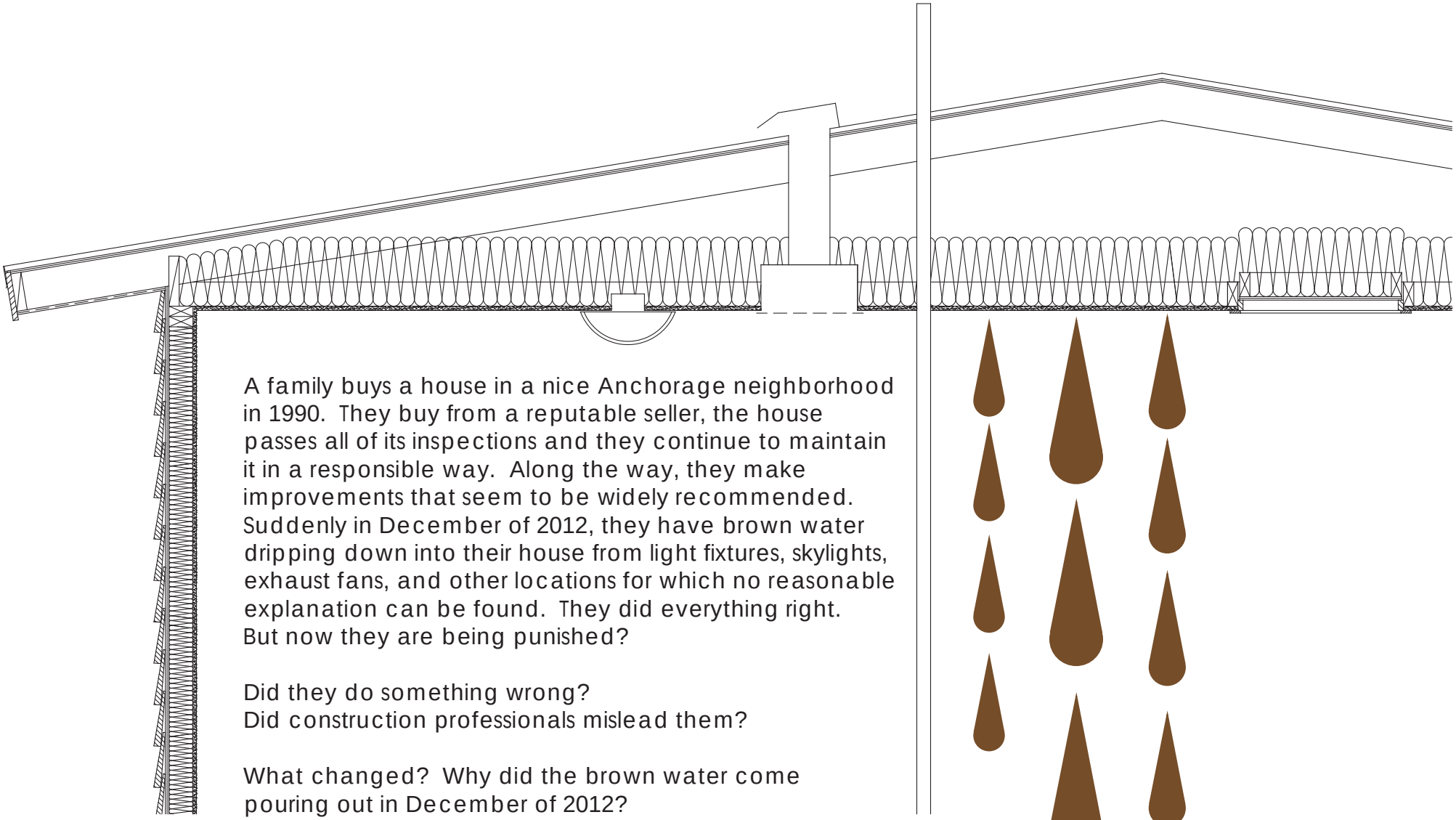

A family buys a house in a nice Anchorage neighborhood in 1990. They buy from a reputable seller, the house passes all of its inspections and they continue to maintain it in a responsible way. Along the way, they make improvements that seem to be widely recommended. Suddenly in December of 2012, they have brown water dripping down into their house from light fixtures, skylights, exhaust fans, and other locations for which no reasonable explanation can be found. They did everything right. But now they are being punished?

Did they do something wrong?
Did construction professionals mislead them?

What changed? Why did the brown water come pouring out in December of 2012?

!!!ATTACK OF THE BROWN WATER!!!

an historical graphic novel, though mostly true, of life in Anchorage Alaska

december 2012

Author and Designer
(of the novel, not the disaster)

Mike Mense
mmenseArchitects

Technical Consultants

JB Walker
Tom Rygh
RedOak Construction

Owners and Victims

Kimberly Olmsted
Dan Dickinson

TEMPERATURE LEGEND

- 35° Outside Ambient
- 35° Attic Ambient
- 35° Ambient at Ceiling
- 35° Ventilation Air
- 35° Surface

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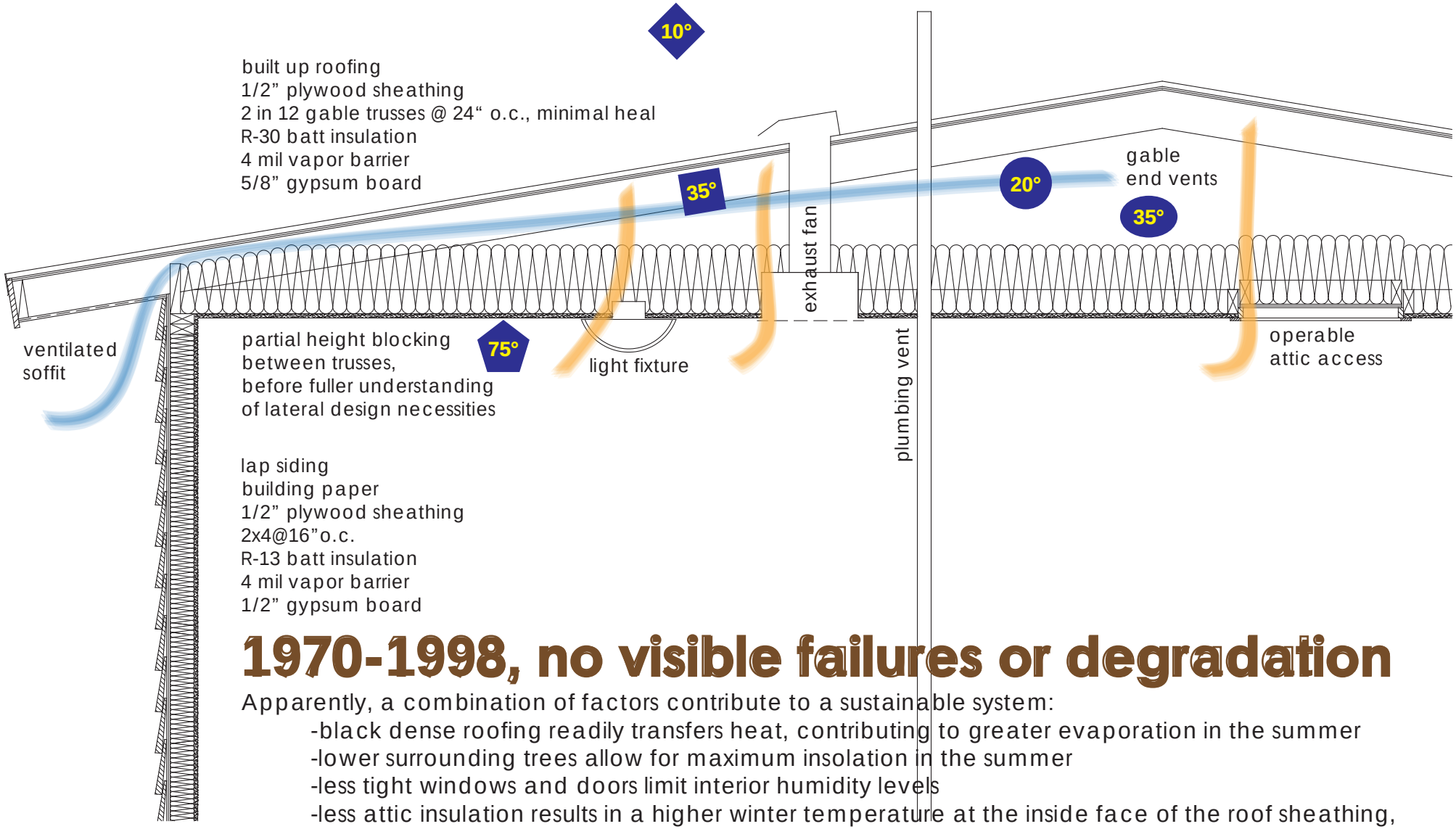


