



Owners And O&M

By **Wayne Webster**, Member ASHRAE

To ASHRAE members, O&M means operations and maintenance, but it implies owning and managing to most real estate professionals. The two disciplines overlap and complement each other. The following article demonstrates the importance and value of a technically trained owner who also fills the role of facilities engineer, and provides direction to operations and maintenance staff, and service contractors.

The building structure under review is comprised of 11,600 ft² (1078 m²) of commercial space at the street level, 119,600 ft² (11 114 m²) in the residential tower, 28,900 ft² (2689 m²) of basement/parking garage and 2,100 ft² (193 m²) of penthouse equipment room. It was built in the Central Business District of Kingston, ON, Canada, as a university student residence and opened fall 1972.

It suffered from recurring problems between 1972 and 1991. It was in distress again in 1991 due to building deterioration, high vacancy, a municipal work order to repair deteriorated balconies,

increasing financial losses, and an associated bad reputation. At that time the building staff consisted of a manager, three full-time and two part-time maintenance staff, one full-time and one part-time administration staff and the owner. Today, staff consists of one full-time and two part-time maintenance workers, two part-time superintendent couples, and a similar amount of time for administrative staff and owner involvement.

In 1991, the new ownership priorities were to improve tenant acquisition/retention, and address deferred maintenance. The major expenditures were di-

rected at improving the product to attract and retain customers. An improved product meant better quality tenants and reduced vandalism. Since student residences have a high turnover, the building's bad reputation was forgotten within a few years.

The following administrative tasks contributed to the reduction in utility costs:

- One of the commercial restaurants had a gross lease (the building owner paid for utilities). At the earliest possible date, the lease was renegotiated to have the tenant to pay for his electrical consumption. The owner continues to pay for heating and water consumption for practical reasons but the nonessential mechanical and electrical systems are shut off during unoccupied periods;
- Utility use and costs were recorded and analyzed to identify areas for savings that could be achieved; and

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Wayne Webster is president of Princess Towers Inc., in Ottawa.

- A schedule of operations and maintenance tasks was developed by the technically trained and knowledgeable owner. Some of the routine tasks could be performed by staff, others required more expertise. All required follow-up and verification, not unlike the commissioning process.

Utility Cost Reduction

The owners and managers for medium to medium-large properties often delegate operations, maintenance functions and initiatives to staff that do not have the training or skills to understand how systems operation affects utility costs. This presentation primarily is devoted to the premise that significant reductions in utility use can be achieved if a sustained management commitment and involvement exists over an extended period.

It also suggests that a logical progression exists from no cost items and low-cost solutions, but changes requiring significant expenditures periodically occur in the life of a structure. An understanding of the operations is vital to ensure these windows of opportunity are not lost. No attempt has been made to cost justify individual changes.

As in most operational initiatives requiring limited capital expenditures, a rigorous analysis was not performed, because the owners' comfort level was maintained. The results as summarized in the analysis and displayed in the figures present a compelling endorsement of the approach and execution.

Quick Fixes and No Cost Items

In early 1980, a new indoor-outdoor temperature control system from a major supplier was installed to schedule the boiler water supply temperature. When we checked its operation in the fall of 1991, it did not appear to be working. The installer was asked to verify the operation, which he did. However, when the manual temperature adjustment was increased, the burners still did not start, nor did they stop when it was decreased. The tradesman subsequently stated that his equipment was working because the signal was being sent to the boilers.

On close examination a manual/automatic switch was found on each boiler. These switches were all set to manual and each boiler therefore was controlled by its fixed temperature controller! The expensive control system had been short circuited for some unknown time. The tradesman then suggested that the manual switches should not be removed to allow manual operation if the controller failed. They were removed immediately so the system could never be bypassed again. It is vital that the KIS—ASAP (Keep it simple—as simple as possible) principles be applied to all systems and installations.

Repairs were made to leaking faucets and valves on plumbing fixtures. Replacement faucets have a “washer-less” design.

The CO control system in the parking garage was serviced to reduce operating times for fans and exhaust.

Solving Problems and Low Cost Solutions

Gaps in the commercial ceiling space building envelope caused the sprinkler and heating pipes to freeze. This would not have been discovered and remedied had it not resulted in water leaking twice during the 1991–92 winter.

