

# Solar Efficient Building Uses Energy And Cost Efficient Thermally Powered VAV Diffusers For Cooling

WINSLOW, Washington—Architects living in solar buildings of their own design had better be on their toes. When Washington state architect John Rudolph designed the Solarmarine Building for his own use as well as for rental space to other tenants, he realized that his skills would be judged on his ability to maintain energy efficiency and comfort levels in the new building.

Therefore, in addition to using solar energy for heating, Rudolph incorporated many other design features and pieces of equipment designed to promote comfort and energy efficiency. Thermally powered VAV diffusers are one of the more important elements in this mix.

"When Dick Stern, my mechanical engineer, described Acutherm's Therma-Fusers to me, I knew that they would be ideal for my building," says Rudolph. "These units enable me to provide individual temperature control for comfort, and significantly reduce the wear and tear on equipment as well as maximizing cooling efficiency by making possible use of low pressure in the ductwork. In addition, Dick determined that the installed cost of Therma-Fusers would be, at most, half that of other alternatives."

## A place in the sun

The Solarmarine Building comprises three floors, the upper two overhanging the first floor, totalling 11,000 sq. ft. The first floor is a daylight basement of 2,500 sq. ft., glassed on the south side. The second floor, at 3,500 sq. ft., overhangs the first, and the 4,000 sq. ft. third floor overhangs the second.

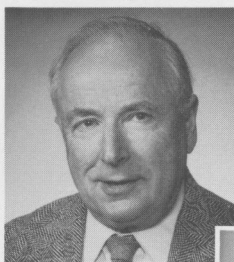


The wood frame, wood siding building incorporates windows on the north and south sides that account for approximately 20 percent of the building's wall surface.

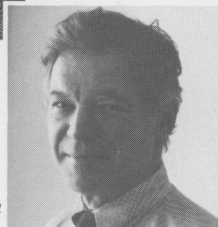
In terms of winter energy efficiency, the glass surfaces create warm air on the south side that is drawn into the air conditioning system, mixed to the proper temperature, and distributed to the office spaces. In addition, the system picks up heat from the fluorescent lighting, human bodies and other sources. During the summer, the overhanging floors on the south side shade the glass.

The building was designed to incorporate Therma-Fusers from the beginning. Accord-

ing to Stern (TML/Stern Engineers) the alternatives were either fan mixing or standard VAV boxes. Unfortunately, standard VAV would have been difficult to implement with the solar air conditioning system. Installation costs for a fan mixing system were prohibitive, and neither system provided the flexibility that Rudolph wanted.



Dick Stern



John Rudolph

"I didn't want to incur major costs every time a new tenant moved in or an existing tenant remodeled," he says. "Because thermally powered VAV diffusers require no pneumatic controls or electrical connections, they can be moved quickly and easily, and at minimal cost."

## How it works

Sensors and a computer determine the operating mode for the Solarmarine Building, based on the sunny, south side exposure. Therefore, the entire building is either in heating or cooling mode. When cooling is required by the south side, northern exposures are heated, if necessary, via radiant panels.

A heat pump is located on the building's roof and connects with a central supply shaft located adjacent to the central stairwell. Up to 100 percent outside air can be brought in, if necessary. Conditioned air moves through the shaft propelled by a single fan unit. Air is delivered to horizontal ductwork running the length of each floor, which terminates in Therma-Fuser thermally powered VAV diffusers. These diffusers are controlled by the temperature in each space, which is maintained to within two degrees of the set point.

The low velocity ductwork system is sized by static regain. According to Stern, low-pressure systems are much more economical than high-pressure systems.

"While standard VAV boxes can be contrived to work in low-pressure environments," Stern says, "thermally powered VAV diffusers deliver their best performance in such environments and, once again, facilitated an energy-saving feature."

Static pressure is controlled via a bypass damper located in the ceiling space of the second floor. The individual space duct runs terminate in Model TF-CW heating/cooling Therma-Fusers. The building contains approximately two diffusers per space, for a total of 54 units.

The building runs on a full economizer arrangement, where heating and cooling is determined by return air sensing. The system provides three phases each of heating and cooling, as well as a neutral recirculation phase to achieve this economy. The thermally powered diffusers, which open and close in response to space temperature, work nicely in such an arrangement. Typically, unit efficiency is high, maintaining temperature to within two degrees of the set point.

## Benefits

Several first cost benefits were attained by using thermally powered VAV diffusers. Installation costs ran approximately \$44,000 as compared to an estimated \$57,000 using standard VAV. To get the same number of zones with standard VAV would have cost twice as much, and fan mixing three times as much as the current diffusers.

However, Rudolph states that even if the Therma-Fusers had been more expensive, it would have been worth the cost. "Comfort is extremely important to me and to my tenants. After all, my reputation as an architect is on the line. I have been able to provide individual temperature control at a moderate cost, and there is no dumping, no stagnant air and no operating noise, thanks to the Acutherm design."

Perhaps the lion's share of cost savings are in the operations arena. Rudolph estimates that his total energy bill (heat, lights, hot water, ventilation) would have run around \$1,000 a month without thermally powered diffusers. However, the bills now run around \$600 a month, and sometimes drop as low as \$400. In addition, there is less wear and tear on the fan motors, which means that expensive equipment lasts longer.

"I'm really pleased with the performance of the Solarmarine Building," says Rudolph. "And the thermally powered diffusers play an important part in providing both comfort and efficiency."



2000 Powell Street, Suite 1290  
Emeryville, CA 94608  
(415) 428-1064