1970-1998, no visible failures or degradation

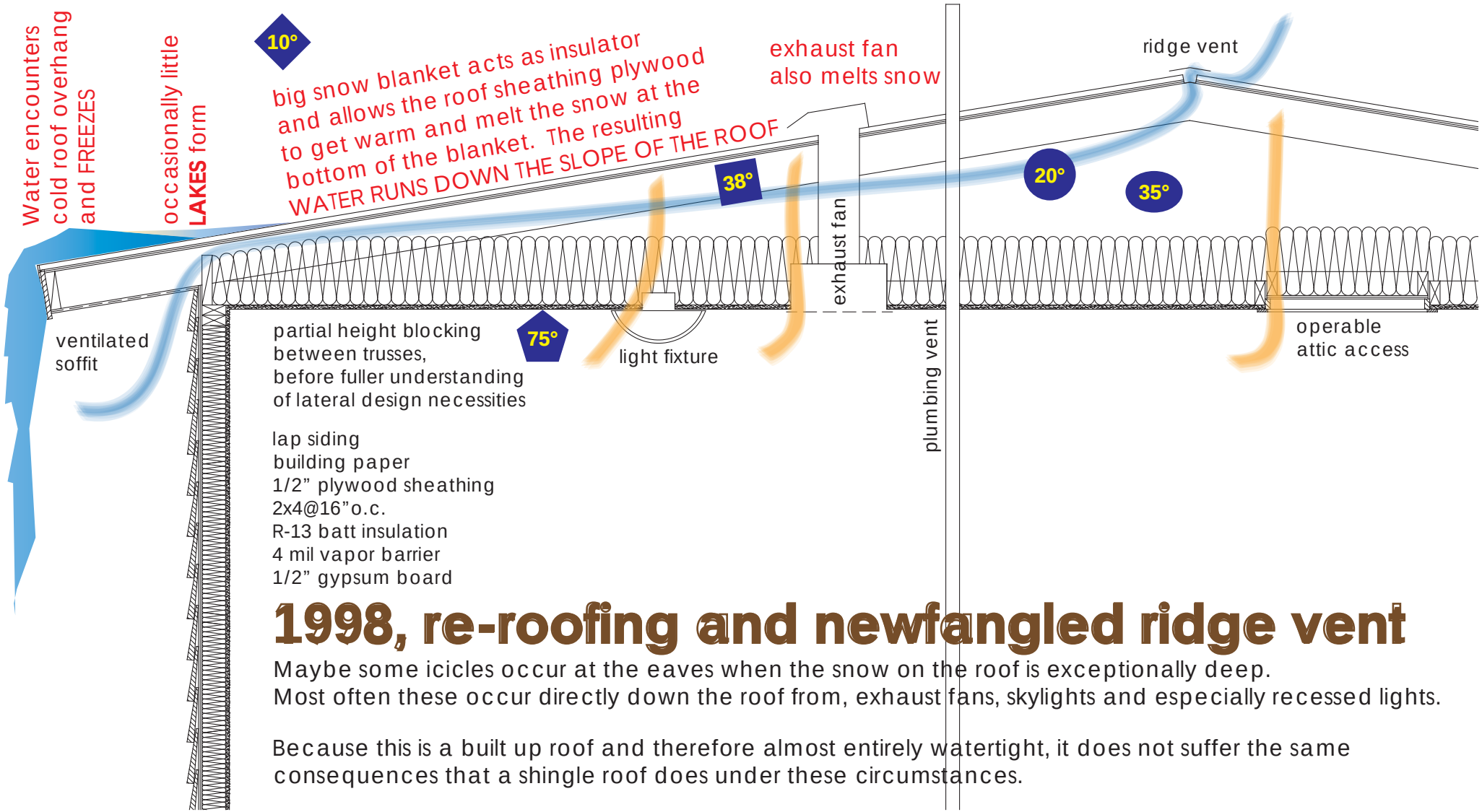
Apparently, a combination of factors contribute to a sustainable system:

-black dense roofing readily transfers heat, contributing to greater evaporation in the summer

-lower surrounding trees allow for maximum insolation in the summer

-less tight windows and doors limit interior humidity levels

-less attic insulation results in a higher winter temperature at the inside face of the roof sheathing, resulting in less condensation there (INSULATION SLOWS HEAT TRANSFER, IT DOES NOT STOP IT)