Some units had overhangs with rigid insulation that had to be reinstalled. The floors are still cold. It is suggested that our architectural colleagues be encouraged not to design overhangs for bedrooms of building structures in a cold climate. Alternatively we, the HVAC consultants, should request a heated space under the floor.

When the electric ramp heater to the underground garage failed, a roof structure was installed that involved a similar cost and provided substantial electrical savings.

Pipe insulation was installed on the uninsulated boiler room heating piping, and the boiler room temperature dropped.

The building envelope did provide some heating cost savings and improvement to occupant comfort when we sealed the leaky windows and doors.

Electrical System Changes

Incandescent lights were replaced with compact fluorescent fixtures in the halls, stairs and garage. Standard fluorescent tubes were replaced with T8 light fixtures and electronic ballasts in the office and laundry room. The office light switches were rewired so only one tube in one multi-tube fixture was on all of the time instead of having all four fixtures on for security. Emergency exit incandescent fixtures were replaced with compact fluorescent tubes. The electric laundry dryers were converted to natural gas. The original elevator motor-generator set was replaced with a variable-voltage-variable-frequency (VVVF) drive and control as part of the elevator modernization.

Mechanical System Redesign

Several garage, service, storage, and equipment room space heaters were removed. Even in the cold northern climates, operating equipment provide adequate heat for unoccupied service and equipment rooms. All four heating circulation pumps were oversized. We were able to take one out of service, and trim the impellers on all the rest. We also modified the piping to permit the abandoned pump to operate as standby to all the other pumps. No standby provision was in the original design!

Operations and Maintenance

In the original building design, the space heating boilers in the 17th level penthouse heated domestic water via a heat exchanger. During the early 1980s, a separate domestic water heating boiler was installed in the penthouse so the heating boilers could be shut off when not required—approximately four months per year. Piping from the domestic water storage tank on the 17th level penthouse was connected to an identical 1,000 gallon (4500 L) storage tank in the basement.

The tank in the basement had been designed for the lower six floors of the building and the tank in the penthouse for the upper 10 floors.

This arrangement was problematic as 120 psi (825 kPa) hot water was circulating in the plumbing system in the lower portion of the building. In the lower portion of the building the occupants of each apartment had to mix the 120 psi (825 kPa) hot water with 60 psi (410 kPa) city supply cold water at the fixture. Additionally, there was inadequate hot water with increased occupancy.

We could not install a chimney from the basement through the residential tower, so we installed a condensing domestic water heater. The high- and low-pressure plumbing systems were again separated. An additional benefit was a significant reduction in the system power requirements of the pressure booster pumps. They were no longer required to pump the domestic hot water for the lower portion of the building.

Previously two pumps, 5 hp and 7.5 hp (4 and 6 kW), were observed to operate frequently. Subsequently, the base 5 hp (4 kW) has been adequate for almost all the time.

A variable speed drive was installed on the main domestic water booster pump, the pressure regulating valve removed, a pressure control placed at the top of the building, and a pressure discharge reflecting actual requirement to the top floor for the various flow conditions is now maintained. The normal operation is 45 cycles (rather than 60) per second.

Pump affinity laws indicate that power (energy) is a function of the speed (rpm) to the power of 3. Thus if the speed is only 75%, the energy required is only 42% of that previously consumed.

The original heating system did not have automatic control valves in the accommodation units. Consequently inefficiencies exist. The distribution system has a north and south zone. Solar and wind controls have been installed to provide an additional adjustment to the water temperatures based on orientation. A wind from the north will cause an increase in the north zone temperature. A similar adjustment is made for a south wind. The south zone temperature will be reduced when there is a significant solar gain.

An outside air temperature sensor stops the heating pumps above approximately 52°F (11°C) in the commercial area and 58°F (14°C) in the residential area. Above this temperature, the

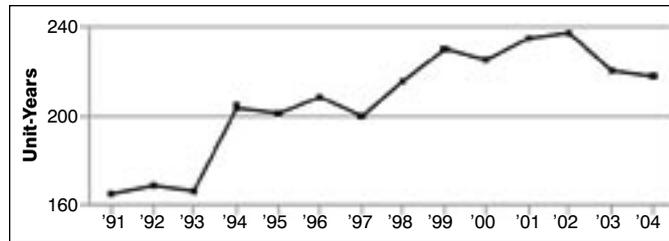


Figure 1: Occupancy-residents for the Princess Towers.

