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PLUMBING & MECHANICAL

(8)

Pipe relining saves condo water pipe

The 411 on heat pump water heaters

An 800-gal. buffer tank is hoisted into place on the property of a Sanders County, Mont., hunting lodge.

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Montana green heat

The heating system for this hunting lodge complex includes a woodgasification boiler, radiant floor heating and hydronic unit heaters.



Bill Smith, project manager for Ambrose Geo Heating & Cooling, headed up the radiant tubing installation to stay ahead of the tight concrete pour deadline.

S anders County, Mont., is known to many outdoor enthusiasts. Bear, elk, deer and mountain lion far outnumber the four-people-per-squaremile population. Consisting almost entirely of parts of three national forests — Kaniksu National Forest, Kootenai National Forest and Lolo National Forest — steady work is hard to find in the huge county. Many residents make a living from the land.

Cody and **Koliss Carr**, a young couple with three girls, have built a thriving business in the rugged landscape, which provides work for other families in the area. Cody Carr's Hunting Adventures is primarily a big game hunting outfit but also entertains hikers, fishermen and others escaping the daily grind of urban life.

The company recently expanded and so has its infrastructure and payroll number of guides, cooks, horses, all-terrain vehicles, hunting vehicles and sleeping quarters. The seemingly endless amount of hunting and camping equipment, as well as chest freezers and tack, were spread out over a variety of small outbuildings on the property. In early 2013, the Carrs decided to put an end to the organization challenges by building a central shop with garage bays, a tack room, office space, a bathroom and storage. The challenge was to determine the best way to heat the space.

"There's no shortage of dead, standing wood here since the mountain pine beetle has been attacking large tracts of forest," Carr explains. "We needed a shop and I've always wanted a wood-fired heating system."

He hired Stevensville, Mont.-based Ambrose Geo Heating & Cooling, which focuses on geothermal HVAC work. However, Carr was interested in the company's experience with intricate hydronic systems. Owner **D'Aron Johnson** and Project Manager **Bill Smith** were involved from the job's design phase.

"Gone are the days of smoke-billowing wood stoves that need to be stocked hourly," Johnson says. "Welcome to the age of thermal mass, re-burn boilers and variable-speed pumping."

Johnson's 30 years in the heating industry have given him a grasp on what's possible when using nonconventional heat sources. He and Smith designed a system to heat four different zones in the 2,700 sq.-ft. shop, both levels of the home, the entire guest lodge and domestic hot water throughout — despite the tight space constraints in the existing buildings.

Wood gasification

The two-story shop has all the western trimmings, from batten board vertical siding to a green-colored steel roof. With a tack room, mezzanine office, space for four pickup trucks and a mechanical room, the building is pure rustic, utilitarian space.

Although mechanical components are found in different locations on the property, the shop's mechanical room



Lead Ambrose Geo installer Justin Johnson works on a manifold inside the house, where water comes in via underground pipe and is distributed to air handlers and a domestic hot water tank.

needed to accommodate the blue 200 MBH Econoburn woodfueled boiler, an 800-gal. buffer tank, expansion tanks, manifolds and circulators.

The wood-fueled boiler uses a gasification process that delivers an 87% thermal efficiency rating. As wood is burned in the firebox, fresh air is blown downward through the logs and coals. This creates a mixture of hot air and wood gases that are forced through a refractory — or second combustion chamber — where it meets a jet of super-heated air, creating a torch-like combustion of the retained gases. This process is known as wood gasification. The smoke and creosote vapor that would normally go up the stainless-steel, dual-wall smokestack as visible smoke is instead burned at nearly 2,000° F. This high-temperature secondary combustion not only cleans up emissions but gives the boiler near-condensing levels of efficiency.

Burn times vary greatly depending on moisture content and species of the wood, but a properly sized system will range from six to eight hours, the company says. At Carr's, local softwoods are used in the boiler, keeping burn times shorter. But the system Ambrose Geo designed uses the boiler to its full potential, regardless of output fluctuation, with the help of a buffer tank.

The Niles Steel Tank thermal storage tank is 12 ft. tall and shrouded in 4 in. of insulation and sheet metal. Acting as a huge flywheel, it absorbs the wide temperature swings coming from the boiler. In the event no one is available to put wood in the stove, the storage tank alone can supply heat to the property for quite a while.

A 2-in. boiler loop and Taco 0015 circulator moves a water/ glycol solution between the boiler and the glass-lined buffer tank, which has no coils. Ambrose Geo ordered the tank without coils so it can double as a massive hydroseparator. The delivery system is designed to work at temperatures between 140° and 180°.

"The tank's water temperature varies according to where the boiler is in its cycle and what the heating loads are," Johnson explains.

Including the buffer tank, boiler and connected pipe, more than 1,000 gal. of water is in the system. Smith and Carr fired the boiler for the first time in late August last year, before the lodge filled with archery hunters. It took nearly a day for the tank to reach its target temperature.

"When we fired the system, we brought the big tank up to temperature, let the fire in the boiler burn out and then went away for a three-day weekend," Carr says. "When we came back, the tank had only lost 3°!"

Shop radiant

The shop has two heating elements: 3,000 ft. of 1/2-in. Watts RadiantPEX+ with an EVOH oxygen barrier installed on top of blue-board insulation with a concrete slab overpour and three Modine Hot Dawg H20 hot water unit heaters.

