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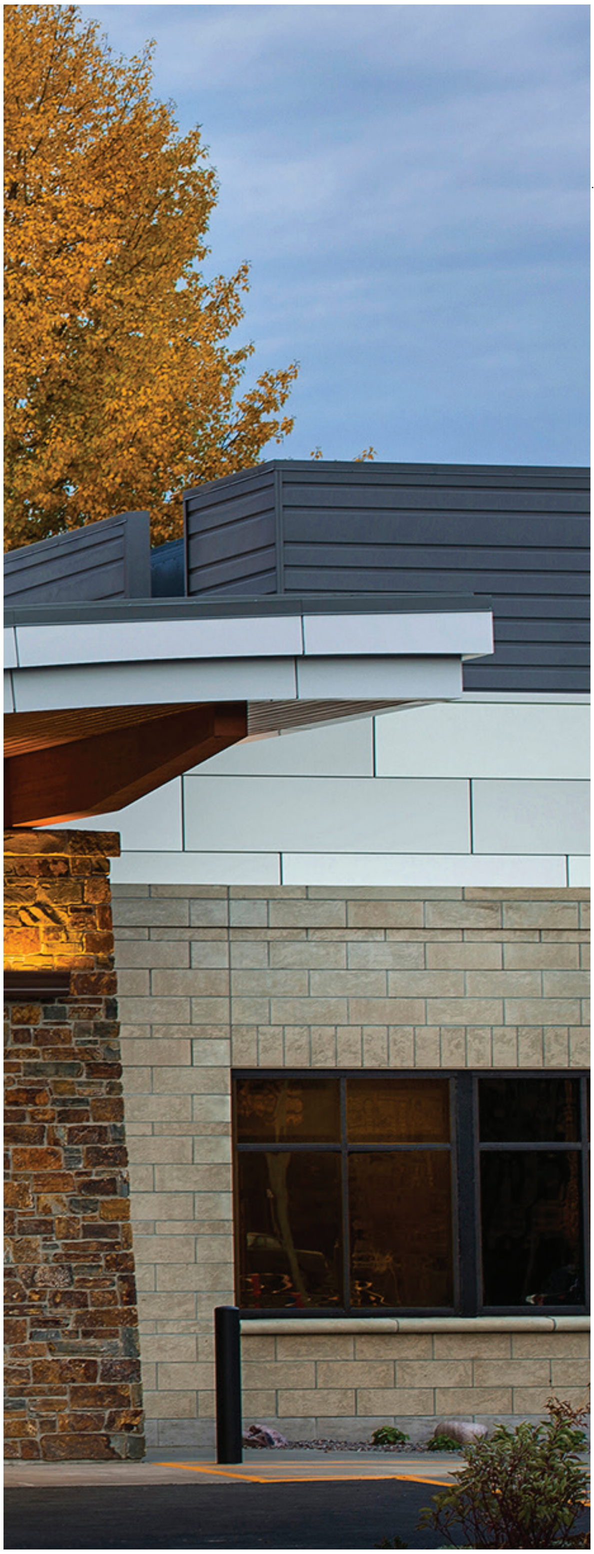
Missoula, Mont.'s new Community Cancer Care facility at the Community Medical Center is a big improvement over the much smaller original oncology facility, although patient satisfaction has always been very high. Mark Bryant Photo.

Cooled by a Rocky Mountain aquifer

Radiant cooling keeps patients comfortable in Montana.

By Dan Vastyan



Cancer is a cruel opportunist, always taking away. Though lately, modern health care has won more battles against the disease than it's lost. And in Missoula, Mont., one facility is a fine example of how patients with the disease receive *comfort* with treatment. It's smart, deep-down comfort and energy savings from Mother Nature herself.

"From the outset, the main design criterion of this project was patient comfort," says Dennis Greeno, partner at OZ Architects, the firm that designed the new Community Cancer Care facility at the Community Medical Center. "From the floor plan that minimizes patient travel inside, to the heating and cooling system at work behind the scenes, the goal to provide comfort for patients was woven into every aspect of the building." Input from staff and patients weighed heavily into the building's design.

The 30,000-sq.-ft., state-of-the-art cancer treatment facility, also referred to as the Oncology Center, rests a mere 40 ft. above the Missoula Aquifer. The massive underground aquifer is all that remains of prehistoric glacial Lake Missoula, which at one point held as much as 600 cubic *miles* of water — roughly half the volume of Lake Michigan.

According to the University of Montana, the aquifer flows at three to four feet per day; a rapid pace compared to most aquifers which move that distance over the span of a year. In Missoula, the water is consistently around 50° F. It's the ideal resource for groundwater cooling applications.

