of the curtain on the window, and it is a full-length curtain.

The opposite occurs as the furnace stops working. Suddenly the warm side of the window starts to lose heat back to the room and it looks like there's an enormous surge in the R-value of the window. This is clear at every spike of the insulation R-value

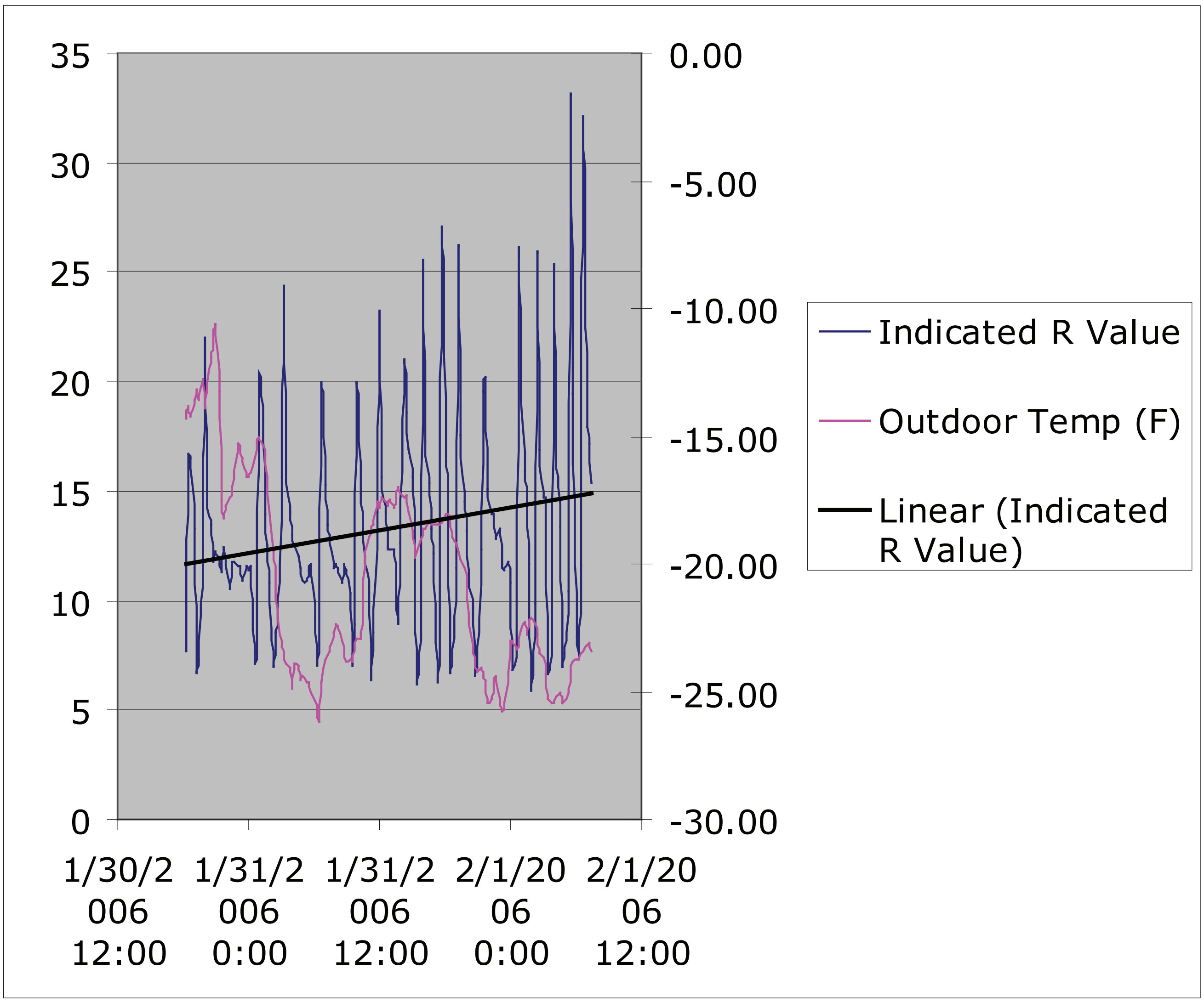

Figure 6. This is a data plot of the calculated R-value versus time for a test of the performance of my Quad-pane superwindow. Time of the test was 6:30 pm January 30, to 7:30 am February 1, 2006 a total of 36 hours.

measurement. At some points during the test it actually goes up to nearly 24.5. This is a short-term effect that happens right after the furnace stops convecting and the heat flow, for a short time, reverses back into the room and makes the window look like it's actually performing almost twice as good as it is. You can see from the data however that it drops back down as the window cools to both the inside and the outside and returns more closely to its actual performance. This happens during each cycle of the furnace and the cycle of the furnace is indicated by these peaks on the data.