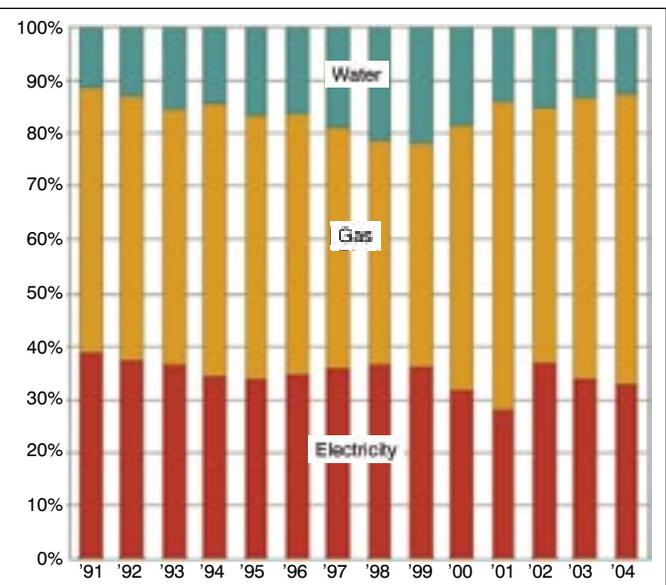
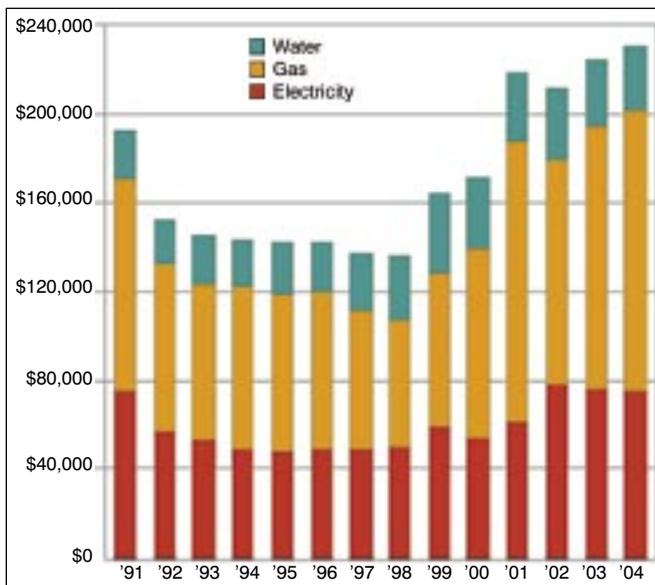


Figure 2 (left): Annual utility costs. Figure 3 (right): Utility cost percentages.

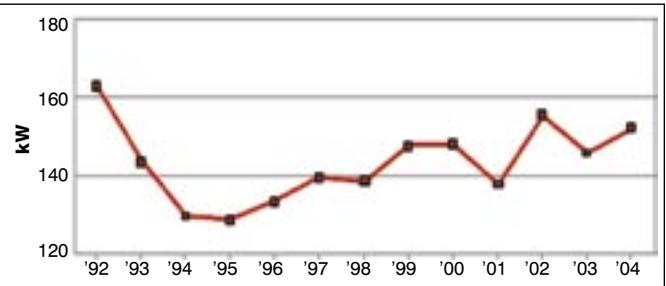
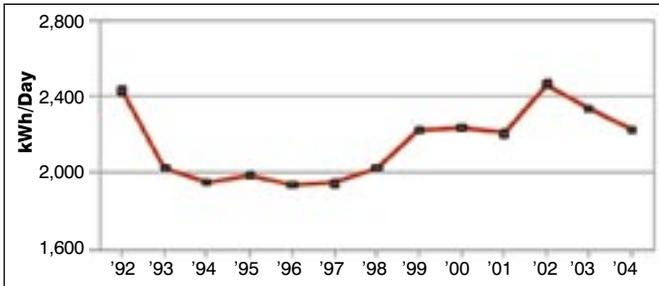


Figure 4 (left): Electrical average consumption. Figure 5 (right): Electrical average demand.

internal and solar heat gains are adequate to offset heat loss, and it is not necessary to purchase energy for heating.

