In Pittsburgh, the sixth and final office building is now being built in the Gateway Center. When it is finished, a major phase of the famous Pittsburgh Renaissance will have been completed.

The new building was dedicated last August and will be owned and operated by the Equitable Life Assurance Society of the U.S., developer of Gateway Center.

When the Pittsburgh rebirth began, Equitable purchased the land at the confluence of the Allegheny and Monongahela Rivers — an area at that time covered with ramshackle warehouses, bars, and places where people did things they wouldn't tell their mothers about.

Equitable, working with Pittsburgh's planners, laid out a six-building scheme which stretched from three buildings on the north to the final, sixth building, on the south.

Each of the six buildings, as it turned out, was to have unique qualities. The first three Gateway Center Buildings were cruciform in design — to capitalize on the unique scenery. In these buildings, just about everybody has a window with a view. Four Gateway Center is an award winner, outstanding for its creative use of glass. The IBM Building, Five Gateway Center, is creativity in steel. It is supported by the ground at only eight points, and uses high-alloy steels in its lower floors to supply strength without excess weight or bulkiness. . . . a real accomplishment in steel.

The sixth Gateway Center Building — the Westinghouse Building — will be suitably enough, an accomplishment in electricity. It is total electric. It has high, modern light levels. It has a very sophisticated and yet simple mechanical system. And above all else, it costs no more to build, and will cost less to operate and maintain. Like each of the other Gateway Buildings, the Westinghouse Building is something special.

Model of the Westinghouse Building now under construction in Pittsburgh's Gateway Center. Building will be owned and operated by the Equitable Life Assurance Society of the U.S. Thirteenth floor will house the building's air handling systems and other auxiliary mechanical equipment.
Westinghouse Building

The basic floor plan of the building is one which has proved both practical and popular. In the center are the elevators and other services. Surrounding them is the core — an open floor in which secretaries and others will work. Around the perimeter of the building are the executive offices. The architect has used a 4½-foot modular design, allowing the building owners to make any number of changes in office layout to suit the changing needs of tenants.

From an environmental control point of view, there is basically just one problem. Summer, fall, winter, and spring — heat must be moved.

Except in the most extreme cases of below-zero cold, the core area always has too much heat. The perimeter offices, on this other hand, have a definite seasonal problem. During the winter they lose heat through the walls and windows. In summer, they build up too much heat, although the building uses double-gazed solar glass to minimize this problem.

Basicall, an environmental system was designed which will almost always be moving heat out of the core area... and which will either move heat out of the perimeter area, or into it. It's useful in this connection to remember one fundamental piece of physics: Coolness is a negative quantity; it is a lack of heat. When a room is air conditioned, coolness is not moving in, but heat is moving out. So basically, the environmental engineering problem is largely one of moving heat from where it is not wanted to where it is wanted.

Sources of Heat

The Westinghouse Building — like many other very modern buildings — has many built-in sources of heat.

The largest constant source of heat is the lighting system. In this building, the smaller executive perimeter offices (normally 13½ x 13½ feet) will enjoy a minimum of 150 footcandles, and the open core areas will often average from 200 to 225 footcandles. These levels conform to the most recent recommendations of the lighting industry. The high lighting levels are one of the chief attractions of the building. These levels of lighting bring a bonus in heat. Less than 20 percent of the electrical energy which flows into a modern fluorescent lamp emerges as useful light, the other 80 percent is directly converted to heat. It has been correctly observed that lighting fixtures are excellent electrical heaters.

People are also a source of heat, as are all the many forms of office machinery which populate today's clerical work areas. This is why the core area especially has more heat than it needs — even during the winter. It has many heat sources, and no exterior walls to drain the heat away. During winter, the opposite is true in the perimeter offices.

In the Westinghouse Building, all these heat sources add up to enough heat to take care of all the building's heating needs some 95 percent of the occupied time. Obviously, a traditional heating system is not needed. What is needed is a way to get the heat from the wrong places to the right places.

Ideally, the excess heat should be taken from the core and moved to the perimeter office during the winter, or into a storage system where some of it can be saved to heat the building at night and on weekends. Also, it might be necessary, at times, to get some of this heat out of the building entirely — just dump it. The last of these choices is, of course, the process of air conditioning; not moving coolness in, but moving heat out.

