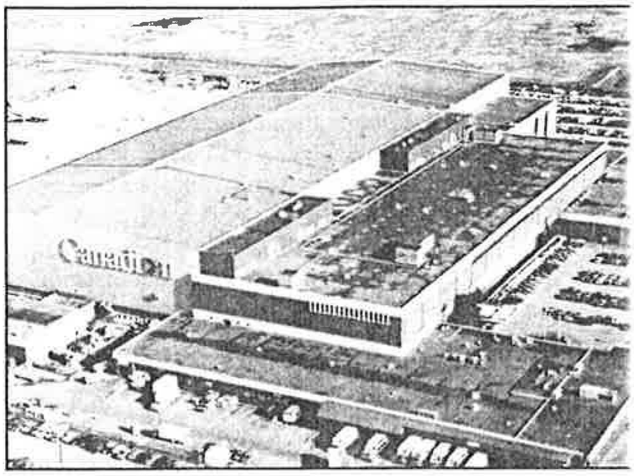
1998 ASHRAE Technology Award

Energy Retrofit Of Aircraft Hangar Facility



Canadian Airlines' maintenance base in Vancouver, Brit Columbia.

By Brian O'Donnell, P.Eng.
Member ASHRAE

Since deregulation of air travel, most airlines have restricted capital projects unrelated to their core business. This article describes an airline's building energy management project that overcame the financial hurdles and succeeded in achieving its goals.

Canadian Airlines International has an aircraft maintenance base in Vancouver, British Columbia. The facility was constructed in 1969 and has a floor area of 1,006,000 ft^2 (93 500 m^2). There are three main types of space use in the building; 1) four maintenance hangars and supporting shops; 2) testing and flight simulator areas; and 3) office and training areas.

An energy management retrofit project was initiated under the local utility's Demand Side Management program. Following a detailed energy study and subsequent design, implementation of the retrofit measures began in the fall of 1994 and extended through the spring of 1995.

Although the focus of the retrofit was energy savings, a key objective of the owner was to replace or upgrade electrical and mechanical system components that were nearing the end of their useful life.

An innovative aspect of the design was the conversion of the dual duct air-handling systems to variable air volume (VAV). Interior dual duct mixing boxes were modified to operate as VAV boxes by capping off the hot deck inlet and replacing the actuators and controls. Perimeter boxes were converted to heating and cooling VAV and were interconnected with the perimeter radiation.

The hot duct was converted to include both heating and cooling operation and serves the perimeter zone boxes. Daytime fan speed is varied to maintain static pressure in the ducts, while at night fan speed is reduced by 50% to maintain comfort conditions for the low overnight occupancy. Fans are shut off during unoccupied periods. The main supply fans were downsized from 150 hp to 75 hp (112 kW to 55 kW) with variable frequency drive control.

Systems Overview

A central heating and cooling plant located in a separ utility building provides the majority of heating and cooling the complex. The heating plant consists of three 400 hp (39 kW) hot water boilers. Hot water at 240°F (115°C) is circulat to radiation, unit heaters and air-handling unit heating co throughout the complex. Heating is available throughout year. Three primary circulating pumps can deliver up to 1,8 gpm (114 L/s) to the heating circuit.

Central cooling is provided by three 357-ton (1250 kW) sorption chillers designed to produce 44°F (7°C) water. A four standby chiller, is a 200-ton (700 kW) centrifugal chiller use the beginning and end of the cooling season and at peak pe ods. Chilled water is distributed to cooling coils in air-handli units. The condenser consists of a four-cell tower for the sorption chillers, and a separate tower for the centrifugal chill

Heating is provided throughout the complex by the cent heating plant to the hot water radiation baseboard heaters, u heaters and ventilators, and air handling units (primarily mu zone and dual duct built-up systems).

Unit heaters heat hangars 1, 2 and 3 using hot water heati coils. Hangar 4 is heated using four gas-fired unit ventilat located directly over the hangar doors.

Several dual duct and constant volume systems prov heating and cooling for the shops and office areas. These f operate continuously.

The original controls for the building systems were pn matic. A building automation system was installed in 1985 upgraded in 1990 to control several of the air-handling un the air compressors, the radiation water pump, flight simula building air conditioning and boilers, and main boiler sta

About the Author

Brian O'Donnell, P.Eng., is president of Prism Engineering in Burnaby, British Columbia. He is the Standards Subcommittee Chair of ASHRAE Technical Committee 1.7, Operation and Maintenance Management.

and water temperatures. The 400-point system includes an operator interface located in the maintenance office.

Mechanical Measures

The following measures were designed using ASHRAE Standard 55-1992, *Thermal Environmental Conditions for Human Occupancy* and ASHRAE Standard 62-1989, *Ventilation for Acceptable Indoor Air Quality*.

