CONSIDER THE **RADIANT HEATING AND COOLING** ALTERNATIVE

GLUMAC DESIGN STRATEGIES

Architecture firm **Gensler's** downtown Los Angeles office features **ceiling- mounted chilled sails.** Chilled water is passed through copper piping, and the metal ceiling panels disperse the energy, then uses radiant cooling to provide comfort to the occupants.

EFFICIENCY FOR INTERIOR CONDITIONING

RADIANT HEATING AND COOLING

Circulating heated or cooled water through existing surfaces and structures (floors/ walls/ceilings) to absorb or release radiant energy to condition a space and to raise or lower air temperatures

Although an old technology, radiant heating and cooling presents an increasingly popular choice within many modern building designs. Where 100 percent air systems utilize convection primarily to heat or cool a building, radiant technologies condition spaces through a combination of radiation and convection. Radiant systems can significantly reduce energy consumption while providing superior comfort for occupants. Applications include in-slab radiant floors and ceilings (activated thermal mass) and overhead chilled elements. Ideal scenarios for radiant floor cooling range widely – from any indoor space with controlled conditions to those with a connection to outdoors (in climates with low summer humidity) such as entrance lobbies. Active or passive chilled beams also offer an efficient cooling alternative, particularly for spaces with high cooling needs, programs that require room-by-room control, or building operations where it is feasible to decouple

Energy savings for both heating and cooling can be achieved with **radiant flooring.** Water is run through HDPE tubing cast in underfloor concrete, and requires about one-seventh the amount of transport energy of a forced-air system.

(at a zone level) the cooling and heating loads from the central system.

OVERHEAD RADIANT SYSTEMS

Overhead radiant systems – integrated into ceilings or suspended below the ceiling plane – provide surface area for both radiant and convective conditioning. The amount of space required depends on the type of equipment. Occupants also experience the radiant effects, improving comfort levels.

According to rated capacity per area, overhead radiant falls into four categories: flat panels, chilled sails, passive chilled beams and active chilled beams. Passive chilled beams deliver significantly more capacity per unit area than flat radiant elements and function much like a radiator, circulating tempered chilled water to produce both a radiant and convective cooling effect. As air comes in contact with the chilled beam, it becomes more dense and falls through the beam, inducing air flow through the coil. Glumac designers use passive models strictly for cooling. Active chilled beams provide the highest capacity per unit area. These devices cool entirely by forced and induced convection, with the chilled beam connected to the ventilation air system and supplying air directly into the space. Similar in nature to induction units along the perimeter of many high-rise office buildings of the 1970s, this technology fell out of favor because the equipment took up floor space. Today's active chilled beam, however, achieves comparable energy efficiency and comfort levels without reducing floor area.

RADIANT FLOORS

In commercial construction, the composition of in-slab systems usually includes HDPE tubing cast in concrete. Water flowing through the piping becomes the transport medium to heat or cool the floor surface and condition the space above. In heating mode, radiant floor slab systems increase the mean radiant temperatures of served spaces; as a result, space air temperatures can be set as low as 65°F (18.3°C) and still maintain excellent comfort during heating seasons. Although less common, radiant floors also provide cooling quite successfully. Tempered water that is 60°F (15.6°C) circulates through the floor slab and is maintained at a surface temperature slightly higher than the room dewpoint. This temperature becomes the limiting factor on cooling capacity — important in preventing condensation on the floor.

In both heating and cooling modes, radiant floors consume less energy, requiring about one-seventh the amount of transport energy to pump water versus moving air with a forced air system. While conventional systems utilize 48°F/8.9°C for cooling and 140°F/60.0°C for heating, radiant systems narrow that range to 60°F/15.6°C water for cooling and 90°F/32.2°C for heating. This capability facilitates the use of earth coupling, super-efficient condensing boilers, nighttime evaporative cooling with cool water storage, and solar supplementation.