Even though the temperature was well below zero outdoors, the furnace cycles only once every two or three hours. All of this is very reassuring and makes me feel fairly good about having an R-13.25 window on the north side of my house. The window performs remarkably well and I have no reason to believe it won't continue to do so for some time.

GO TO ALASKANS FOR THE EXPERIENCE YOU'RE SEEKING!

Editor's explanatory note: *The following is developed from a letter sent by Greg Egan as a result of reactions to a "Talk of Alaska" radio show on the topic of renewable energy. Greg is a journeyman electrician and owner of Remote Power, Inc., a company that sells alternative energy equipment. I urge all interested Alaskans to check the website:* www.alaskasun.org *for local expertise in renewable energy.*

It is so good to finally see the interest in energy efficiency, conservation, renewables, green building etc. It is also good to know that someone who actually "knows of what he speaks" is going to be getting the word out. Thank you for doing whatever you needed to do to get on Talk of Alaska (Jan. 17, 2006) tomorrow, and good luck with it.

While on hold last week, listening to the program, I heard a couple of things that were somewhat misleading. It was when Nick from TDX told people to go to "Real Goods" for their RE equipment, and that Atlantic Orient (maker of village sized wind turbines as you know), may be coming to Alaska. When you hear only of outside companies doing a particular service, it sounds like there's no place in Alaska to get the service or equipment.

What I didn't hear was, Power Corp Alaska is already in Anchorage producing state of the art wind/diesel hybrid village sized systems with Vestas wind turbines. I also didn't hear that there are companies that have been selling and installing remote power systems in Alaska for many years.

Here at Remote Power we've done installs for the Nat. Park Service, oil companies, lodges, gold miners, telephone companies, UAF, off-grid homeowners, ADF&G, etc. We've designed and/or installed systems from 30 miles west of Mt. Foraker to Inuvik NWT, and from Ketchikan to Prudhoe Bay.

I've been fortunate to have been able to attend schools on wind turbine installation, Outback Inverters, SMA (sunnyboy) inverters, Surrette and Trojan batteries, National Electric Code, PV panels and mounting systems, solar hot water system installation, to name a few. Cathy (Greg's wife) went through SEI's Women's PV design and installation course. Tony (an employee) has been through SEI's wind installation course and others, and has lots of bush experience.

Rather than the Alaska "brain drain" problem you hear about, companies like PowerCorp and Remote Power Inc. act like a "brain pump", spending tens of thousands of dollars to bring design & installation expertise and the latest proven technology INTO the state. I can tell you from experience that most of the RE systems that have failed in Alaska (and in the process, given clean power a "black eye"), haven't failed because of poor quality equipment. They've failed because of lousy design, installation and/or maintenance.

RE systems are similar to your recent (and awesome I might add) energy efficient remodel, in that, if you don't know what you're doing (i.e., don't use all weather wood where it contacts the ground, aren't careful with the vapor barrier, caulking, use the right windows in the right locations, consider the effects of passive solar, apply the insulation properly, etc.), the system is not going to perform well. Thanks to the efforts of people like yourself, Alaskans know more about building science and how it's best applied to Alaska's diverse climatic conditions.

Remote Power Inc. is working to educate Alaskans on energy efficiency and RE systems, because they go hand in hand. We have an 800 number and spend more than half our time answering questions by phone and email (explaining to someone why they shouldn't try to run their electric hot water heater and clothes dryer on PV, or why their money is better spent getting more efficient lighting rather than more PV panels.) At the end of these conversations, some people ask if we're a non-profit organization.

So, when you're on the air tomorrow, and someone calls in and recommends that people buy their equipment outside, here's are a few things you might mention, to help local RE businesses continue to provide services to Alaskans:
• there are RE businesses in Alaska that have the knowledge, Alaskan experience and equipment they need.
• high volume mail order places won't have professional system installers with years of Alaskan experience.
• when you add in shipping and handling, the prices are usually the same anyway. Returns are cheaper and easier to do locally.
• and not only do local companies have Alaskan expertise, they hire Alaskans, pay local taxes, and contribute to our economy in many ways. When you send your money South, it's gone for good.