![Figure 1. Water-cooled light fixture.](image)

**Water-Cooled Lighting**

This "heat transferring" is started at a very logical place — the lighting fixtures (Figure 1). In the Westinghouse Building, these fixtures will be water cooled. A little less than a gallon of water per minute will pass through tubes which are an integral part of each fixture. The water will pick up heat from the fixture and carry it away, thereby sharply decreasing the amount of heat...
which would otherwise escape from the fixtures into the surrounding area. In the process, the water temperature in each lighting module will be increased by nine degrees.

The water passages in the fixtures are made of thin bonded-steel sheets (forming the housing) that have a high rate of heat transfer.

The lighting cooling system is modular in design. The basic water circuit consists of three to five fixtures connected in series. A minimum of 70 percent of the electrical energy fed into the lights is picked up by circulating 0.8 to 0.9 gallon of water (per minute) at 70 degrees, through each light-fixture circuit. Most of the remaining energy is converted to visible light.

While still producing the light levels desired, only 30 percent of the normal electrical heat enters the space. While 7.1 watts per square foot is fed into the system, only 2.1 heat-producing watts enter the area.

The thirteenth floor of the Westinghouse Building has been set aside as a mechanical room — housing the air-handling systems and other auxiliary mechanical equipment. The building is 23 stories tall, including an open lower level. So the thirteenth floor is midway — ten floors above, and eleven below.

The heat-removal system for the lighting is divided into two closed-loop water circulating systems (Figure 2). The water used to cool the lights is circulated up 10 floors through about 490 light fixtures per floor and returned to a heat exchanger on the thirteenth floor, carrying with it nine degrees of heat from the lights. The water in the lower loop is circulated down eleven floors through about the same number of fixtures per floor and again carried back to a second heat exchanger. The heat exchangers remove the heat from the lighting system, and send the water back toward the fixtures at its original 70 degrees.

The heat has now been transferred to a second water system. This second system operates at considerably lower temperature. The cooling water enters each light heat exchanger at 55 degrees. After the excess heat has been added to it, the water leaves the heat exchanger at 57 degrees. Having removed much of the excess heat from the wrong places, it must now be put in the right places.

**Heat Pump**

This process begins by taking the heat away from the thirteenth floor to the basement mechanical room which contains heat pumps. The heat pump is essentially a device which moves heat from one place to another — and so is tailor-made for the needs of the building.

The heat which has just moved downstairs in the chilled water system at 57 degrees enters the heat pump and is extracted from the water. Now the heat originally removed from the lighting fixtures is in an energy level to be used. It can either be dumped or sent back into the building to the right places.

**Air Distribution System**

Remember that the lighting fixtures are not the only natural source of heat in the building — even though they are by far the prime source. There is still heat generated by people, by machines, by the radiant heat which light fixtures give off, and in summer, by external heat.

This excess heat is picked up by an air distribution system, which supplies air to — and draws air out of — both the core and perimeter areas (Figure 3).

The air in the building is completely changed at least eight times an hour — and some locations will enjoy an air change 14 times an hour. This is two to three times better than many modern office buildings. The air is also treated to remove pollen and decrease humidity.

The rapid rate of air turnover eliminates smoke and other fumes that often linger when other systems are used. There is no “changeover” period when the system is changing from winter to summer, or summer to winter operating conditions — the air-handling system provides heating and cooling capability every hour of every day.
As the air system draws air out, it takes heat along with it. The return air is carried through ductwork to the thirteenth floor where the air-handling blowers are located. At the blowers, some of the circulated air is bled off and replaced with fresh air. The bled-off air, at about 75 degrees, is sent down to the underground parking garage, to help warm it in the winter, and cool it in the summer.

To complicate matters, the external environment adds a wide variable. The incoming air in Pittsburgh can vary in temperature from a low of −10 degrees to a high of 95 degrees. The typical mixed and freshened air returned to the air-handling system can vary all over the lot in temperature, from low of about 45 degrees to a high of about 85 degrees. This isn't desirable. To cool the building the air should be at 60 degrees, and to heat it, the air should be at 87 degrees. In the Westinghouse Building, however, two outdoor air systems precondition the outside air by filtering, humidifying, or dehumidifying, heating or cooling the air to a constant 60-degree temperature. This preconditioned air is introduced into the main cold duct leaving the cooling coils.

**Double-Duct Air Circulating System**

The problem is handled by splitting the moving air into two ductwork systems — called a double-duct system — one of which passes through heating coils, and the other through cooling coils.

A source of heat is needed for the heating coils and a source of cooling for the cooling coils. The heat pump supplies both. The heat-pump system is connected to the cooling coils in the cold side of the air distribution system. Water coming from the cold-water side of the heat pump at 45 degrees extracts a sizeable amount of heat from the air passing through the duct. This reduces the temperature of the air in this half of the recirculating system to the required 60 degrees, and the heat removed is carried — by way of a side trip through the lighting system — back to the heat pump.

