BETTER BUILDINGS

Toronto (Ontario)

CASE STUDY NUMBER 55

HVAC, CONTROLS AND BUILDING ENVELOPE UPGRADE

OVERVIEW

Three towers built in the 1970s compose a 1,008 unit apartment complex. Clad in precast concrete with 27,600m^2 (300,000 sq.ft.) each, they sit above a subway station in northern Toronto, formerly North York. The upgrade work was based on a guaranteed performance contract implemented by the former Ontario Hydro Energy Company. It included the design, installation and financing of the retrofit HVAC, thermostat controls and building envelope upgrades with a guaranteed annual payback of $200,000 in energy savings.

View of the project

PROBLEMS AND CAUSES

The owners were dealing with steadily escalating energy costs, ($1M/yr), 27-year-old heating and air conditioning systems that had reached the end of their useful life, and spiralling maintenance requirements. Heating was provided by electric units. Air conditioning was supplied to 2/3 of the units by packaged terminal air conditioning (PTAC) and the remaining third had ducted systems.

The property managers realized in 1989 that the complex needed considerable attention. It was increasingly difficult to maintain and replacement parts for the original heating and air conditioning units were very costly. There was excessive use of the heating and cooling systems. Tenants were turning up the heat or the air conditioners, while leaving windows wide open, and because they did not pay the energy bills there was little motivation to conserve.

A building envelope audit revealed that stack effect was extreme and was causing comfort problems, particularly with lower units. No water leaks were visible and no work was done on the windows or surrounding area. The building envelope contractor informed the owners that controlling stack pressures would improve comfort, energy efficiency and odour control. Stack pressure was noted from smoke tests. Smoke was used to

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verify location and severity of leaks in terms of rate. Though not actually measured, the observation helps estimate the overall air leakage rate. Smoke test cost is part of the envelope upgrade budget.

OPTIONS

The managers considered conversion to natural gas through a local ESCO, but were concerned about the time and disruption involved in installation. At the same time, the energy services company approached them about serving as a pilot project for a newly formed guaranteed savings offering. The proposal offered a generous guaranteed payback and allowed for a fast and clean upgrade with minimal disruption to the tenants. This was a big consideration for the managers.

Although the proposed ClimateMaster air source heat pumps were much more energy efficient than their predecessors, the main element of the energy savings aspect of the project was to impose adequate controls to ensure proper usage. The guaranteed savings depended on guaranteed control over the systems. The units had to be run at a specific temperature in order to realize the returns, while at the same time provide adequate comfort levels to the residents.

For the managers, tenant relations were paramount. They knew that they were dealing with the lives of families and individuals and insisted that any upgrade create minimum disruption.

MECHANICAL SYSTEM RETROFIT

After considerable search efforts and an in-depth examination of available options, the owner decided on a turnkey project that involved the replacement of all heating and air conditioning units with heat pump combined heating/cooling units.

Horizontal air source heat pump in one-bedroom suite

Vertical air source heat pump, removed for maintenance

Installation of the air source heat pump units from ClimateMaster began in 1998, and was performed by Total Mechanical under the leadership of Groundheat Systems International Inc. who served as coordinators for the project. Installations took up to three hours per unit and were performed during the daytime to minimize inconvenience to tenants.

Vertical units were installed in the two-bedroom suites, and horizontal units in the one-bedroom suites. Total installation took five months to complete.

Thermostat energy management system

The solution to improved control of energy usage was found in a smart thermostat from Log-One called the EMS-APT (energy management system - apartment). A technology that had been used in school boards for several years, the Log-One EMS-APT is a unit that was customized for apartment building use. A controller for heating systems and heat pumps, the thermostat features a motion detector on the

front panel and is pre-programmed to control the amount of override that a tenant requests (i.e. ±3°C). When motion is not detected, the thermostat gradually reverts to a pre-programmed set temperature of 21°C. Tenants can increase the set temperature on their return by pushing an up button. Heat is increased at a rate of 5°C every 15 minutes to a maximum of 24°C. When controlling the air conditioning system, an absence of 18 hours will automatically turn off the system. Adjustments can be made to the pre-sets for seniors and other tenants with special needs.

The manager for the site felt it was important to educate all tenants on the new thermostats. Tenants were not used to thinking in terms of hydro bills; they simply turned up the heating or air conditioning without hesitation. They were also in the habit of opening windows and doors to regulate the temperatures while leaving these systems running at full blast, and would think nothing of leaving the heat or air conditioning on when they went out.