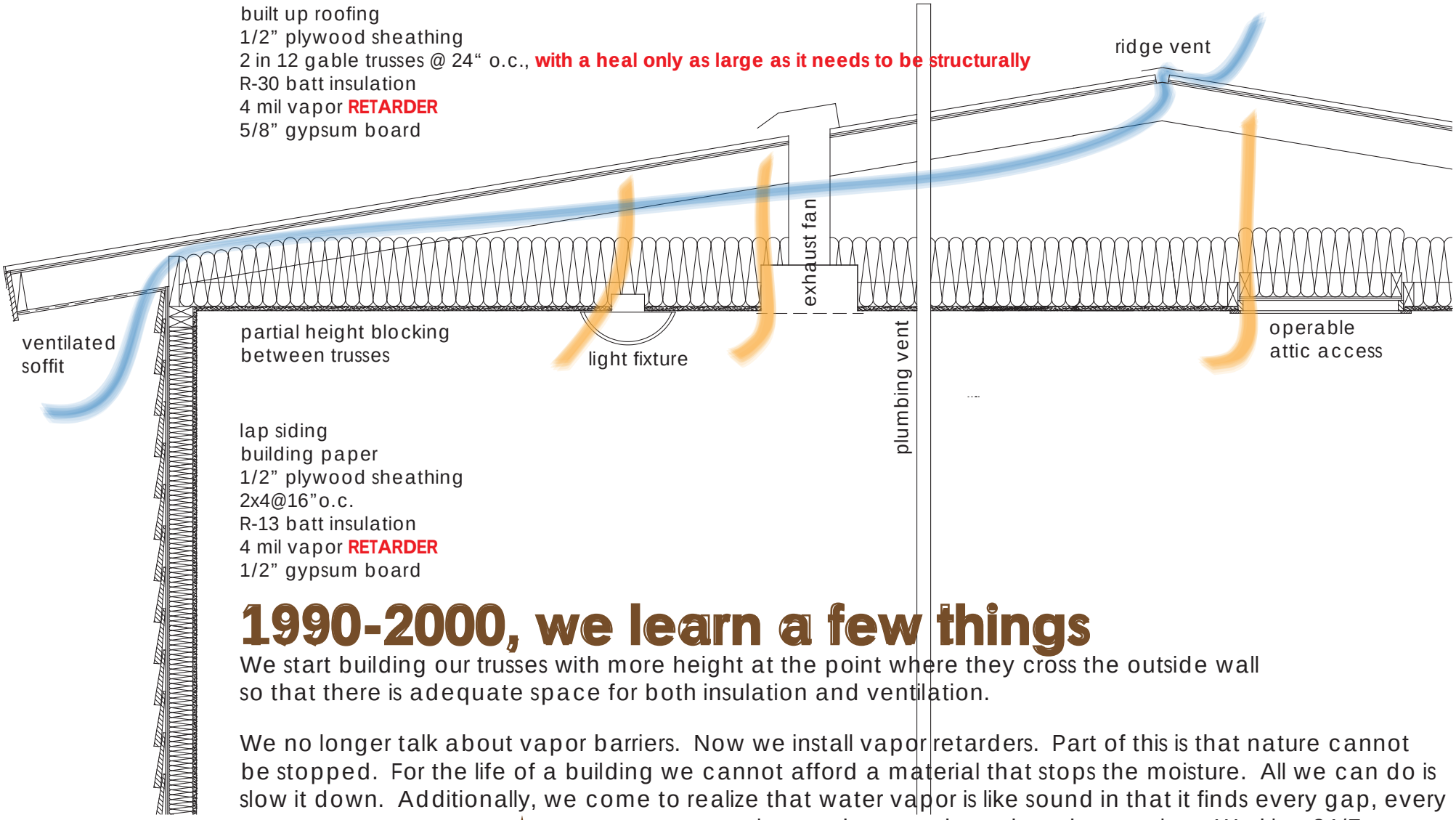


1998, re-roofing and newfangled ridge vent

Maybe some icicles occur at the eaves when the snow on the roof is exceptionally deep. Most often these occur directly down the roof from, exhaust fans, skylights and especially recessed lights.

Because this is a built up roof and therefore almost entirely watertight, it does not suffer the same consequences that a shingle roof does under these circumstances.

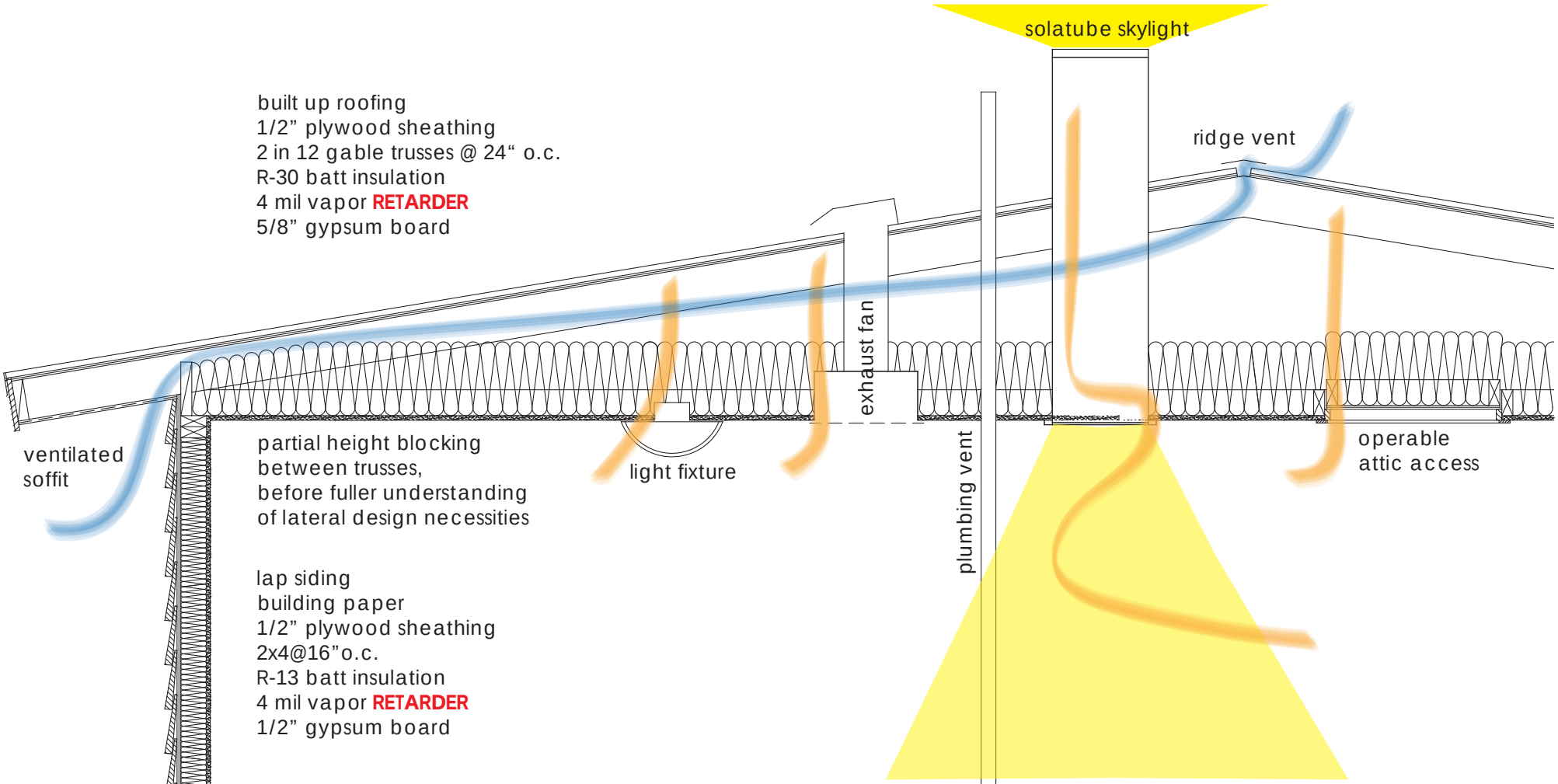
It also may be that the neighbors' trees have grown up and are now shading the house more than in the past. The resulting lack of insolation may mean that the attic no longer dries out completely each summer.



