Climate Control Systems Design and Climate Change

By Ernest A. Conrad

The Past

Over the last twenty-five years of designing climate control systems for all sizes and types of facilities situated in both the northern and the southern climates of the United States, I have noted that no specific design criteria relating to temperature or relative humidity changes have been identified by the various engineering standards agencies—such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)—instructing designers to adjust their designs to address the impacts of climate change. Even so, the same agencies have been changing their design strategies dramatically to focus on all of the sustainability elements, especially those of energy conservation. Why? The ASHRAE published design weather data show no change in weather conditions over a thirty-year period, yet we are being told to conserve. It appears that ASHRAE fears the potential of climate change. The elimination of chlorofluorocarbon (CFC) refrigerants is an example. To the U.S. Green Building Council, the answer is obvious. They fear the changes occurring as a result of climate change; these are ice caps receding and air pollution levels spiraling upward. This paper explores a question—What if a 1°C global temperature increase should occur? How would that increase affect the roles of those of us working in the profession of preservation?

It's Always Been Preservation

In over twenty-five years of designing climate control systems for the preservation of collections and historic buildings, I have seen that our basic rules of the road have never changed. The rules have been to preserve our heritage through a balance of protecting the fabric of the historic building as well as the collections it holds with the comfort needs of its occupants. *The New Orleans Charter for Joint Preservation of Historic Structures and Artifacts* (formulated in 1990–91) was created to promote this philosophy. And even before that, the secretary of the interior's guidelines have been on the books for over fifty years; they state that historic buildings must be preserved—and preserved in a respectful way. These philosophies have always embraced sustainability by their focus on saving existing materials rather than discarding them and putting back new materials.

Design Criteria

As mechanical engineers, we look at statistical weather data to determine the heating and cooling loads imposed on the buildings we design. The weather data we use most are published by ASHRAE; they consist of a rolling thirty-year average of weather conditions. In reviewing this weather data—published in 1950 and 1980 and again in 2005—I have seen no changes in temperature conditions or rainfall averages. However, data being published relating to airborne pollutants reveal a serious concern.

What If?

Imagine a 1°C increase in these thirty-year average conditions globally. Scientists are now predicting enormous ecological changes. But what would we see happening in our small corner of the world of preservation? From a climate control systems design standpoint, a 1°C change in outdoor weather is insignificant to a modern well-financed museum that has complete year-round precision heating, ventilating, and air-conditioning (HVAC) systems. Yet other, less-financed facilities do not have the luxury of substantial budgets and precision heating and cooling systems to achieve year-round constant climate control. From our work in historic buildings of institutions in the heating climates of North America, we usually see heating systems installed, but cooling systems are not the norm. For cooling, at best we will find one or two small window air conditioners located in the staff office and sometimes in a small storage room.

We consider it likely that if a 1°C rise in temperature occurred (or if the temperature rose even a few more degrees), such a facility would continue on and try to cope with the situation. The heating costs in winter would be less—or would they be? What would happen to energy costs throughout the year? What would happen to preservation costs?

Three Major Problems

Humidistatic Heating Effectiveness

Humidistatic heating has been a great low-cost way to preserve artifacts and historic buildings over much of the nine-month yearly heating cycle in northern heating climates. Humidistatic heating has used low-level heating as a means of controlling relative humidity without the risk of adding active humidification in buildings not capable of accommodating it without condensation damage. Any increase in outdoor weather temperature would reduce the number of hours of cold weather during which the use of humidistatic heating would be of benefit.

Summer Humidity Increase?

If the planet warms up, will the amount of moisture in the air increase? It stands to reason that it will. It is very possible that the tropical regions will expand and the heating-climate regions will decline. Such changes would mean that there would be an increase in the number of less financially supported historic buildings in the enlarged tropical region. The existing facilities, as well as facilities in the then-expanded tropical region, would become more susceptible to deterioration from increased exposure to warm and wet weather, which causes mold and rot in the absence of summer cooling and reheat dehumidification systems. To prevent these adverse effects, such institutions would need to introduce new climate control systems and would need to devise new ways to pay the increased energy bill. For some, such demands could break the budget.

