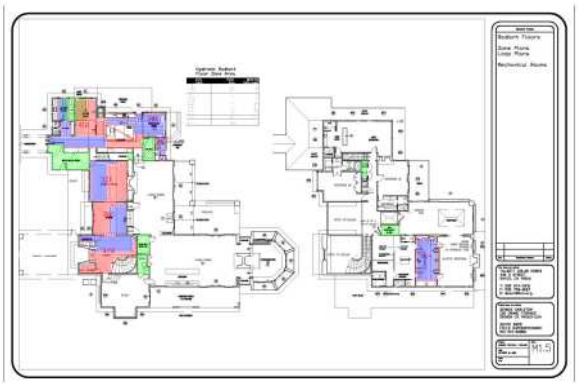
***x*Lath™**

Ceiling Module Radiant Cooling Case Studies

*x*Lath™ radiant ceiling heat exchange module prototypes are being used in eleven homes throughout Northern California totaling twenty-eight thousand square feet.

1. Strack / Bonk residence, new construction, Cool CA. 1800 SF, georadiant
2. Silverman residence, room addition, Meadow Vista CA. 2500 SF, mixed georadiant, combi-boiler
3. Nichols residence, total rehab, Davis CA, 1400 SF reversing chiller
4. Wolfe residence, room addition, Davis CA, 1000 SF reversing chiller
5. Huynh residence, new construction, Clear Lake CA, 1800 SF SIP, well water cooling, combi-boiler



6. Carlston residence, total rehab, Orinda CA, 8000 SF Thermalflow chiller, combi-boiler Crestron controls
7. Wilson residence, new construction, Woodland CA, 1400 SF air source chiller, combi-boiler
8. Fernandez residence, new construction, Woodland CA, 1400 SF air source chiller, combi-boiler
9. Garcia residence, new construction, Woodland CA, 1400 SF air source chiller, combi-boiler
10. Green residence, new construction, Napa CA, 4000 SF Thermalflow chiller, combi-boiler
11. Antipa mixed use, rehab and new construction, Sacramento CA, 3420 SF, air source chiller, combi-boiler (under construction in spring 2010).

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With the exception of 5, 6 and 7 each residence was designed by a different architect and developed by the homeowner. Cases 5, 6 and 7 were designed together and developed by Habitat for Humanity. Zurn Wrightsoft Residential energy analysis software was used to size the cooling and heating loads for each case. In the software setup, the ducts are changed to be inside the insulated space to switch off duct losses. A similar strategy is employed by Accurate Energy for the Title 24 reports.

The mechanical equipment varies in these cases, but in most cases cooling is accomplished with a vapor compression chilled water device controlled by a Honeywell aquastat set at 55°F. In these climate zones hot humid days are rare, and this setting is good enough. Clearly a controller which calculates and controls based on the dew-point would be better, and would be necessary in more humid climates.

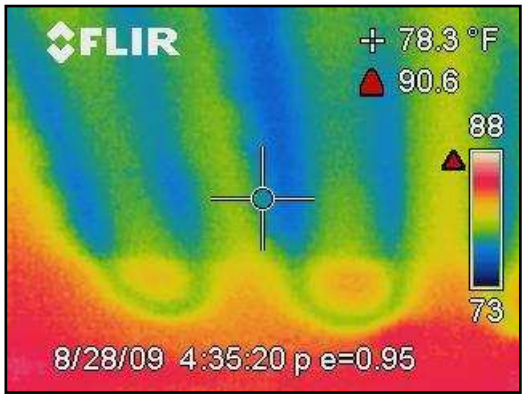
With the exception of cases 1 and 3 each building includes one or more small air handlers for dehumidification when needed. With the exception of cases 5 and 11 each building is a single zone. Chillers, like boilers are sensitive to flow and a multi-zone design requires some method to vary the rate of cooling under part load usage. To keep the mechanical design simple and reliable a single zone design is used in all but the largest buildings. A buffer tank or modulating chiller is also required in the smallest designs to keep the flow through the chiller adequate, making simple radiant designs challenging for small jobs. Plain tap water is used as the heat transfer fluid in all but 1 of these cases.

To control the homes several thermostats were tested. The Honeywell VisionPro IAQ thermostat provides a great client interface and all the functionality needed for radiant heating and cooling. The VisionPro locates the relays near the mechanical equipment makes it easy to design the control layout and control the equipment.

Cases 1 – 3 utilize Wirsbo (Uponor) A5075002 1/2" Double Groove heat exchange plates parallel to the joists with the drywall affixed through the plates to the joists. These

installations took significant time to “lace” the tubing through the joists, and the edges of heat exchange plates were not in good contact with the drywall. It was one of these jobs where the tubing was screwed by the drywall installers. Where the ceiling joists were on 24” centers the coverage was only about 50%. Nevertheless with the exception of two upstairs west facing bedrooms they work.

Case 4 utilizes the Wirsbo Double Groove plates mounted on ¾” Z-bar and laid out perpendicular the joists. This resolves the problem with 24” ceiling joists layout and allows the tubing to be rapidly installed on the surface of the radiant panel. The drywall is affixed to the plates as is the practice with Resilient Channel (RC) in multi-story buildings. This method achieves good contact between the heat exchange plates and drywall.



Quietside Ondol galvanized steel double groove plates mounted on ¾” Z-bar are used for cases 5 – 10. This material installs like the Z-bar Wirsbo assembly, but is significantly cheaper.

The Western Cooling Efficiency Center (WCEC) at UC Davis studied cases 6 and 7 for comfort effectiveness. Hobo™ temperature and humidity data-loggers were placed at key locations in each house for about 3 weeks in August and September 2009. When the outdoor temperature was over 100^{o} F from 11: AM to after 7: PM the living room was cooled to 68^{o} F and the upstairs west facing bedrooms got as high as 78^{o} F. The ceiling radiant cooling systems perform very well and the electric utility bills are very modest.

The *x*Lath™ module is now available at a significant cost savings in material and labor compared to the prototype assemblies used in these cases.

xLath™ module profile, including joist mounting area, offset for tube zone with impact and sound attenuation, hydronic tubing groove, heat exchange fin and drywall mounting area.