PROCESS/TOOLS

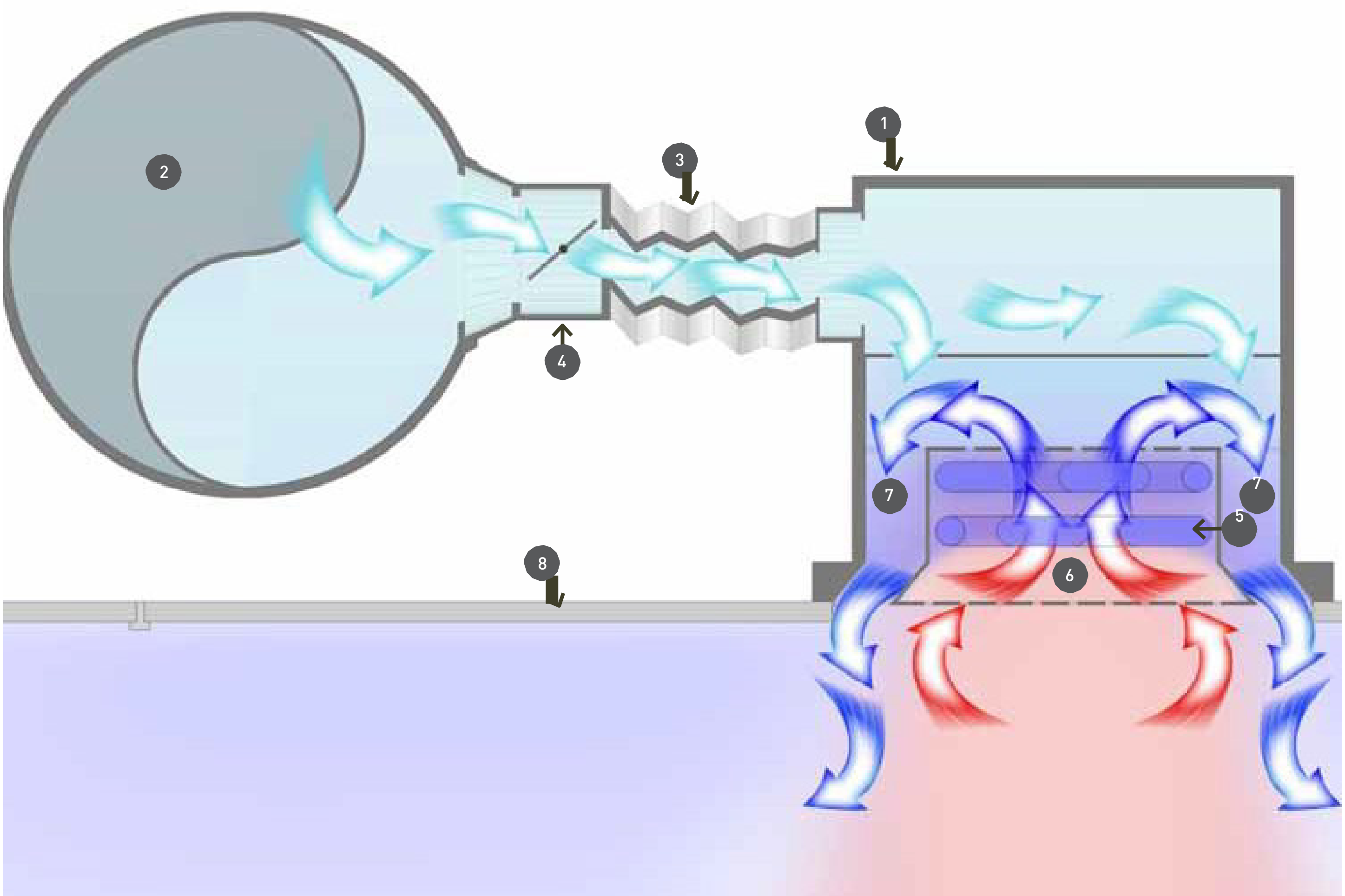
Glumac's design process begins with a finite element analysis to determine the cooling capacity of a radiant floor system. Because humidity control tends to be difficult in entrance lobbies and similar spaces, engineers work to ensure the supply air's dewpoint falls below the radiant element surface temperature to avoid condensation. Capacity of the radiant element then becomes a function of a surface temperature above this dewpoint. Determining surface temperature can inform load calculations and control sequences to ensure a floor system is operating within design parameters.

One challenge in configuring overhead radiant systems involves economically defining the number, size and placement of radiant elements necessary to meet the cooling capacity and comfort needs of a building space. Flat panel sizes in a passive radiant system, for example, run the risk of being so large they dominate the ceiling plan. Similarly, while higher capacity chilled beams require less area, their high unit cost requires careful consideration related to budget. To optimize

LINEAR ACTIVE CHILLED BEAM AIR CIRCULATION

1. linear active chilled beam
2. fresh air supply duct
3. flex connection
4. volume damper
5. cooling coil
6. warm air recirculated through cooling coil
7. recirculated air mixed with fresh outside air & supplied to room
8. suspended ceiling

Lower Energy Higher Output: Integrated with a building's primary ventilation air supply, active chilled beams deliver higher air velocities and more cooling potential (about two times higher) than passive systems. Primary air passes through an induction nozzle, inducing additional airflow from room air (secondary air) through the cooling coil and down to the conditioned space.



a radiant system, thorough analysis may include both CFD modeling and comfort analysis using a tool like the Center for built Environment's Advanced Human Thermal Comfort Model.

FURTHER DESIGN FACTORS

All radiant installations require a ventilation system as a source of outside air for occupants. In winter, a radiant floor can provide 100 percent of the heating capacity for most spaces; during warmer weather, it may support approximately two-thirds of space cooling, with the remaining one-third handled by the air system.

Overhead radiant systems also have limits. Maximum cooling capacity varies from approximately 10 to 250 bTU per hour per square foot (32W/m2 to 2,700W/m2) of installed device. For low density devices in particular, perimeter loads on a building's south and west sides often exceed capacity, making supplementary cooling necessary. However, where designs limit glazing to 30 percent of the building façade – and by incorporating shading devices – radiant ceilings may provide adequate cooling for both perimeter and interior spaces. Evaluating whether to install active or passive chilled beams comes down to cost, energy efficiency, cooling capacity and the aesthetic goals of a space. Passive systems perform well for applications requiring very low loads per square foot/meter and along perimeter spaces with a high performance envelope or glazing, well-shaded exposures, etcetera. Alternatively, active systems deliver a higher volume of air and more cooling capacity while utilizing a smaller panel area. G

RADIANT HEATING AND COOLING

1. passive chilled sails
2. chilled ceiling
3. active chilled beams
4. underfloor air distribution in open office area
5. perimeter convector
6. atrium with stack ventilation
7. skylight with motorized windows for natural ventilation

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