1990-2000, we learn a few things

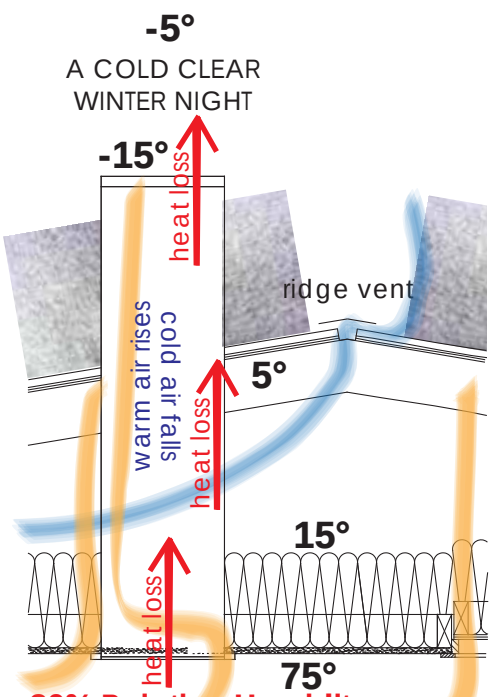
We start building our trusses with more height at the point where they cross the outside wall so that there is adequate space for both insulation and ventilation.

We no longer talk about vapor barriers. Now we install vapor retarders. Part of this is that nature cannot be stopped. For the life of a building we cannot afford a material that stops the moisture. All we can do is slow it down. Additionally, we come to realize that water vapor is like sound in that it finds every gap, every penetration, and passes through at those points. Working 24/7, nature manages to move amazing amounts of water through those gaps. We no longer talk about vapor retarders or ventilation. Instead, now, “We do the very best we can at both (and cross our fingers too).”



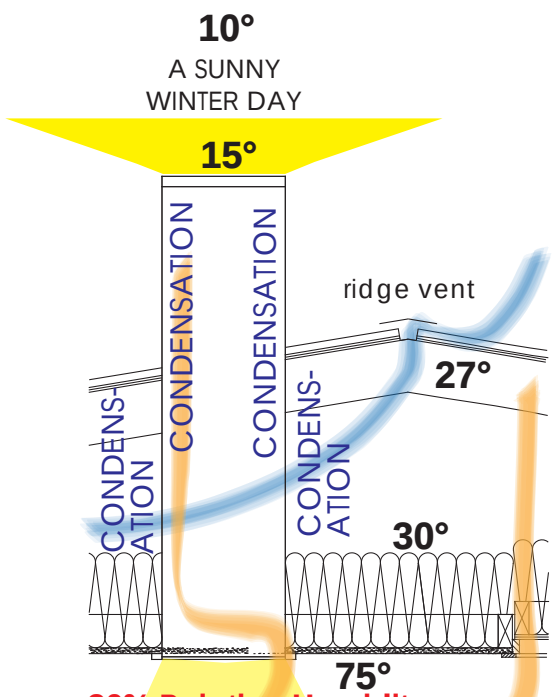
Summer of 2009, add solatube skylights

Interestingly, these tubes while seeming to be an excellent source of light, also seem woefully unprepared for the rages of winter in Alaska. Neither the tubes nor the lenses at the top or at the bottom are particularly sealed. It seems as if the manufacturer’s plan is that you can open up the skylight and drain it whenever you see moisture.



30% Relative Humidity

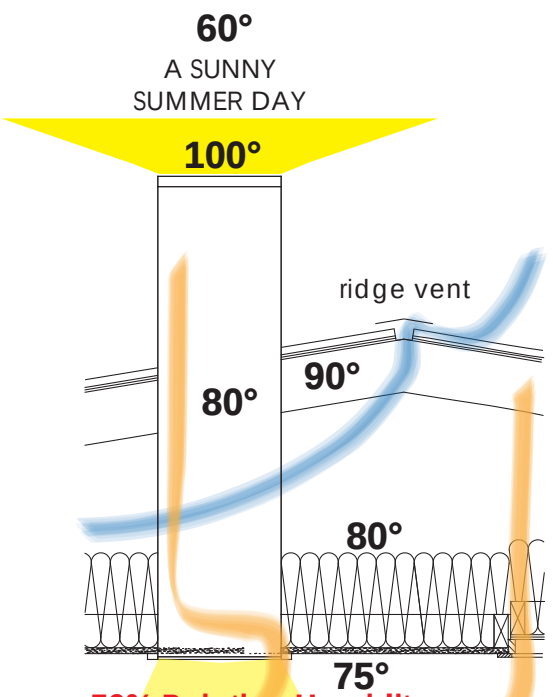
The tube is not carefully sealed. Air can easily enter the tube at the bottom and at tube joints within the attic. The tube is a heat transfer machine (in this case 90° ΔT from the top to the bottom). Inside the tube, air carries heat from the bottom to the top by convection. The metal of the tube is constantlypulling heat up and out. Much of the tube is at a temperature below the dew point of interior air, so condensation is occurring both inside and outside of the tube.



30% Relative Humidity

The dew point of 75° at 30% relative humidity is 39°. More or less, all of the tube that is above the top of the batt insulation is below the dew point. Any warm interior air that manages to get into the tube or into the attic will condense moisture onto the tube. Much of the tube is well below 32° and thus much of this condensation will be stored as ice.

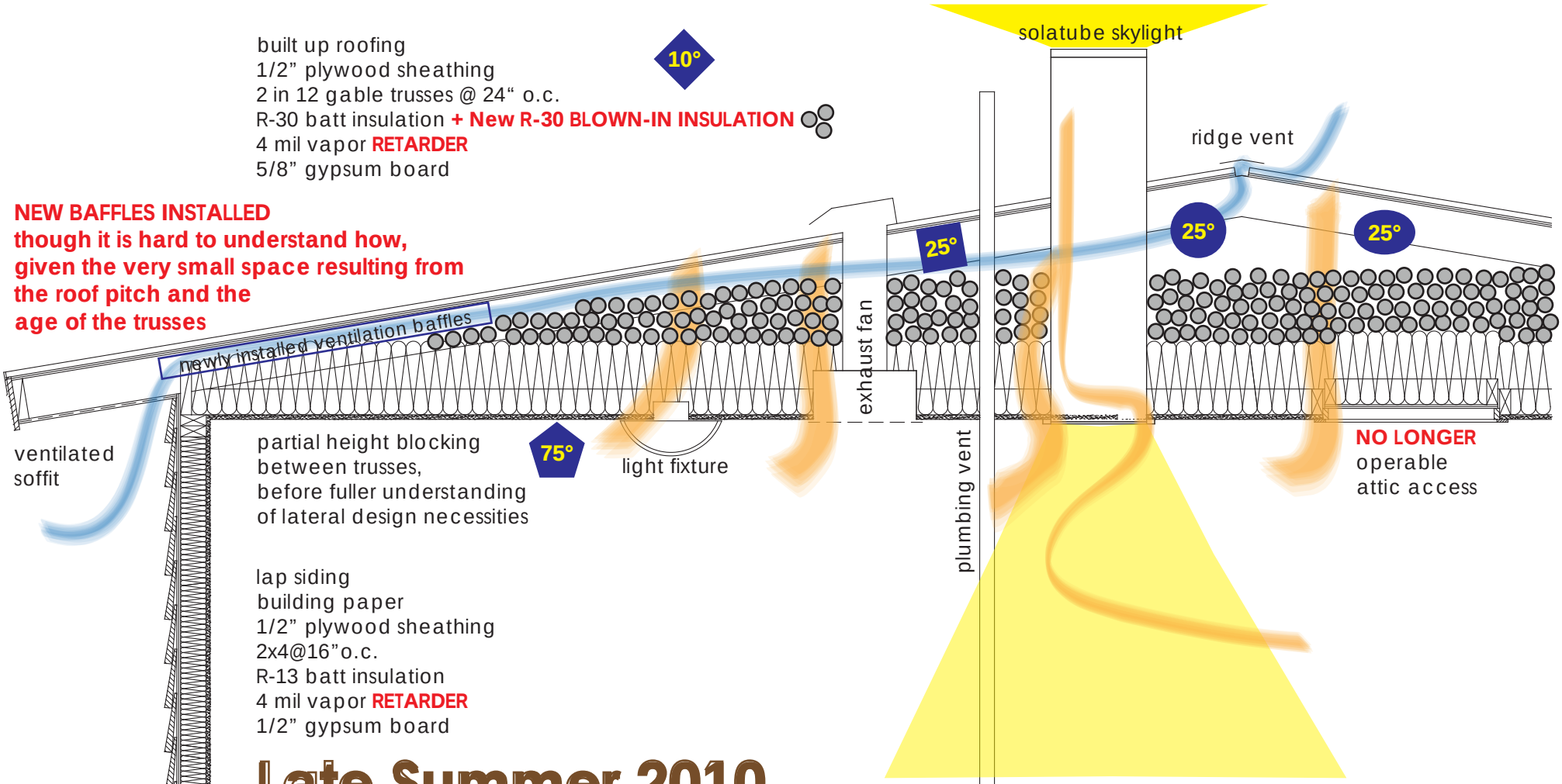
75° is equivalent to 68° at the thermostat.