One other thing: if you mention someone, mention their company too. For example, in your ABSN article, if you write "Greg Egan designed and installed the system on the cover of the new Solar Design Manual", follow with "of Remote Power Inc." You may know who the person is and where he works but most won't, and will have no idea how to contact him/her. All the RE companies in Alaska need the publicity, and we don't have big advertising budgets. Business owners will love you for it.

Finally, I must say that before I left UAF, I completely took for granted services local businesses provide, and I didn't even think there were any costs involved. Only profits I guess. Now that I'm using my own money - suddenly it's crystal clear to me.

Greg's website: www.remotepowerinc.com Also, see www.alaskasun.org for renewable energy information and Alaskan expertise.

A RADON MITIGATION EXPERIENCE

Dale Powell, correspondent and self-mitigator

Some time ago you offered advice regarding radon mitigation. My home is on a bluff 125 feet above the Tanana River in the Rosie Creek subdivision, specifically about ¼ mile below Howard Luke's camp (Fairbanks area).

Much to my dismay we found fairly high Radon levels after the house was built. It had an average reading around 32 (piC/l). I have an electronic radon meter for measurements. Our house is dug into sloped ground, and the rear of the slab is around 9 ft. below grade. The front is walk-out. We did not install the sewer drain piping and plastic under the slab. Material under the slab is 2" of foam, and pit run gravel. I dug lots of gravel out of the holes, maybe 100 pounds from each hole for the radon mitigation.

Readings varied depending on temperature and time of the winter, and hot spots were present, up to 80 piC/l in a downstairs closet.

I bored three 4-inch holes in the garage floor, next to footers placed around the perimeter. Following your advice, I bought a Fantech 6" inline (150 watt) unit and installed 4" PVC pipe to the first suction point. Radon levels were reduced to around 15. I then hooked up the second suction point and levels are now down to 1-2 piC/l throughout the house when below 0 degrees (F). Levels drop greatly when the temp. rises above 0. Levels in that closet are still about 20, but nowhere in the house is it above 2. I may install the 3rd suction point which is right next to the closet. After the holes were bored in the garage floor, and before the fan was installed, I measured Radon in the garage at floor level of over 250 piC/l near the holes.

Sub slab depressurization really does work, even without the plastic and drain pipes installed, in this

Figure 7. A photo of the axial fan and exhaust piping that removes radon from Dale Powell's sub-slab area as a result of his radon mitigation effort. The pipe ultimately dumps the radon-laden air outside.

case. The problem is the system does not meet EPA requirements since the fan is installed in the garage, with living area above. The fan can't be mounted outside, and there is no attic (log house with hot roof). Hope this info is useful.

Thanks-Dale Powell

My response to Mr. Powell's email follows:
Well first, thanks very much for this valuable experience. I wouldn't be too concerned about not meeting EPA requirements because it is really a bad idea to exhaust radon through what is essentially a vertical chimney on the roof. In Interior Alaska the air exhaust stream from the radon mitigation system is typically very moist and will frost up, perhaps even wrecking the exhaust fan by unbalancing it. Secondly, if it works, that is more valuable than following a recommendation for temperate zones. After all, that's the POINT of mitigation! So no worries.

This situation you detail sounds much like my own experience, especially that wonderful time of pulling the soil and gravel out from under the slab when installing the standpipe. Always good to know it was worth the hassle.
Rich Seifert

ONE YEAR WITH THE VW JETTA

by Erika Kienlen

Ed. Note: Erika works in the renewable energy industry and runs a business called "A Change of Scenery".

One year and 12,300 miles later my Jetta is still a wonderful car. The mileage hasn't changed much: still in the high 20s-low 30s. For this time of year these numbers are not surprising. Some new developments in our way of life may make a difference.

For the last 8 years we have been living on the Anchorage Hillside. While a beautiful and quiet place to live, the commute was heinous at times. To get almost anywhere required getting to the highway, which was just over 5 miles away in one direction. So any trip, whether to the grocery store, work, or other requires a minimum 10 miles of driving. We have now eliminated that 5 miles and live within an also quiet .5-mile distance of the highway. Estimating daily driving, the savings could be in the 4–6000 miles a year range. The trip to the grocery store takes minutes and in the summer can be easily walked.