- Conversion of dual duct HVAC systems to VAV, reducing fan horsepower by approximately 50%, and allowing installation of new, smaller EE motors. For cost purposes, approximately 400 dual duct-mixing boxes were converted to VAV operation rather than being replaced with new boxes.
- Installation of 28 variable speed drives on supply and return fans. Daytime fan speed is controlled according to duct static pressure. During low occupancy periods, the operating speed is limited to 50%, providing ventilation and air movement for the occupants. Systems are shut off when the area served is vacated.
- Synchronous belts replaced V-Belts on systems retrofitted with VSDs, eliminating slippage losses and reducing maintenance.
- Improved zoning of perimeter radiation for better control and scheduling of water temperature. Perimeter radiation control was linked to the perimeter VAV boxes so that there would not be simultaneous heating and cooling.
- Heating water temperature for the hangar fan coil units was scheduled according to outdoor temperature.
- Solar film was added to the third floor windows allowing the shutdown of four rooftop units that had been added years earlier due to excessive heat gain on the perimeter.
- Updating and expanding the building automation system by approximately 150 points for a total of 550 points. In addition, panels were updated and an improved graphic front end was installed for easier operator interface. Control strategies were improved for fresh air mixing and temperature control, VSD control and sequencing of fans, pumps, chillers, cooling towers and boilers.
- The automation system now monitors the building electrical demand and provides demand limiting. Approximately 200 kW of peak demand are saved monthly by temporarily reducing the daytime fan speed when a preset limit is approached.

Energy Efficiency

Annual electricity use before the retrofit was 28,160,000 kWh, and fuel use was 168,500 GJ, resulting in a total Building Energy Performance Index of 2655 MJ/m²/yr (74.6 ekWh/ft²/yr or 255 Mbtu/m²/yr).

Energy management retrofits have been implemented on the building lighting and HVAC systems, comprising of 15 contracts awarded with an implementation cost of $1.74 million. Lighting measures included retrofit of virtually every light fixture in the building, resulting in a demand reduction of 750 kW and an energy reduction of 43% of the previous lighting demand.

Electricity use in 1996 was 21,424,000 kWh, a 25% reduction, and natural gas use was 114,200 GJ, yielding a savings of 32%. Overall cost savings were $550,000 (Canadian) annually. Canadian Airlines has been monitoring the electricity use monthly.

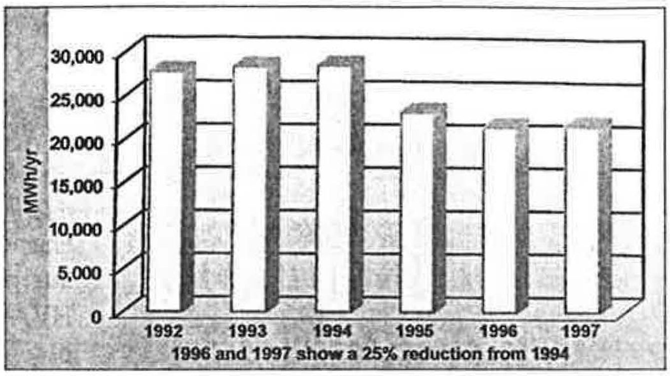


Figure 1: Annual energy use in MWh.

Operation and Maintenance

Aging, and in some cases, non-functioning mechanical and electrical building equipment was repaired or replaced as part of the energy management project, resulting in better comfort control and reduced maintenance.

The existing DDC system used a menu that was difficult for the majority of the operators. An interactive graphics front end was installed on the DDC system, improving the operators' ability to monitor building conditions.

Lighting maintenance was reduced by replacing fluorescent fixtures in shops with Metal Halide, reducing the number of fixtures by 65%. Installation of silver film reflectors in fluorescent fixtures reduced the number of lamps and ballasts by 50%.

Cost Effectiveness

The total retrofit cost was $1.74 million, including $640,000 for mechanical and $1,100,000 for lighting. The electrical utility contributed approximately $750,000 as part of its demand side management program. Documented post-retrofit reduction in costs for 1996 was $550,000, including $320,000 in electricity and $230,000 in gas cost reductions or a 29% reduction in energy costs. The resulting simple payback is 1.8 years after the utility rebate.

Conclusion

The success of this project has resulted in Canadian Airlines undertaking energy management measures at all its properties and hiring a dedicated energy manager for a two-year period. Additional benefits include reduced maintenance cost through equipment modernization and a reduction in the numbers of fixtures; improved visual comfort and aesthetics from the lighting systems; improved environmental control; renewed mechanical and electrical equipment; and nearly 1,000 kW of electrical capacity made available for other loads.

Please circle the appropriate number on the Reader Service Card at the back of the publication.

Extremely Helpful	466
Helpful	467
Somewhat Helpful	468
Not Helpful	469