50% Relative Humidity

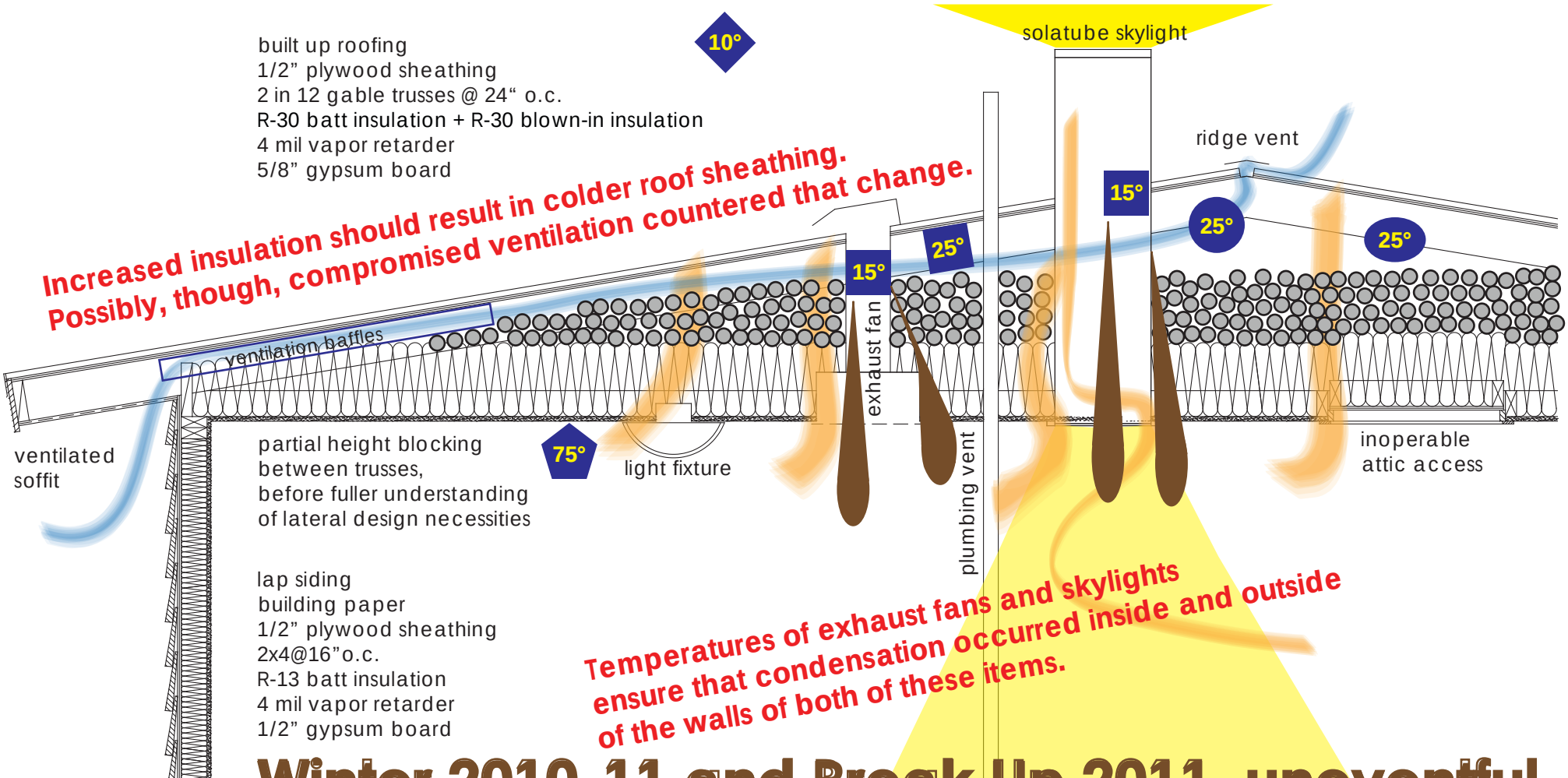
The solatube has exhaust ports at the top. That combined with the temperatures shown here make it likely that the solatube can boil off all of its accumulated condensation every summer. But that only takes care of the moisture insidethe tube. The moisture on the outside of the tube has likely dribbled down and damaged insulation and gypsum board below.

the life of a solatube skylight in Anchorage Alaska



Late Summer 2010, Energy Audit leads to added insulation.

Attic access panel edges were sealed but shim spaces around frame WERE NOT SEALED.
Electrical boxes, at lights, penetrations in ceiling vapor retarder WERE NOT SEALED.
Exhaust fan penetrations in ceiling vapor retarder WERE NOT SEALED.
Ducts and skylight tubes have never been wrapped with insulation and a vapor retarder.