The performance of this car has been great. Anchorage has had a very slippery winter, but with studs, I have not had any problems. The snow doesn't seem to be much of a problem either, unless it gets really deep. Then the low profile on the car tends to not be very helpful. The low-end torque however, makes it very powerful and will motor through just about anything in its way.

The other savings have come in maintenance. The first 20K miles the oil needs to be changed every 5000 miles, after that VW Alaska recommends every 7500 miles. The cost is a little more because of the "special" synthetic VW oil but over time it comes out less than a gas car.

All in all, I highly recommend this vehicle to anyone. The car is comfortable, fuel efficient, well designed, fast and very nice to drive. After June it will also be a lot cleaner to operate as well (ultra-low sulfur diesel will be available).

I don't buy cars very frequently and in our family we usually drive them until they drop. This car will be with us for a while. I have however been looking into some possible choices for the future. By the time I am up for a change these may be in mass production.

The Prius and Honda Accord hybrid cars have made huge headlines over the past few years and have had laudable and much deserved success. More automakers are looking to use this same technology for their cars. I started asking the question: Why not a diesel hybrid? It turns out there have been a few concept cars with this engine in them. Dodge Intrepid was one and the Opel (GM) Astra was another. The Opel concept would also offer an AWD version. The Ford Reflex concept car delivers up to 65 mpg, has a lithium-ion battery pack, and solar panels built into the vehicles' headlamps and taillights. None of these are being produced now. Another was the VW Lupo. This production car sips diesel at 3L/100km or 78 mpg. It was recently replaced by the Fox.

Diesel hybrids are being used in mass transit systems. In 2004, King County (Seattle, WA) Metropolitan Transit Authority purchased 213 hybrid diesel buses. Jim Boon, who is the Fleet Maintenance Manager, had nothing but good things to say about this decision. The first benefit was the 30% fuel efficiency increase. The second was the payback. The cost difference of $645,000 for hybrid over $445,000 for conventional diesel buses seemed pretty steep. But according to Boon, the payback on these engines will be 8.5 years and the life of the bus is over 12 years. The third is cleaner emissions. When I asked about the ultra low sulfur diesel and if those costs had been factored in he said that in 2002 the Transit Authority made a brilliant management decision to buy cleaner ultra low sulfur from a Conoco facility in Washington that was already producing it. The initial cost was $.18 per gallon more but over the last 2 years the volume was so high the price has come down.

The hybrid fleet has logged 12 million miles so far and a rider ship of 100 million passengers a year. They have not replaced or had a problem with a single battery. Boon said that in the future the direction they are taking would most likely be to replace the older diesels with hybrids. Seattle is not the only city to do this. Minneapolis, Honolulu, New York, and other cities around the US are moving in this direction as well. Every day Boon gets phone calls about their buses from around the US and the world.

The forward thinking of Seattle is a lesson to all of us. Diesel hybrid technology is available and ready to be used. The fuel efficiency ratings of the concept passenger cars were in the high 60s and some up to 99 mpg. With the combination of the EPA ultra low sulfur and the already increased mileage of diesel the next step to a diesel hybrid should be coming. Diesel hybrid vehicles have the added advantage of being sustainable by their ability to run on bio diesel.

ABOUT YOUR HOUSE

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Arctic Hot Roof Design
(North Series 6 — www.cmhc-schl.gc.ca)

The roof is the most exposed part of a building. It is a particular challenge to designers, contractors and building managers in the North, where building envelopes are subject to severe environmental conditions. They include wide daily and seasonal temperature swings; large temperature differentials between interiors and exteriors; snow, wind and structural loads; and, of course, moisture.

Air pressure differentials drive warm interior air and water vapour outwards and upwards through the envelope. As air travels through the insulation, its temperature, and the amount of vapour it carries, drops. The moisture condenses on the nearest cold surface, where it can threaten the building assembly's integrity. This causes even more pronounced problems in the North's extreme climatic conditions. The Arctic Hot Roof is a roof system specifically designed to meet the North's extreme conditions.

In the North, tight envelope construction is one way to prevent building degradation and significantly reduce maintenance and energy costs. Conventional systems have been installed with a poly-vapour barrier above the ceiling, below the roof structure and insulation. Poor installation, poly degradation and openings for ceiling fixtures, electrical outlets, etc. compromise the air-vapour barrier and allow moisture-laden air to pass through.