Dehumidification Needs Increase Global Warming Spiral

In recent years new technologies have emerged to help keep the energy cost of dehumidification relatively low. Even so, for many institutions, the cost is more than they can afford. As more and more institutions decide to install dehumidification systems on a building-wide scale, such systems will increase the global use of energy. As a result, supply and demand forces in the open market will recognize this new demand, and the spiral of energy demand will help make energy costs soar.

Also, there may well be a spiral effect of a global increase in energy consumption from increased air-conditioning demands for basic cooling. Without even greater pollution controls on electric power plants, even more pollutants will be released into the air.

Speaking of Pollutants

Twenty-five years ago, we recommended adding only gas phase filtration systems to museum facilities with holdings of objects considered "the rarest of the rare" in densely occupied cities of the United States such as New York, Boston, Chicago, and Philadelphia.

Today it has become the norm to recommend at least a minimum level of activated carbon filtration for outside air introduced into any major museum facility. Building codes now recognize that outdoor air can be of lower quality than indoor air at times of high-vehicle, rush-hour traffic. Consequently, codes now allow "demand ventilation" systems, which shut off the introduction of outdoor air into a building unless the indoor carbon dioxide levels rise above prescribed limits.

There is no question that pollutants such as sulphur dioxide, ozone, oxides of nitrogen, and unburned carbon from internal combustion vehicles are plaguing our museums as well as our workplaces and homes.

Water, Water Everywhere

Believe it or not, water is a fixed resource on this planet, and water availability is changing very rapidly. Polar ice caps are melting, and the aquifers beneath us are being sucked dry by wells. I also see the museum industry using more and more reverse osmosis to filter water for use in humidifiers—an extremely wasteful practice. The process wastes a significant amount of the water it uses to backwash itself. This waste has a significant impact on groundwater levels and drinking water availability. For example, in arid regions such as Arizona, such waste is part of the cause of extremely low groundwater levels.

What about Weather Extremes?

Although an increase in average global temperature of 1°C might not have a great impact on the energy bills of many preservation institutions, its effects on their disaster plans and catastrophic insurance costs will be a major concern. Hurricane Katrina was only a warning to us—there is more to come. Extreme weather changes caused by global warming are the most serious concern for all institutions, no matter where in the world they are located. We have only begun to see the might of destruction in regions known for their weather-related high risk. What will happen in these high-risk regions as their populations continue to expand? An increase in extremes of weather is far more dangerous to our historic infrastructure than is a small ambient temperature increase.

A Slow but Good Start

A new movement in sustainability has begun. We are now encouraging clients to go green, and they are, slowly but surely. Geo-exchange projects are becoming very popular, and photovoltaic electric power is right behind. We are now using gray water for reuse—a practice that was a code violation not long ago. New HVAC energy saving techniques are now the norm; they incorporate hot refrigerant gas reheat, heat recovery, variable speed controls, and many more features. The agencies endorsing this movement include the Environmental Protection Agency, in their Energy Star program; various utility companies; and the U.S. Green Building Council, in their Leadership in Energy and Environmental Design (LEED) program.

Conclusion

It seems that a global program of sustainability is needed. It is not enough to reduce the rate of damage that civilization is inflicting on the globe; rather, a program of reversing the damage is urgently required. A zero carbon emissions program will not, in fact, be sufficient. What will be needed is an aggressive campaign to reverse the global damage inflicted since Drake first discovered oil in 1859. It will only take 200 years for civilization to consume all the oil created by plants and dinosaurs over 500 million years!

Author Biography

Ernest A. Conrad is president of Landmark Facilities Group, an engineering and design firm based in Norwalk, Connecticut, that specializes in museums, libraries, historic structures, and their collections. A graduate of Drexel University, Philadelphia, with a master's degree in environmental engineering, he has been involved in the design of climate control systems at a number of U.S. cultural institutions, including the National Gallery of Art, the Metropolitan Museum of Art, the Frick Collection, and the Library of Congress. Conrad is a licensed professional engineer and a LEED Accredited Professional.