The building is the tallest in the region. As such it has attracted communications providers who have installed antennae on the roof and heat generating equipment in the basement. Being in a residential part of the central business district, it is important to minimize noise. Initially a condenser was placed outside. Since then, two condensers have been installed in the garage under the exhaust fans used to evacuate carbon monoxide. The fans are controlled to start when the space temperature increases above 80°F (27°C). This arrangement provides the heat required by the garage for most of the winter at no cost to the building owner.

Controls—Miscellaneous

The heating distribution and makeup air supply temperatures are checked periodically and maintained as low as possible during the heating season while avoiding complaints. Also, the setpoint temperatures controlling the heating equipment in the garage, entrance and stairwells, as well as the domestic water storage tank, are checked periodically.

Photocells replaced the timers that had controlled the roof, lobby, entrance and parking lot lights. A seven-day control

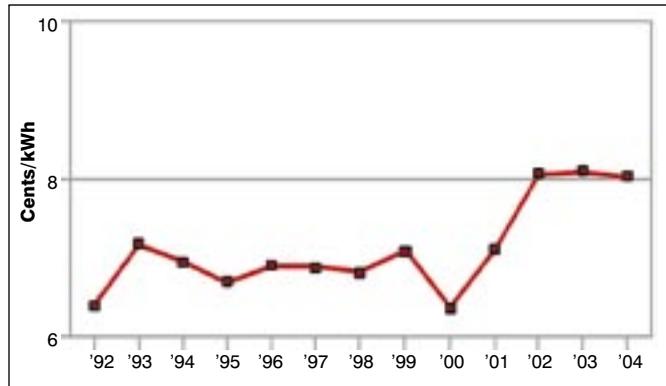


Figure 6: Electrical unit cost.

was installed for the office air-conditioning and ventilating unit. A tank temperature control was installed to shut off the domestic water heater circulating pump when the tank temperature is adequate. Some thermostatic rad valves were installed in selected units, but they could not be cost justified and were often ineffective.

It is vital that someone with a vested interest in utility savings is involved in a MBWA (management by wandering around) program. The settings and operation of equipment

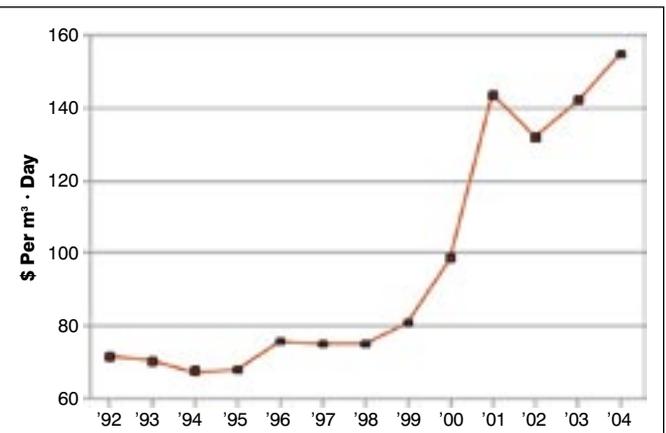
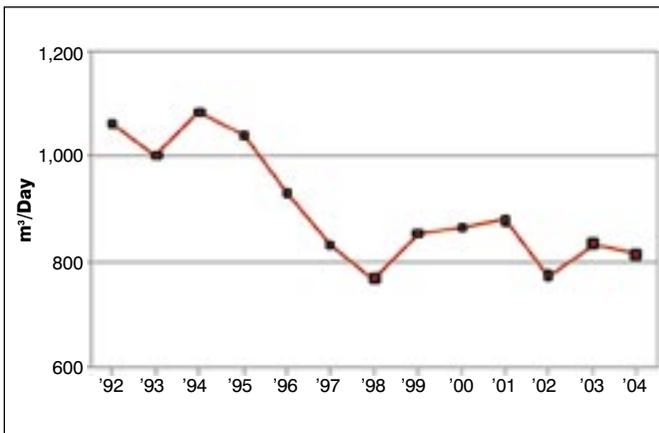


Figure 7 (left): Natural gas consumption. Figure 8 (right): Natural gas unit cost.

Operations and Maintenance

and systems must be checked and rechecked as settings are periodically modified and not returned to their original setting. Settings should be adjusted based on the season.