In the North, roof systems that rely on venting to purge moisture, such as open attics and ventilated cathedral ceilings, seldom vent moisture before it condenses and turns into frost (see Figure 8).

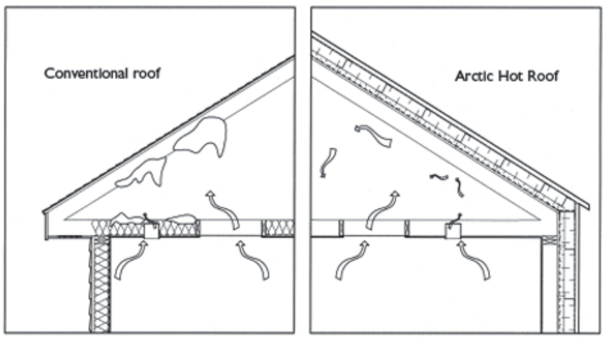

Figure 8. Conventional roof versus Arctic Hot Roof design.

The imperfect membrane permits heat and moisture to escape into the assembly and damage insulation. This increases heat loss. The ongoing cycle damages interior wall and roof finishes and degrades insulation and the structure. In addition, if high winds and fine snow infiltrate the vents, snow piles up in roof cavities. In the spring thaw the snow melts and drains through the leaky membrane (see Figure 9).

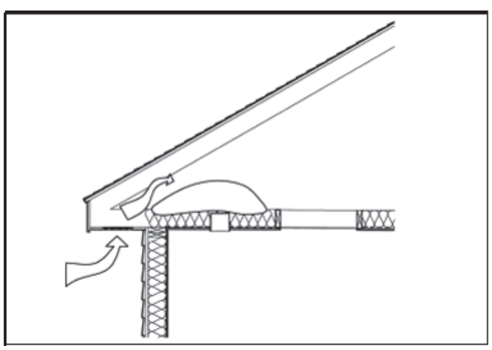

Figure 9. Snow infiltration in conventional roof systems.

The Arctic Hot Roof's design minimizes the amount of moisture that can enter the assembly and provides adequate, controlled, non-damaging venting. Any moisture entering the assembly can escape without reducing the insulation's efficiency or penetrating the building membrane.

Essential to this system is a continuous-membrane air and vapour barrier on the warm side of non-organic insulation, but still on the outside of the structure and decking. This stops moisture-laden interior air travelling through the insulation to the dew point, where condensation occurs. The colder the climate, the more important the quality of installation of the barrier.

The Arctic Hot Roof membrane and insulation are on the exterior side of the structural members. This placement achieves the following:

- Potential for damage to the structure from condensation is virtually eliminated.
- Interior finishes can be applied directly to structural framing, with no need for additional strapping or protection for the membrane.
- Penetration of the membrane by mechanical and electrical systems is reduced to those elements that must exit the building, while a secure utility chase is created between structural members.
- With fewer penetrations and the application of the membrane directly above a rigid deck surface, good quality installation is easier.
- Thermal bridging between the structural members and the roof cover is eliminated.

The hot roof system has been used successfully in the North in apartments, houses and larger buildings for about 15 years. There are four basic components in a successful hot roof design (see Figure 10):

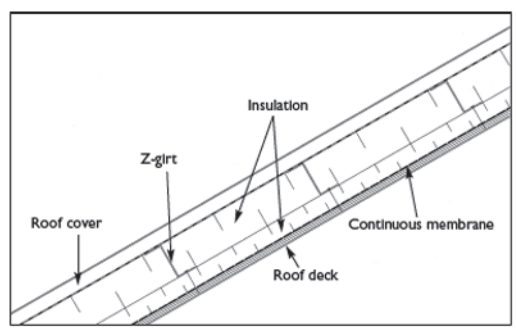

Figure 10. Arctic Hot Roof assembly.

1. **Roof deck**, for continuous, rigid support for the membrane, eliminating the problem of the barrier "drumming" as air moves back and forth through the roof assembly.
2. **Continuous membrane**, as both the air and the vapour barrier, on the warm side of the insulation. Modified bitumen membrane (MBM), a single-ply, torched-on membrane, is a strong sheet material that remains flexible at temperatures as low as -40°C. It has proven to be very suitable in this application. When properly installed and sealed, MBM maintains its integrity and is not susceptible to moisture degradation.
3. **Two layers of rigid insulation** that are impervious

to moisture caused degradation. Installing insulation panels at right angles to each other and attaching one layer with "z-girts" and the other with screws minimizes thermal breaks. This also reduces penetration of the membrane.
4. **Roof cover** that serves as UV protection and sheds moisture.