Winter 2010-11 and Break Up 2011, uneventful

AN AVERAGE WINTER

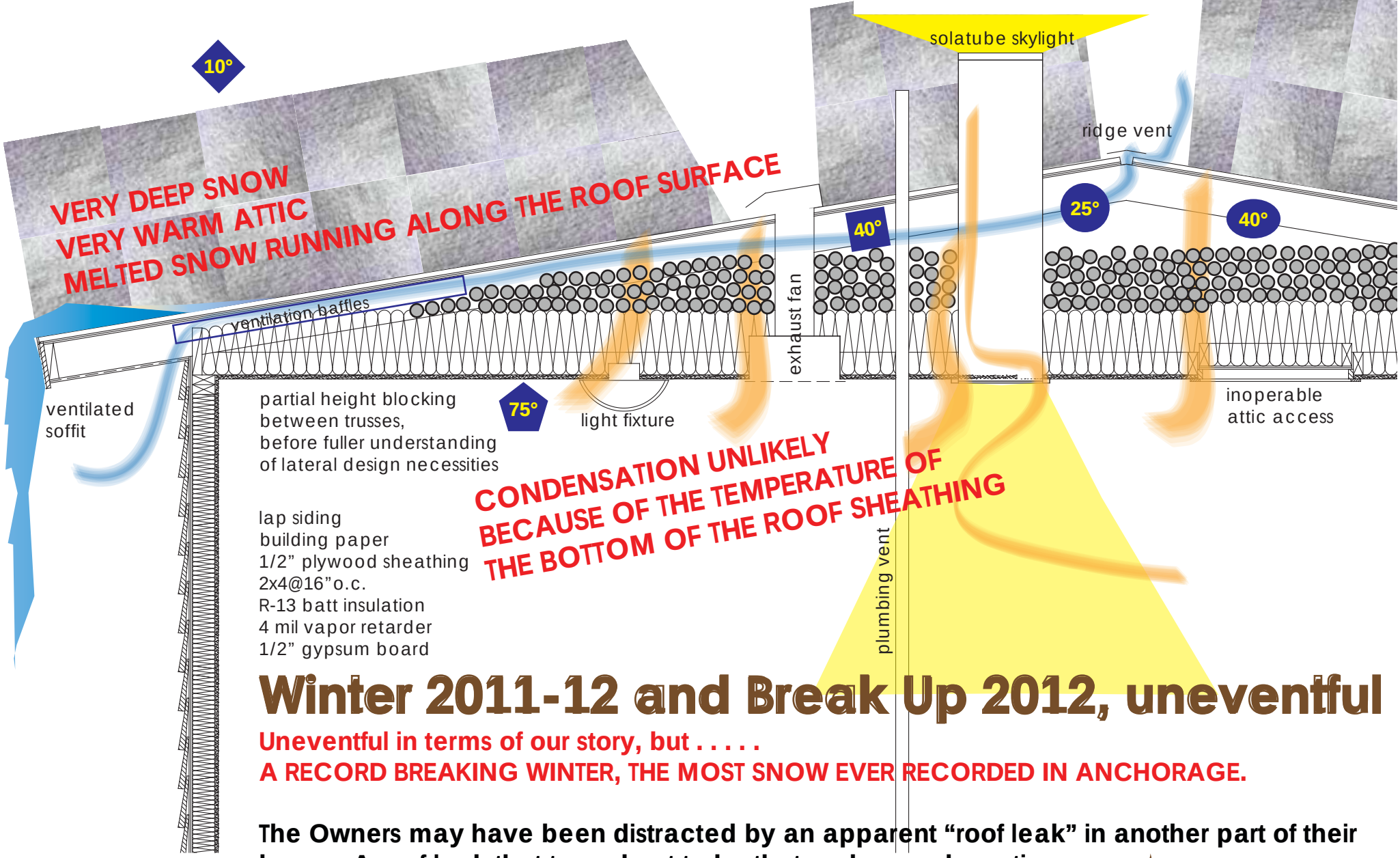
DESPITE LESS FAVORABLE CONDITIONS, THE SYSTEM SEEMS TO CONTINUE TO WORK.

Compromised ventilation works in opposed ways:

It allows the attic to get warmer, reducing condensation but also increasing the likelihood of glaciation on the outside.

And

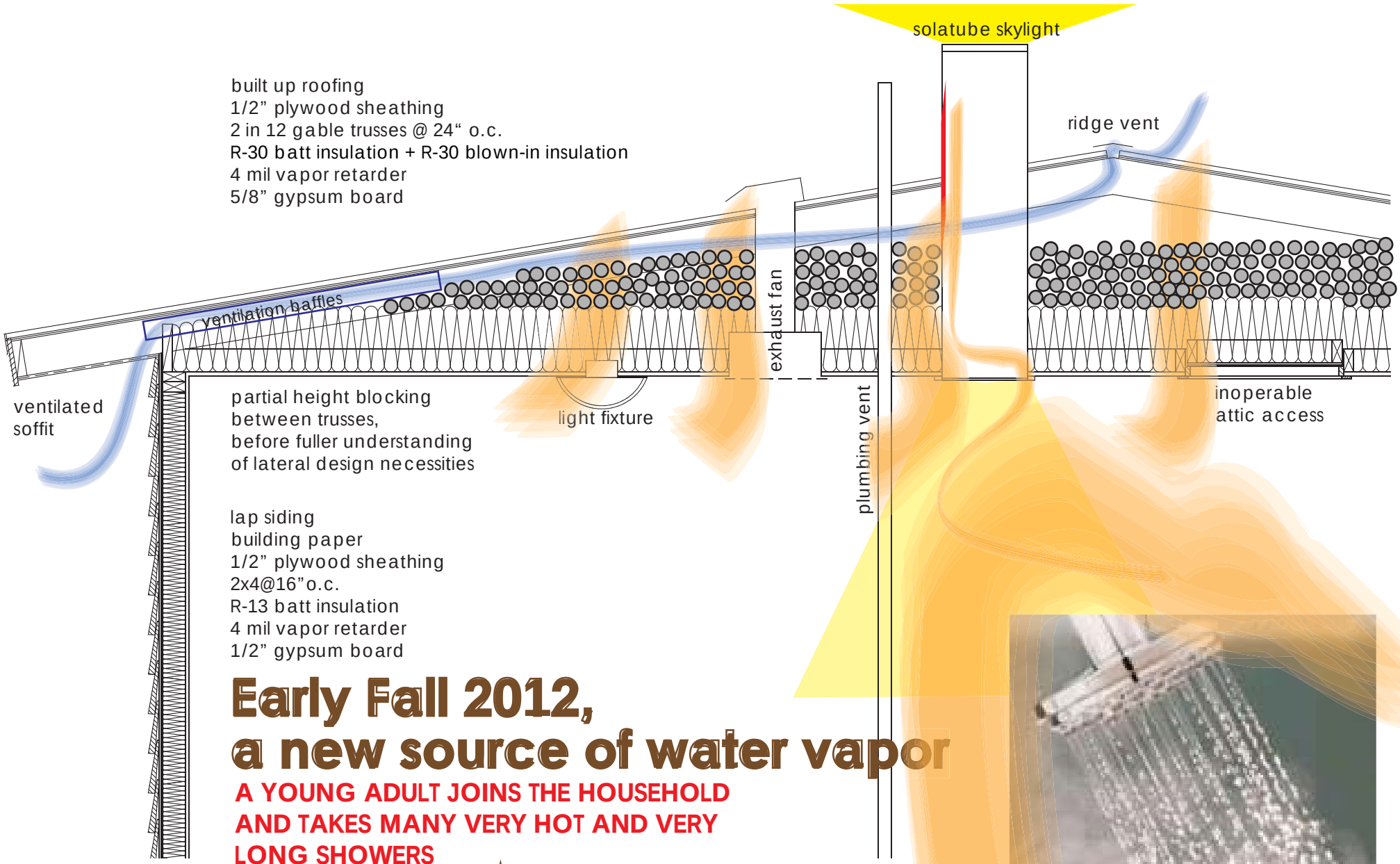
It may reduce the ability of the attic to boil away moisture during the summer, warmer, yes, but less ventilation.