The heat pump now has removed heat both from the lighting fixtures and from part of the recirculating air. Consequently, it now has at its disposal a large amount of heat.

In the winter, all or most of this heat is sent right back into the building, by connecting the hot-water side of the heat pump to the air-heating coils in the other half of the double-duct system. Thus the temperature of this air is raised to 87 degrees, about the same temperature at which air is obtained from a traditional furnace system... except that here a heat pump instead of a furnace is used.

In summary, heat is extracted from the lighting fixtures and brought down to the heat pump. Heat is also extracted from the air moving through one side of the double-duct recirculating system.

These two sources, with rare exceptions, supply all the heat required to handle the building's needs... even in midwinter. In fact, all the heat that was originally in the building is retained, except for the amount lost in exhausting bled-off air or through normal building losses.

Some kind of energy conservation and heat redistribution is essential in making an electric building economically feasible.

Some additional details of the air-handling system deserve a closer look. First, recall that in the double-duct system one duct carries air through the building at 60 degrees and the parallel duct carries air at 87 degrees.

Throughout the building are mixing boxes, designed to mix the hot and cold air (blended, tempered air) to meet the exact needs of each perimeter office, and each modular area of the core. Air is supplied to the core through a network of small, flexible ducts connected to air diffusers in the lighting fixtures. The perimeter offices have air diffusers located below each window. Air is returned, through linear slots in the light fixtures, to the ceiling plenum and the central system. Whether a particular light fixture is used to take in or distribute air, or both, depends on the needs of the area where that fixture is located.

The system is designed so that partitions can be freely moved without regard for the air-handling system. And both the mixing boxes and low-pressure linear air diffusers in the light fixtures are acoustically isolated so that there is a minimum of air noise.

The ventilation rate (outside air), for both perimeter and core, is approximately 25 cfm per square foot. Each mixing box (one is located every 31½ feet on the perimeter) is thermostatically controlled. If an area needs heat, it allows more air to be drawn in through the hot-air half of the double-duct system. If the area needs more cooling, the thermostat triggers the mixing box to draw more air in from the cold duct.

On hot summer days, the thermostat does not call for much heat from the hot duct. Thus, there is a generous surplus of heat, which is not wanted. So when that heat arrives at the heat pump on this hot summer day, it is diverted into a river water condenser system which exhausts the excess heat into the central plant.

**Subsystems**

There are a number of subsystems which are part of this scheme, and should be mentioned.

Two subsystems (Figure 4) make additional use of the heat sent through the coils in the hot-air half of the double-duct system. That heat comes from the heat pump at 105 degrees. It returns to the heat pump at 95 degrees... but before it does, it passes through two heat exchangers.

The first heat exchanger picks up some of the leftover heat and applies it to preheat water for the building's domestic hot-water system.

The second heat exchanger transfers heat from the
return hot-water system into a storage tank containing 150,000 gallons of water. The water is heated in that tank to approximately 90 degrees. Then at night, when the lights are off and the people gone, this heat is extracted and put back into the building. Enough heat is stored in the water tank to keep the building warm through a two-day weekend — but not through every three-day weekend.

To take care of that occasional third day in the winter, or when temperatures dip well below zero — there is an auxiliary system, consisting of two small electric boilers. Located in the basement, near the heat pumps, they comprise the only resistance heating in the central system.

Actually there are four double-duct air-supply systems — each serving one quadrant of the building. On the thirteenth floor, two high-pressure air-makeup systems pump fresh air, at 60 degrees, into the cold side of the four high-pressure systems.

All the air-handling equipment is confined to the one mechanical room and the ductwork is installed in the usual way.

At the ground level are two large Westinghouse heat pumps, supplemented by two centrifugal chillers which operate only as air conditioners.

As a result of using water to move heat instead of relying completely on air-handling system, the capacity of the air-handling system is reduced by 360,000 cubic feet per minute to about 440,000. Elimination of the larger ductwork and air-moving equipment cut about 37 feet off the height of the building, greatly reducing construction costs. Also, it made available for rent another 4000 square feet of floor space that would have been used to house larger shafts for duct risers.

In fact, calculations show that the water-cooled lighting system saves not only on initial cost (reducing installation of ductwork and other air-handling equipment), but also saves some $13,000 a year in operating cost . . . the money it would have cost to move all that extra air around.