The nine loops all stem from two sets of Watts stainless-steel Flow Meter manifolds that dial in the exact flow rate needed on each zone. Actuators on the manifolds provide on-off control of that flow on demand from the thermostats.

From the smaller of the two manifolds, Onix EPDM tubing supplies water to the three hydronic unit heaters, one of which heats the upstairs office. Another provides supplemental heat in the main service bay and the third brings the tack room to temperatures the radiant floor can't provide.

"We often get in at midnight with wet saddles," Carr explains. "It's best for the horses and tack if we can have all the equipment dry before we head out again at 5 a.m. Bringing the room up to 80° or 90° in a hurry, plus having air movement, is a huge advantage."

Space between radiant loops was left for Watts Dead Level trench drains. Since snow-caked vehicles parked on a radiant slab mean major water issues, Carr took his floor drainage seriously. Reinforced, stainless-steel slotted grating ensures resilience regardless of what is driven over the drain: car, truck, horse, snowmobile, etc.

Montana green heat



Aaron Miller from Ambrose Geo gets read y to bur y pre-insulated, 1 1/2 in. PEX tubing, which is used to supply the heat to the home and lodge.

Serious distribution

One challenge Ambrose Geo encountered was the distance between buildings, from a thermal and pumping standpoint, in order to provide domestic hot water to all three buildings. The lodge is 400 ft. from the shop and the home is roughly half that distance.

Two runs of pre-insulated 1 1/2-in. Watts R-Flex supply-and-return tubing is used to circulate water — one at 353 ft. and the other at 253 ft. Installed just below the frost line, the pipe consists of oxygen-barrier PEX surrounded by polyethylene foam insulation, all encased by a rugged corrugated carrier. In both the lodge and the house, Magic Aire air handlers and ductwork are used to supply heat. At each building, an 80-gal. Bradford White indirect-fired water heater taps the supply manifold stemming from the R-Flex tubing. Existing electric water heaters provide redundancy.

Ambrose Geo needed pumps with high head and low flow rates. To determine the best pumps for the application, the company contacted **Doug Bird**, Taco senior project manager of water circulation, who suggested a 2400 series pump for each of the two underground supply loops. Given the volatile firing temperatures of a wood-burning system and the wide variety of connected load, Smith took extra precautions with the near-boiler piping. The main supply and return lines from the boiler are linked by a 1-in. pipe and an ECM-driven, variable-speed Taco Bumble Bee circulator.

"To keep the boiler in re-burn mode — and, more importantly, to prevent condensing — we needed to ensure the unit never sees return water temps below 140°," Smith explains. "The circulator runs off a setpoint, pulling water from the supply side to temper the return water in the unlikely event it drops too low."

To keep the huge water volume in an anaerobic state, a Taco 4900 series air-anddirt separator is piped high on the line that runs from the top of the buffer tank to the manifold that consolidates the connected load. Two 150-gal. expansion tanks sit near the buffer tank.

In the shop, the zones heated by the hydronic unit heaters are controlled by Taco three-zone ZVC panels. A Taco SR506-EXP-4 six-zone expandable switching relay handles the shop's floor heating element, as well as distribution to the other buildings. When the camp is full, the hydronic heating system provides hot water for as many as 20 showers daily. In years past, the Carr's were spending roughly \$1,000 each month for LP gas. In September 2013, the family purchased 15 cords of pine and tamarack logs for \$500 from their church's fundraiser.

Before winter set in, Johnson estimated that Carr would burn between 12 and 15 cords of wood. As of press time, Carr burned about 8 cords of wood and is very happy with his hydronic heating system.

"I didn't do this earlier because I didn't want an outdoor boiler smoking up the property all winter," Carr explains. "Now we have a camp full of hunters and nobody knows the heat comes from wood."

View more photos and a video about the heating system in the April 2014 digital edition and at www.PMmag.com.



Project Manager Bill Smith installs a thermostatic mixing valve on one of the 80-gal. indirect domestic hot water tanks.



1. The Carr family operates Cod y Carr's Hunting Adventures, a big game hunting outfit in Sanders County, Mont.

2. The large shop built on the hunting lodge property , which includes a large mechanical room.

3. Mountain pine beetle has been hard on local Montana forests, so there's more than enough dead wood to go around. The Carr' s use the softwood in their woodgasification boiler.

4. P roperty owner Cody Ca rr stokes the boiler during a late 2013 cold snap.









5. Sno w-covered vehic les and radiant heat meant that drainage needed to be taken seriously . Watts Dead Level drains are used throughout the shop.





6. Projec t Manager Bill Smith (left) and Ambrose Geo o wner D'Aron Johnson hang a Modine Hot Dawg H2O hydronic unit heater in the shop's main bay.

7. Although mechanical components are found in four diffe rent locations on the property , the main mechanical room in the shop had to be large enough to accommodate the buffer tank, the large wood boiler , expansion tanks, manifolds and a host of circulators.

8. W hile completing heat load calculations, D'Aron Johnson realized his software didn't provide R-factors for big game mounts hanging on the walls.

9. Ambrose Geo Project Manager Bill Smith installs actuators on radiant floor manifolds.