The property managers focussed much effort on training staff on the smart thermostats and produced pamphlets for the tenants in multiple languages. Often, the staff went to the individual units to explain the system to tenants. It was important to make sure that everyone understood how the system worked and why the management was implementing the controls. For the most part, the education process went extremely well.

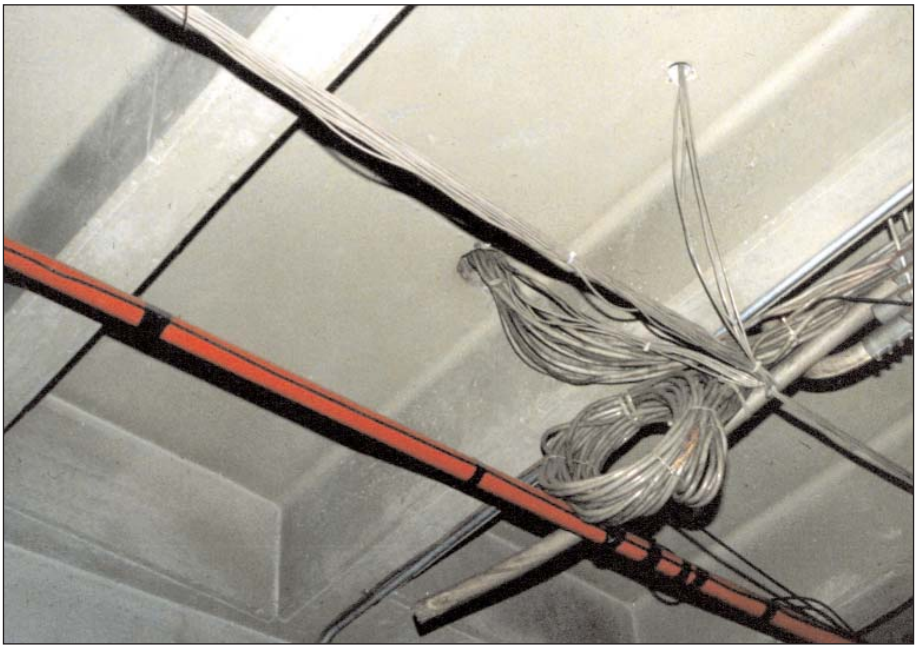
SEALING WORK

The building envelope contractor, in one month, isolated and compartmentalized mechanical rooms by:

- weatherstripping doors
- fire stopping penetrations through rated walls
- reducing the size of cable holes in the elevator shafts and door controller cable penetrations using tin sheet fastened with rivets and caulking
- sealing the bus bar and other electrical penetrations through the floor of the elevator rooms

Sealing included the many penetrations found in the underground parking areas, among them: sprinkler hangers, conduit, cable, ducts, pipes, cracks and gaps between infill walls to slabs. Access doors to adjoining areas were weatherstripped.

Cable penetrations in parking garages were air sealed



Air sealed bus bar, conduits and cable penetrations

COSTS AND RESULTS

Actual expenditures

HVAC	$2,600,000
Thermostats	$300,000
Envelope	$100,000
Total upgrade cost	$3,000,000

Staircase doors often had two-inch gaps at the bottom, so they were also fitted with weatherstripping. This isolated floor to floor areas and reduced stack pressures. Other areas of work included fire cabinets, garbage disposal rooms, electrical rooms and other service shafts.

Materials used included one- and two-component polyurethane foam as the primary air sealant. If fire-rated continuity was required, the polyurethane foam was covered with AD fire barrier mortar to achieve a 3-hour fire rating, as per ULC Standards.

The project was financed by the Ontario Hydro Energy Services with a 10-year term loan. With the smart thermostats in place and much more energy-efficient heating and cooling units, the energy savings exceeded original expectations of $200,000 a year. The project management company reported that although the controls represented only about ten per cent of the total retrofit cost, they contributed from 40 to 50 per cent of the total savings. After the first full year of the conversion to the combo units, owners reported savings of close to $300,000 in energy costs, plus an additional $100,000 approximately, in maintenance – all without incurring any major disruption to tenants or compromising day to day comfort levels within the units. Surplus funds from energy savings are kept in a trust fund for future projects or used as a float to offset project and financing costs.

Parts for the old HVAC systems were costing about $100,000 a year, and were extremely hard to find. With all the units under warranty, 5 year comprehensive, the parts and maintenance budget went to practically zero. The only maintenance required now is changing air filters twice a year.

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For more information about building envelopes solutions and best practices, visit the Canada Mortgage and Housing Corporation (CMHC) Web site at

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