The sod roof, which has been used effectively in northern countries for centuries, is the historical model for the Arctic Hot Roof.

A sod roof is placed above a timber-framed roof structure. Birch bark, which provides a shingled drainage surface, or some other moisture barrier, goes on the timber frame. An earth-sod cover is insulation over the "shingles."

The inverted roof is the contemporary interpretation of the sod roof. It has been an alternative since the 1960s to the continuing problems of roof membrane failure in conventional systems. The Arctic Hot Roof is an interpretation of the inverted roof—with one fundamental difference.

The inverted roof allows moisture to seep to the level of the membrane, which is the only barrier in the system. The Arctic Hot Roof keeps this single-ply membrane and adds a water-shedding weather barrier above the insulation, which can be created in several ways. This system is a response to the North's high winds and blowing snow, and is especially applicable to residential buildings.

Deciding if an Arctic Hot Roof design is right for you
The amounts of snowfall and wind conditions are primary factors to consider when deciding whether to build an Arctic Hot Roof. Snow infiltrating roof vents is of particular concern in areas where snow tends to be very fine and winds sweep freely across the landscape—which can cause conventional, vented roofs to function poorly. High winds also increase the air pressure differential across a building, increasing the force of air and vapour movement through the envelope.

Builders should be aware that snow's insulating value is approximately RSI 7 per metre (or R1 per inch). Where snowfall accumulation can exceed 20 cm (8 in.), the roof's surface temperature might cause the snow to melt, create ice and then dam. Water can then leak under asphalt shingles, over flashing or through any seam in the roofing membrane.

The Arctic Hot Roof design strategy relies on the wind to clear the roof of accumulated snow. To be effective, the average annual wind speed must be at least 16 km/h (10 mph)*. Other ways of removing snow must be found if there is a heavy snowfall, or if the wind and the slope of the roof cannot clear the roof of heavy snow loads.

Assembly
The single-ply membrane prevents both air and vapour from flowing through a building's wall and roof assemblies. The barrier must be continuous to be effective. That means that it must not leak through individual panels, joints between the panels or at service penetrations. Connections between wall and roof membranes must be properly detailed to prevent water vapour from inside the building and moisture from outside the building from leaking into cavities or into the interior of the building. The protected location of the membrane in the Arctic Hot Roof system saves it from many of the hazards of a conventional roof system, including:
• Degradation from ultraviolet light.
• Damage from hailstones, roof traffic and general mechanical damage.
• Temperature swings. A conventional membrane may experience a temperature range of as much as 38°C over a day, and as much as 93°C over a year. A properly designed Arctic Hot Roof experiences swings of less than 6°C a day and 17°C over a year at the membrane[+].
• Thermal stress. Virtual elimination of thermal stress in the membrane, which remains above freezing even in the coldest weather. The membrane may be adhered to the deck either fully or partially. Uncertainty about effects of cracks and joints is one argument for spot adhering the membrane to the deck rather than fully adhering it. However, the advantage of spot-adhesion is probably more than offset by the difficulty of locating a water leak in the membrane. When the membrane is only spot adhered, water can move long distances along the top of the deck before it enters the building. With full adhesion, lateral movement of water at the interface between

*Richard Seifert, *Attics and Roofs for Northern Residential Construction.*
[+]C.W. Griffin, *Manual of Built-Up Roof Systems,* p. 227.

deck and membrane is inhibited. A fully adhered membrane should not be specified on a deck that may be subject to expansion and contraction. The torched-on membrane is a fully adhered system.

Extruded polystyrene has proven to be the most successful in this type of application. Two layers of insulation with staggered joints eliminate thermal bridges created by joints in single-layer insulation. Both layers may be attached by z-girts, or the first may be connected by screws, and the second laid at right angles to the first and connected using z-girts. The insulation protects the roofing membrane from UV radiation, thermal stress and physical wear and tear. Therefore, the insulation itself must be protected from UV radiation (see Figure 10).