**Computer Studies**

It should be emphasized that these figures are not guesswork. Thanks to modern computer technology, more is known about this building — which is not yet standing — than is known about most buildings which have been standing for years.

Not the least important aspect of the building is the fact that up-to-the-minute computer technology has been applied to its development. When it first became definite that Westinghouse was to be the prime tenant of this new building — in fact, that this was to become Westinghouse executive headquarters, it was natural that a total electric building was considered. But neither Equitable nor Westinghouse was interested in paying a premium price.

Using the computer, cost comparisons were developed between conventional systems and total-electric systems. The computer studies indicated that by using the system described there could be a total electric building, with its higher lighting levels, without additional capital investment or higher operating costs.

The sequence of events leading to the owner's and architect's decision to go all-electric involved the use of computer technology almost 'every step of the way. It pooled the engineering and design talents of Equitable, Meyer, Strong and Jones, Harrison-Abromovitz and Westinghouse.

First it was determined what cost per square foot could be tolerated and still generate sufficient income in rental. After an initial site review, the architect, Harrison-Abromovitz, drew up several preliminary building designs. These called for a structure 100 x 200 feet in cross section and about 25 stories high.

This preliminary design of information on the building was programmed into the computer. This included structural details — for example, the heat transfer characteristics of the glass and aluminum required — the lighting and occupancy levels, the use of space, the physical orientation of the building, and the average outside temperature for every hour of a typical year. The computer determined the heating and cooling loads for each exposure of every floor throughout the general commercial area, for the plaza, and for the rental spaces in the lower levels. The studies showed, for example, that a particular room on the sixth floor . . . at three o'clock on an average June day . . . would require
18,852 Btu's of air conditioning over an hour's time.

Once the heating and cooling data was obtained, four basic mechanical and electrical systems were designed. The four systems evaluated were an induction system; an all-air system with conventional lighting; an all-air system with water-cooled lighting; and an all-air system with water-cooled lighting and heat storage capability. Needed modifications in building structure were made for each design. As an example, the all-air system with conventional lighting required two air-handling mechanical rooms to house equipment, while the final design needed only one.

These four mechanical designs were computer-reviewed to determine what energy requirements they would have, while still staying within the economic limits previously established. The computer showed the difference between the energy requirements of each system, since this was the only variable allowed.

The computer ran each of the proposed systems through a normal year of operation — 8760 hours. Typical information used by the computer included occupancy hours, cleaning schedules, vacation periods, internal usage of the building, and actual reported hourly temperatures — it even took into account the atmospheric haze that affects the intensity of solar radiation. The computer determined the energy performance capabilities of each of the mechanical-electrical systems. It produced detailed information on the heating and cooling loads of every area of the building at every hour of every day of the year. Dozens of engineers would have to work for several years to develop the same information using traditional methods.

Using the computer readout, the Duquesne Light Company determined the operating costs of the various systems — with both steam and electric energy. Also using the computer results, the consulting engineer, Meyer, Strong and Jones, working with the architect, prepared detailed specifications for the equipment required by the four systems. Finally, a local contractor, George A. Fuller, determined installation costs.

Armed with this total economic picture — both installation and operating costs — all parties agreed that the best choice was a building using an all-air system with water-cooled lighting and heat storage capability.

Other valuable design decisions were also made based on the computer studies. For example, the information dictated a reduction in the amount of glass ... to about one-third of the total wall surface. As a result, the architect economically justified and specified double-glazed solar glass. Reducing the amount of glass, and going to double-glazed solar glass, went a long way toward making the total electric concept feasible — and made no change in the basic beauty of the building.

The computer information not only helped the architect and engineer, but most important of all, it gave assurance that the total electric building was economically attractive in the rugged Pittsburgh climate.

The value of the studies will not end when the building is built. Additional valuable data in on hand; for example, the heating, cooling, lighting and air-handling requirements are available for every office configuration that can be designed from variations of the basic 4½-foot-square modules, in case the offices are remodeled or redesigned.

This use of computer technology was by no means an experiment. Computer engineers at Westinghouse began three years ago to offer this kind of service to all parts of the construction industry. When time came to examine the Westinghouse Building, the Company decided to use it own service.

Today, the new Westinghouse Building is an artist's drawing ... an excavation ... some steel structure climbing steadily higher. But soon — sometime early in 1969 — nearly 800 Westinghouse executives will move in, knowing they are enjoying the most modern office facilities in Pittsburgh, and perhaps in any city.