Miscellaneous

Low water flow toilets and faucet aerators have been installed. A number of water cooled condensers demand periodic repair/replace/adjustment of the control valves. Timers have been installed on the makeup air and kitchen exhaust fans to shut them off between 1 a.m. and 6 a.m. during the winter. Washroom fans run continuously.

Future Opportunities

We might either replace several small water cooled air conditioners and commercial tenant freezers, or recover the heat rejected by them and use it to preheat the domestic hot water.

Assessment—Analysis

Utility consumption and associated costs in multi-unit residential structures have both fixed and variable components. Inflation has increased costs over time but ideally consumption would not increase if equipment operation does not deteriorate. Increased occupancy (reduced vacancy) will increase all utility use and costs (domestic cold and hot water, appliance and receptacle use, and space heating) unless offsetting changes are made. Although some details for the 1991 utilities breakdown have been lost, the Figures obtained from utility bill data indicate:

- Occupancy has increased more than 40% (Figure 1);
- The total utility costs are up 30% (Figure 2);
- Natural gas costs vary from 40% to 56%, electricity are from 29% to 39%, and water from 11% to 21% (Figure 3);
- The electrical consumption dropped 20% for several years but recently increased to the level recorded in 1991. It is considered that this is due to increased occupancy (note that both dropped in 2003 & 2004), and the increased number and use of computers which are standard equipment with today's college students (Figure 4);

- The electrical demand initially dropped 25% but has risen to 85% of the original level. The comments noted for consumption also apply here (Figure 5);

- The unit electrical cost has increased almost 30% (Figure 6);

- The natural gas (space and domestic water heating) has been at or less than 80% of the 1992 level (Figure 7);

- The unit cost of gas has doubled (Figure 8);

- Water consumption peaked in the late 1990s, apparently due to faulty flow control valves and potentially slow response to leaks (Figure 9);

- The unit cost of water has increased 65% (Figure 10); and

- Labor hours have been reduced by approximately 30% (from eight to five person years). This activity is independent of the main focus on utility use in this article. It is included to demonstrate the changes were not simply in the operations and maintenance activities.

Human resource requirements were reduced in the entire operation due to the

owning and managing philosophy. The focus on providing a better product or service, reducing vandalism, waste, and non-productive effort also was applied to the operations and maintenance activities.

Summary

The consumption of all utilities (water, gas, and electricity) has decreased even with increased occupancy during the past 13 years. Further, the total utility costs have only increased 30% while the unit energy and water costs have increased from 40% to 100%, and the occupancy has increased 40%. If the increased unit costs were applied to the increased water and electrical use for the increased occupancy, utility costs would be expected to at least double without the changes described previously. A significant potential exists for reducing the resources consumed by multiunit residential buildings, but the systems must be periodically re-commissioned or the benefits will dissipate. ●

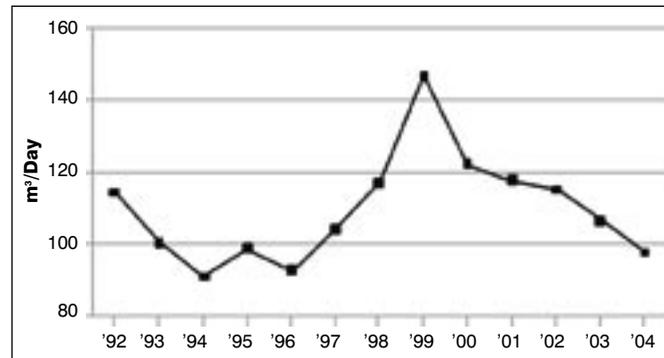


Figure 9: Water consumption.

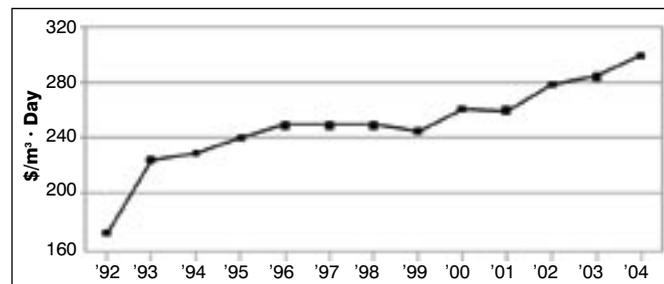


Figure 10: Water unit cost.