Winter 2011-12 and Break Up 2012, uneventful

Uneventful in terms of our story, but . . . . .
A RECORD BREAKING WINTER, THE MOST SNOW EVER RECORDED IN ANCHORAGE.

The Owners may have been distracted by an apparent "roof leak" in another part of their home. A roof leak that turned out to be that and a condensation problem too, but that's another story completely . . . . . .



Early Fall 2012, a new source of water vapor

A YOUNG ADULT JOINS THE HOUSEHOLD AND TAKES MANY VERY HOT AND VERY LONG SHOWERS

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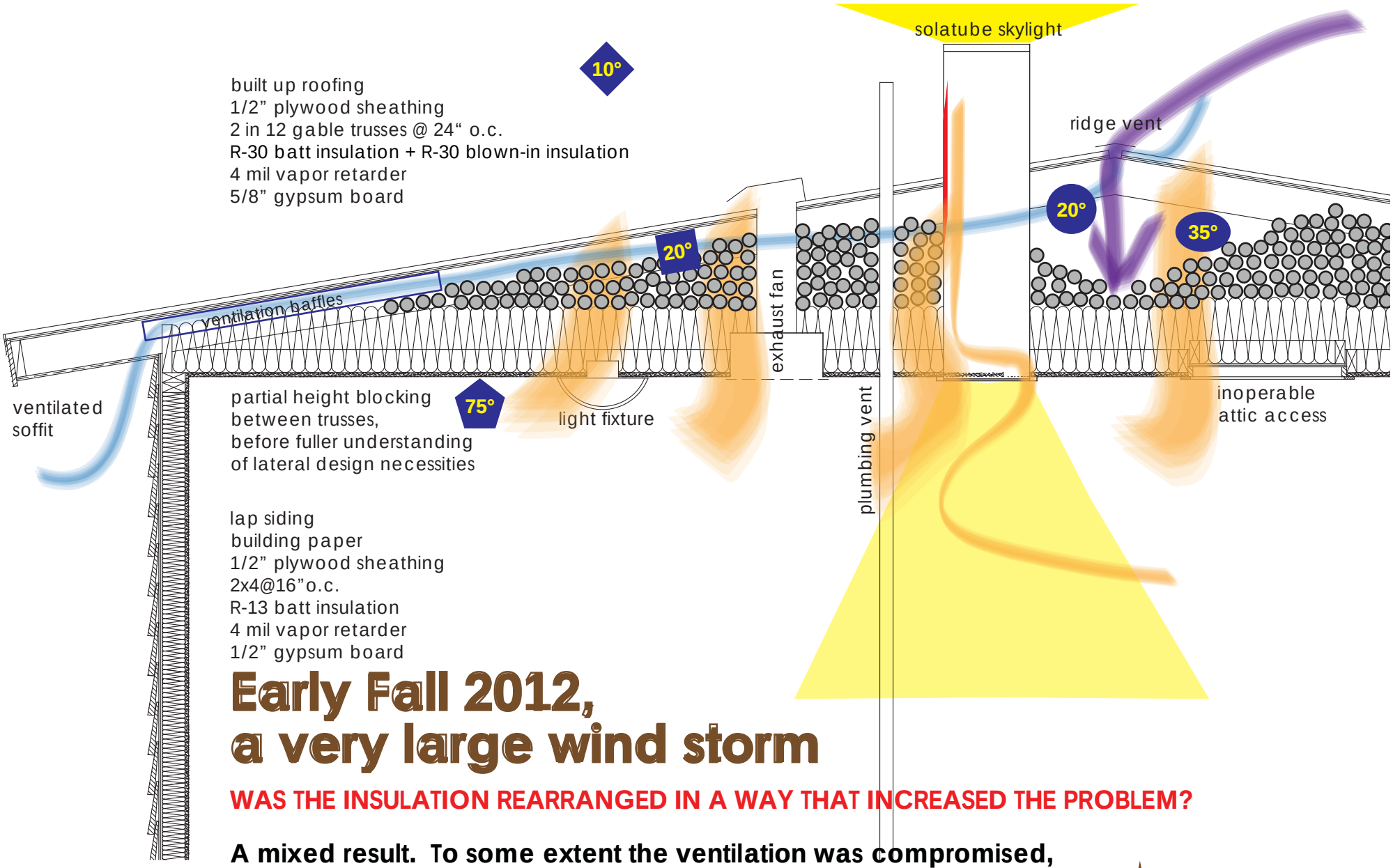


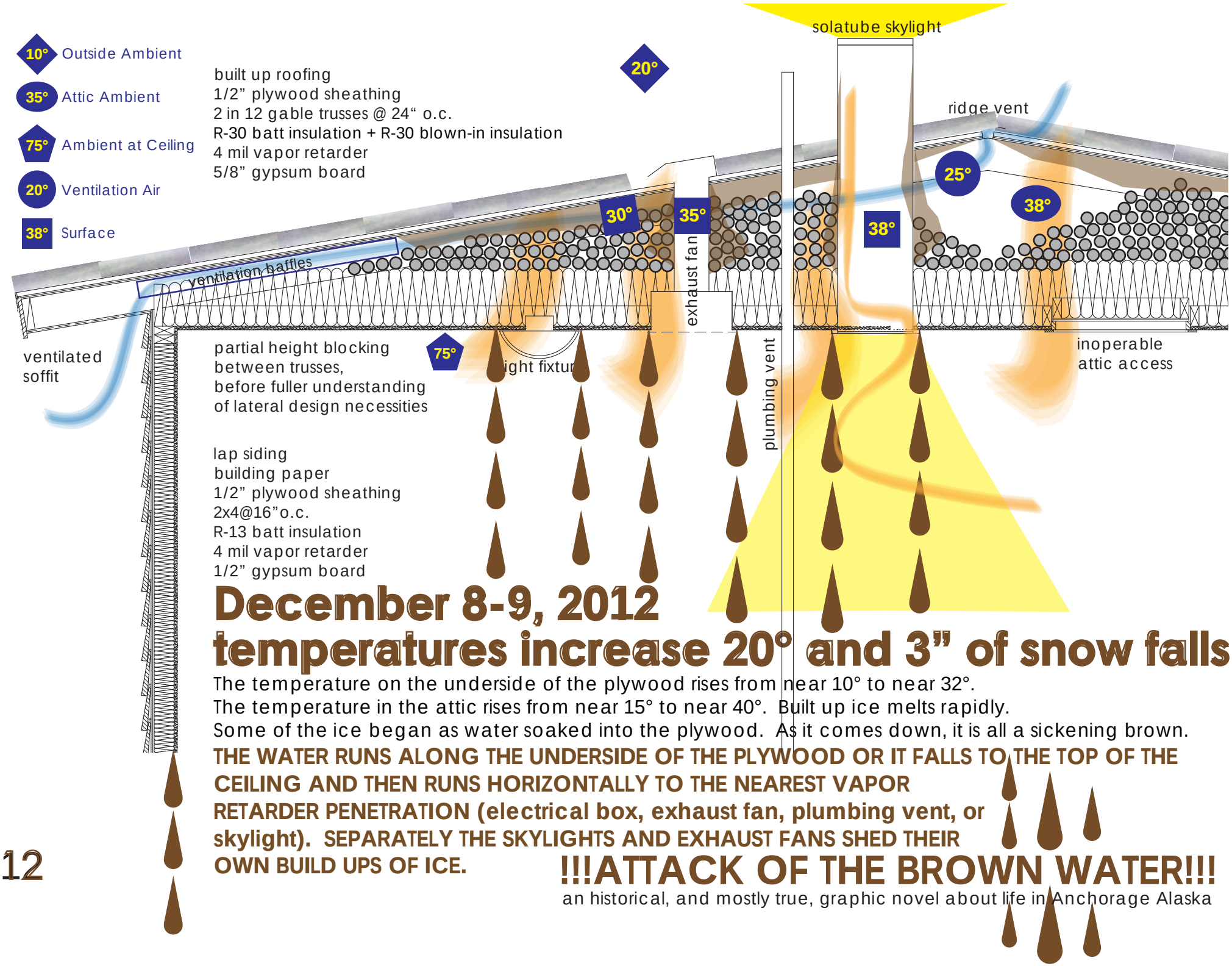
Early Fall 2012, a very large wind storm