To make good use of the aquifer, the Oncology Center uses a "pump-and-dump," groundwater cooling system to tap the aquifer. Water is drawn from the ground, pumped through a large plate-and-frame heat exchanger and injected back into the aquifer.

"The Montana Department of Natural Resources and Conservation handles well permitting here," says **Adam Perine**, Sr. Hydrologist with NewFields, a national environmental consulting firm. "If water use is non-consumptive and less than 350 gallons per minute, it's a pretty simple process to acquire the correct permit." Perine designed the three wells that serve the facility. Although the system only calls for 300 gpm, the wells have been tested at 500 gpm.

"It's the most holistic approach to geothermal cooling," says Jared Swartz, office manager for Associated Construction Engineering, the company that designed the mechanical, electrical and fire suppression systems at the Oncology Center. "No compressor, no refrigerant; just a pump and a stainless steel heat exchanger to handle the building's 1M Btuh cooling load."

Tapping the aquifer

"The pump-and-dump cooling system isn't that unusual here in Missoula," says Cory Hanninen, project manager at 4G Plumbing and Heating. "The system is designed to bring in groundwater at about 53° to 55°, and return it to the ground at roughly 65°. The aquifer is so huge that every building in Missoula could use it for cooling and it wouldn't make a noticeable effect on the source temperature."

Cory Hanninen, left, of 4G Plumbing and Heating reviews piping diagrams with Dennis Nisbet, of Vemco Sales. Common Ground photo.

The cooling system A.C.E. designed stems from redundant, 10-in. bore extraction wells, each 130 ft. deep. Each supply well has a 20 hp submersible pump. Groundwater moves through the 350-gpm plate-and-frame heat exchanger and is then returned to the aquifer via an injection well. On the building side of the big heat exchanger, redundant 15 hp, VFD-powered Taco FI3011 frame-mounted, end-suction pumps circulate a glycol-based solution to rooftop air handling units that supply ducted AC.

4G Project Foreman Hans Halverson works on one of four VFD-powered pumps that serve the oncology facility's heating and cooling systems. Common Ground photo

"We've completed roughly 25 buildings in Missoula that tap the aquifer for cooling," Swartz says. "It's more prevalent here than anywhere in the state, but they're starting to follow suit elsewhere along the Western side of Montana, where the water table aquifers are large and easily accessible. Last year, we designed a similar system for a large hospital in Kalispell."

The new Kalispell Regional Medical Center Surgical Services Addition uses two, 1,200 gpm wells to feed a similar but more complicated ground-source cooling system. The water is used to provide direct cooling similar to the Community Medical Center. In addition to the direct cooling, two more heat exchangers are piped in series to provide condenser water cooling for two 350-ton water cooled chillers before being injected back into the aquifer

A.C.E. and 4G work together routinely. Both Montana-based firms are accustomed to the design factors seen in the intermountain West; long, cold winters with high snowfall and short, hot summers with very low humidity.

"We've concentrated on medical facility work and have been very fortunate to work on many throughout the Northwest. On average, we complete $250 million in construction each year, with medical facilities accounting for more than half of that," Swartz says.

Warmth, healing

While the groundwater system at the Oncology Center is a unique way of cooling a building, the heating side of the system includes its own uncommon elements. There are some interesting and underutilized approaches to providing patient comfort.

Two 1.5M Btu, condensing Aerco Benchmark boilers are set up in lead-lag fashion. A 300 mbh, Taco brazed-plate heat exchanger pulls heat from the building's 180° F, 6-in. primary heating loop to supply 120° water to the radiant panels. The 16 small rooms are split into four zones.

The low-temp branch stemming from the small heat exchanger also heats 2,400 sq. ft. of sidewalk outside the main doors. Before the building approach was poured, 4G installed 3/4-in. Watts Radiant PEX+. The concrete is kept dry throughout Montana's October through April snow season; adding further to patient comfort, safety and convenience.

For common areas, offices and supplemental heat to infusion rooms, high-temp water is pumped to the rooftop air handler and multiple VAV Boxes throughout the building. The big primary loop uses a 7.5 hp, VFD-powered Taco base-mounted pump.

The plumbing for the Oncology Center was completed by 4G as well. DHW is supplied by a 100-gal., gas-fired water heater so that the boilers don't need to run through the summer.

Challenges

The groundwater cooling components came together smoothly, and the radiant portions of the project were no challenge for the 4G crews.

"But we were up against a fast-track, nine-month timeline," Hanninen says. "Between drilling, plumbing, heating, cooling and working around other subcontractors, we had our hands full for most of 2013."

Construction for the first phase of the project started late in 2012, and wrapped up this past August. Phase two, which will offer radiation oncology services, is slated for spring completion.

