RESULT 285

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Dual fan and duct ventilation system at Canadian Space Agency

Summary

Canada's Space Centre in St Hubert, Québec, is a new 27,870 m² complex which was awarded first place in the ASHRAE Technology Awards (1996) for new commercial buildings. A dual duct ventilation system was installed to provide a comfortable and pleasant research environment. Dual duct systems, which are the heart of the mechanical concept, provide high indoor-air quality, along with design flexibility, energy efficiency and low capital costs. During the monitoring period, energy savings amounted to 839,000 kWh/year (electricity) and 275,000 m³/year (natural gas), when compared to a conventional system. The payback period is 2 years.

Highlights

- **High indoor air quality**
- **17 % reduction in energy costs**
- **Flexible design**
- **Payback period of 2 years**

Main entrance to the Canadian Space Agency in St Hubert, Québec.

Aim of the Project

A comfortable, pleasant research environment was a primary concern for the Space Centre, given its elite clientele. High indoor-air quality combined with design flexibility, aesthetically pleasing installations, energy efficiency and low capital costs, were the mechanical design team's main objectives. Dual duct systems allowed the designers to meet these objectives.

Capital costs were controlled by using simple systems that rely on well-established low cost technology and by optimising equipment selection for dependability, low maintenance and maximum efficiency. Dual fan duct systems, with an air economiser cycle and a constant volume air flow, provide comfortable environments in all rooms. As a result, the system is flexible enough to adapt, at low cost, to any interior layout modifications.

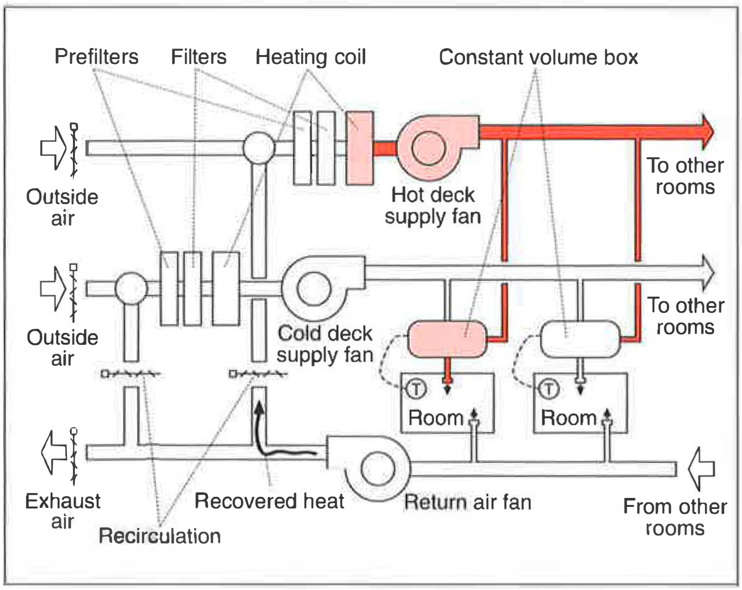
The Principle

To reroute part of the return air to the hot deck as an energy-saving measure, the usual duct configuration has been re-arranged to use two supply fans, one for the hot deck and the other for the cold deck. They are each controlled independently to maintain the required pressure in their assigned duct. The use of constant volume terminal boxes results in a constant air volume (CAV) system. Both decks are provided with an outside air intake to ensure that all rooms receive the calculated percentage of ventilation air, whether they are in full heating or full cooling demand. In perimeter areas, hot water convectors fight cold winter drafts during the daytime and take over for night heating as the air handling units (AHU) are shut down.

Conventional dual ducts involve one fan that sends the mixed air to the hot and cold decks. The economiser cycle affects efficiency because heating energy is wasted as the temperature of the mixed air must meet the requirements of the cold deck. Savings are achieved during free cooling, as the mixed air is not heated to the temperature of the hot deck, as well as during the heating period, when heat from indoor gains carried by the return is directed to the hot deck.