WAS THE INSULATION REARRANGED IN A WAY THAT INCREASED THE PROBLEM?

A mixed result. To some extent the ventilation was compromised, limiting the ability of the air to carry away the condensation. But areas where insulation was blown away, the underside of the roof sheathing remained somewhat warmer, limiting condensation.

November 14-December 7, 2012
temperatures 0-20, barely a dusting of snow

Very cold plywood due to no snow, dense roofing, and nearly R-60 insulation
These conditions overwhelm the potential pluses of compromised ventilation.
Instead, compromised ventilation only reduces the ability of the attic to heal itself.



December 8-9, 2012 temperatures increase 20° and 3" of snow falls

The temperature on the underside of the plywood rises from near 10° to near 32°.
The temperature in the attic rises from near 15° to near 40°. Built up ice melts rapidly.
Some of the ice began as water soaked into the plywood. As it comes down, it is all a sickening brown.

THE WATER RUNS ALONG THE UNDERSIDE OF THE PLYWOOD OR IT FALLS TO THE TOP OF THE CEILING AND THEN RUNS HORIZONTALLY TO THE NEAREST VAPOR RETARDER PENETRATION (electrical box, exhaust fan, plumbing vent, or skylight). SEPARATELY THE SKYLIGHTS AND EXHAUST FANS SHED THEIR OWN BUILD UPS OF ICE.

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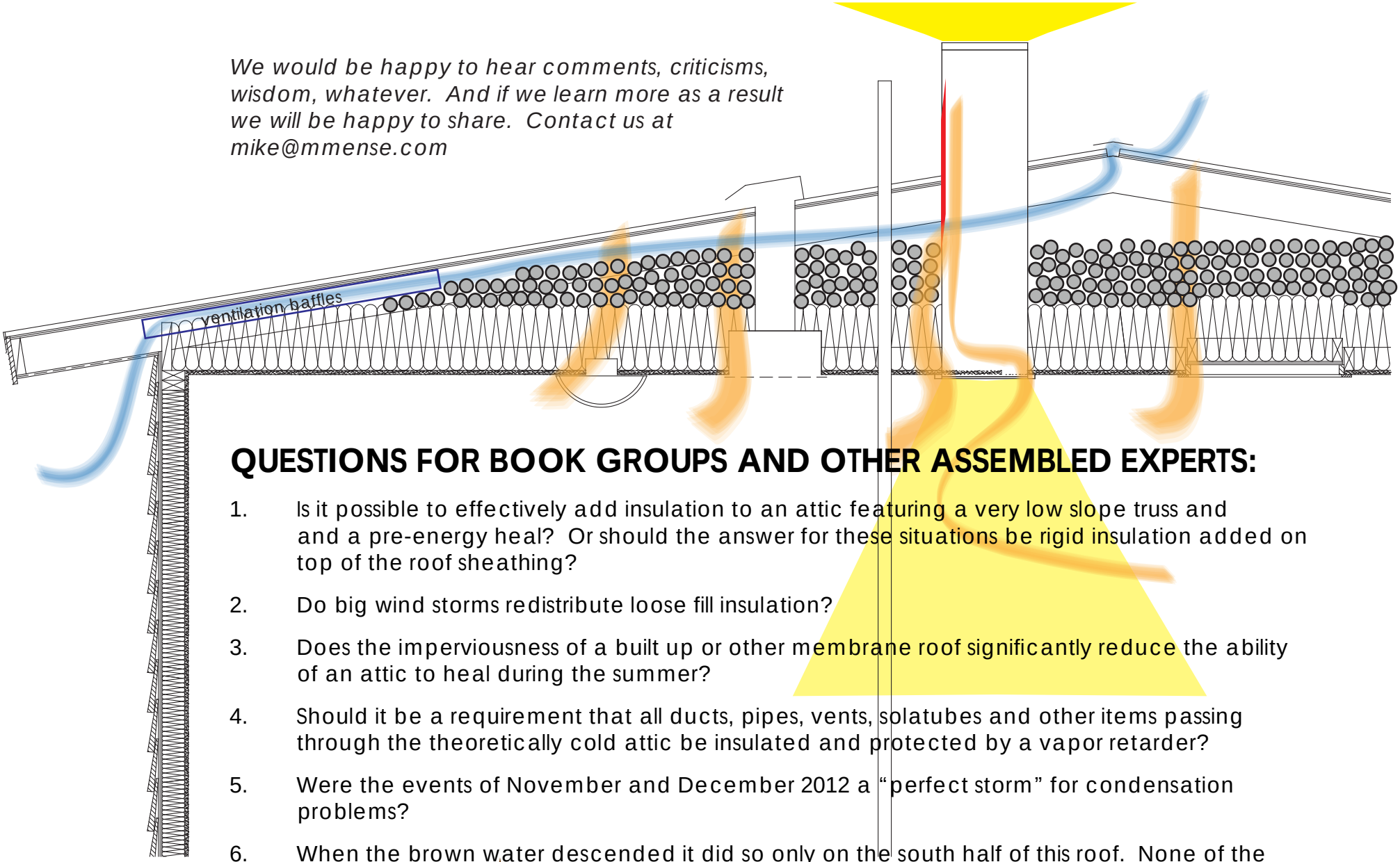
We would be happy to hear comments, criticisms, wisdom, whatever. And if we learn more as a result we will be happy to share. Contact us at mike@mmense.com



QUESTIONS FOR BOOK GROUPS AND OTHER ASSEMBLED EXPERTS:

1. Is it possible to effectively add insulation to an attic featuring a very low slope truss and and a pre-energy heal? Or should the answer for these situations be rigid insulation added on top of the roof sheathing?
2. Do big wind storms redistribute loose fill insulation?
3. Does the imperviousness of a built up or other membrane roof significantly reduce the ability of an attic to heal during the summer?
4. Should it be a requirement that all ducts, pipes, vents, solatubes and other items passing through the theoretically cold attic be insulated and protected by a vapor retarder?
5. Were the events of November and December 2012 a "perfect storm" for condensation problems?
6. When the brown water descended it did so only on the south half of this roof. None of the vapor retarder penetrations on the north half of the roof produced brown water or even gypsum board stains. What might explain that?

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