Western Montana doesn't see much seismic activity but Big Sky Country isn't *in*active. At the Oncology Center, seismic restraints were used for potable water lines, and the pumps and boilers were anchored to the concrete slab. On the roof, the large air handler rests on a seismic-compliant Vibro-Curb unit with integral spring vibration isolation.

The big mechanical room provided ample space for the main system components, but in-ceiling space was at a premium. Ductwork left minimal room for hydronic piping, electric, fire suppression and domestic hot water lines.

Three's company

Montana is the fourth largest state by land mass, but it's 44th in total population. A population density of 6.8 inhabitants per square mile simply means dealing with the same folks more often. Rep, installer and engineer relationships are no exception.

"4G works frequently with A.C.E, and it definitely benefits both companies," Hanninen says. "But our rep relationships are just as important. In Montana, we're farther down the supply chain for a lot of things. Nothing is right around the corner, so Jared and I both lean on Dennis Nisbet, at Vemco Sales, a little harder than a contractor in New York might have to."

4G Project Manager, Cory Hanninen programs a VFD during commissioning. Common Ground photo.

"We do our best to be a resource to both firms," says Nesbit, who is outside sales for the 35-year-old Northwestern manufacturer's representative firm. "We get involved in as many projects across the state as we can. A.C.E. usually designs the systems and sizes boilers, pumps, etc. I help them select the appropriate equipment for the application. As you can see at the Oncology Center, we often get into some unique applications."

Nisbet worked closely with Swartz as he did most of the front-end engineering work at the Oncology project. "I think our biggest challenge was staying under budget and ahead of the 12-month design/construction timeframe," Swartz says. "Dennis definitely helped with both, as he does on all our projects." **RJ**

Radiant cooling

Sustainable solution for high-performance building design.

By Devin A. Abellon, P.E.

More and more jurisdictions and building owners are placing increased emphasis on sustainable and responsible building strategies. As a consequence, design engineers are looking beyond traditional HVAC solutions to maximize energy efficiency while maintaining occupant comfort and safety.

A number of innovative systems have been incorporated on high-profile projects to attain LEED certification in recent years. One such system is in-slab radiant cooling, which has enjoyed popularity both in the United States and abroad for many years.

These systems are used for both space heating and cooling. For the former, warm water circulates through a series of crosslinked polyethylene piping loops embedded in the concrete floor. Water flow rate and temperature are controlled to regulate the temperature of the concrete thermal mass. The warmed surface radiates heat to the objects and occupants in the space, creating a comfortable environment.

This same principle is used in radiant cooling. In fact, in most cases, the same series of piping loops can also be used for cooling. The difference is in the temperature of the water being circulated. By controlling the slab temperature, a radiant cooling system can effectively manage all or at least a portion of the building's sensible load, thereby reducing the total demand placed on a forced-air system and saving energy.

Over the past decade, the number of radiant cooling systems designed, installed and commissioned in North America has increased dramatically. Such systems are gaining exposure and popularity for a variety of reasons. They can provide greater architectural freedom, superior comfort and more effective ventilation control. But the main driver behind the increase in radiant-cooling systems design and specifications, however, is the potential for improved energy efficiency.

Radiant cooling systems can reduce overall building energy usage in several different ways.

- First, because the heat transfer capacity of water is much higher than that of air, a radiant system that uses a circulator to move water (in lieu of a fan to move air) can achieve the same heat transfer using significantly less energy.
- Second, because of the way the human body exchanges heat with its surrounding environment, a radiant system can achieve comparable levels of comfort at higher room temperatures; i.e., 78° F/26.6° C).
- Also, the use of higher water temperatures for cooling may allow for more optimum operation of the system's chilled water plant. Other sources for chilled water, such as geothermal systems, may also be used.

Therefore, a radiant cooling system that manages the bulk of the building's sensible loads, coupled with a smaller forced-air system (for ventilation, latent loads and supplemental sensible loads), can significantly reduce a building's total energy usage. Studies have shown total energy savings for typical office buildings on the order of 17% to 53%.

Recently completed Western projects that have incorporated radiant cooling as part of an energy-efficient design solution include The David Brower Center (Berkeley, Calif., LEED Platinum) and the National Renewable Energy Lab (NREL) Research Support Facility (Golden, Colo.; LEED Platinum/Net Zero).

Devin Abellon, P.E., is the Business Development Manager for Engineering Services at Uponor. He has 19 years of experience in the HVAC industry with a focus on high-performance building systems. He is a registered professional engineer in California and Arizona and an active member of the American Society of Heating, Refrigerating and Air-Conditioning Engineers as well as the American Society of Plumbing Engineers. He is an ASHRAE regional vice chair in Region X, programs subcommittee chair for ASHRAE TC 6.5 and an ASHRAE distinguished lecturer. He can be reached at devin.abellon@uponor.com.