The final covering of the roof is the protective layer for the insulation and a moisture-shedding layer for the assembly. This can be dealt with in a number of ways, depending on the slope of the roof and its desired appearance. Metal roofing or shingles in conjunction with a weather barrier can be used above the insulation if the proper strapping or decking is provided. Corrugations in metal roofing or the air space created by adding strapping to accommodate shingling provides sufficient space to vent the roof assembly.

To ensure that the roof will function properly throughout its anticipated lifespan, there should be regular maintenance inspections and a knowledgeable contractor should repair damage as soon as possible.

Detailing the roof with attention to building as a system

For the roof system to work properly, the roof membrane must be continuous. Any junction or break in the continuity of the membrane must be carefully designed and constructed.

The barrier must carry over the top plates of partition walls. All chimney and flue penetrations must be properly sealed with a flexible air barrier material. Tight seals must be provided because of their thermal expansion and contraction, as well as shrinkage of the membrane and settlement of the house frame. Additional details that require close attention in both design and construction include flashing, roof wall junctions, roof projections and expansion joints.

While the roof assembly must be sound unto itself, remember that it is only one part of an envelope system that is affected by a number of building components. Detailing must be planned and executed so that moisture draining off a carefully designed roof does not infiltrate the wall cavity or leak into the interior of the building. The barrier should lap and form a seal with the barrier in the wall, with flashing detailing directing moisture away from the envelope assemblies, allowing vapour trapped in the roof to escape.

Cautions

The Arctic Hot Roof relies heavily on good design and equally good workmanship. This is vital for all roofing applications, but is even more so for a single-ply membrane. For example, a multiply built-up membrane has some safety margin against one poorly applied layer. A single-ply membrane has none. Failure at a seam in a single-ply membrane means an almost certain leak. Special care must be taken on parts of the roof where the assembly is interrupted—at the edges of the roof where it connects with walls below or above and at all penetrations.

Hot roof systems tend to fail at exposed edges first. The membrane must be properly protected by insulation to the edges to be shielded from UV radiation and temperature fluctuations.

Because it is placed above the membrane rather than below it, insulation in hot roofs is at risk from solvent spills, including fuels and adhesive solvents. Failure of the insulation can be caused by emissions from some roofing membranes or from solvents used with them. Manufacturers usually spell out how to use their product and warn against incompatible material. For best thermal performance, specify at least two insulation layers, with staggered joints.

Controlled venting must be carefully provided to ensure that if moisture gets into the roof assembly it can get out. A positive slope towards eaves at a minimum of 1:25 is recommended. It should be detailed to ensure that minor frost that builds up in the roof system or rain that bypasses the roof cover will simply run down the weather barrier above the insulation and out of the roof. For flat roofs, an air space between the insulation and roof cover, complete with vent stacks, serves a similar function, capped to ensure that additional moisture does not infiltrate the roof assembly.

EXTRA CAUTION URGED WHEN STORING FIREWOOD

By Rich Seifert

In the last issue of our ABSN Newsletter we included an article on efficient convenient wood heating. In the section of that article entitled: *Buying and Preparing Firewood*, we had recommendations listed for how and where to store wood near your house. A concerned reader in Anchorage who is very apprised of wild fire risk urged us to offer a correction or at least an incitement to safer storage for winter wood supply that is not stored under a deck or on a deck too close to the house. The caution was obviously very important to recognize since the wood pile, should there be a wild fire, would supply a huge amount of fuel for a fire and make it worse, if it was stored right next to a house.

The reader from Anchorage recommended that wood be stored at least 30 feet away from the house but still fully sheltered. Store wood as far away from any combustible surfaces on the house to alleviate the risk of adding fuel for an unanticipated wild fire that's sweeping through the area.

Please use good judgment and if you are in any area, which has any substantial risk of fire, do the safe thing and keep the stored firewood away from your house to the degree feasible.

CALENDAR OF EVENTS

Call 474-7201 or 1-800-478-8324 or visit our website: www.uaf.edu/coop-ext/faculty/seifert for information on workshops.

Workshop Schedule for Alaska Building Science Network

Call ABSN @ 1(800) 563-9927 or (907) 562-9927, or email: absn@alaska.net for information.

Small correction: Last month's article about a passive solar home in Yellowknife in the Northwest Territory of Canada was courtesy of Sean Kollee. His name was unfortunately misspelled in the last issue.

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