Figure 1 shows a schematic of the mechanical system at the Canadian Space Agency.

Figure 1: Schematic of the mechanical system at the Canadian Space Agency.



The Situation

Canada's Space Centre offices, laboratories and conference centre are all served by the dual-duct system as illustrated in Figure 1. All major sections operate using an air economiser cycle. Gas boilers provide them with hot water for heating and steam for humidification, while centrifugal chillers provide chilled water for cooling.

Maintaining constant volume air flow ensures an adequate level of air quality as soon as people enter a room. In variable air volume (VAV) systems, ventilation decreases before people arrive and again when they leave. A CAV system has the advantage of continuously removing pollutants (people not necessarily being the main source of pollutants). In perimeter areas, where heating and air-conditioning loads vary considerably, CAV systems are advantageous because ventilation does not decrease on cloudy or cold winter days. The air economiser cycle is

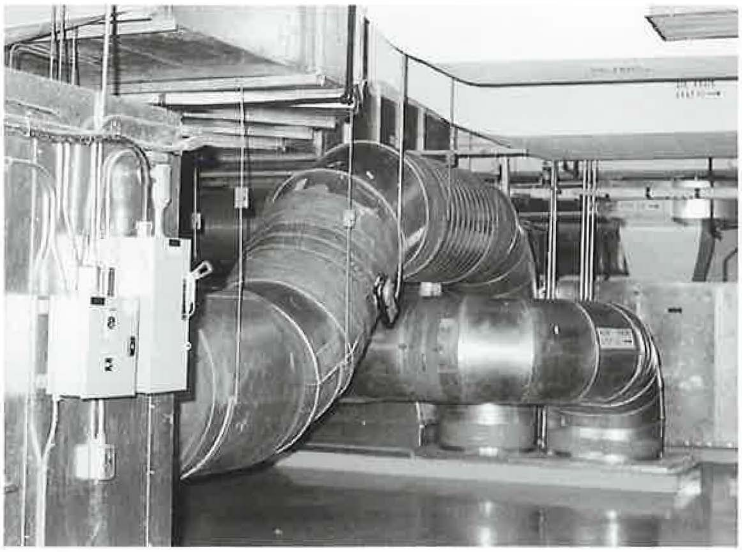
	Dual Duct			VAV	
Type of system	Dual fan dual duct	Economiser cycle	With heat recovery	Economiser cycle	With heat recovery
Electricity kWh	6,394,000	7,233,000	7,400,000	6,052,000	6,196,000
Avg. USD/kWh	0.069	0.069	0.068	0.070	0.070
Total USD	439,000	497,000	503,000	425,000	432,000
Gas m^3	438,000	713,000	443,000	514,000	475,000
Avg. USD/m^3	0.212	0.20	0.213	0.210	0.211
Total USD	93,000	142,000	94,000	108,000	100,000
Total Cost USD	**532,000**	**639,000**	**597,000**	**533,000**	**532,000**
Difference USD		**107,000**	**65,000**	**1,000**	**0**

Table 1: Cost comparison between dual duct and conventional ventilation systems.

beneficial, since outside air admitted into the building greatly exceeds the minimum requirement throughout the year. Measurements show that the ventilation system maintains CO_2 levels well below ASHRAE recommendations.

This system was chosen after computer models, using an energy simulation program, showed that only VAV systems with double-bundle heat-recovery chillers were capable of being more energy efficient than the dual duct system. However, to guarantee the desired air-quality level, VAV systems would have to be zoned according to the building's facades and interior layout, which would have entailed higher capital costs and been less flexible for future floor layout changes. Gas and electricity bills for 1994 and 1995 corroborate the results of the computer simulations (see Table 1 for a USD cost comparison between dual duct and conventional ventilation systems).

Figure 2: Dual duct system at the Canadian Space Agency.



The dual duct system consumes 6,394,000 kWh of electricity and 438,000 m^3 of gas. A conventional system uses 7,233,000 kWh of electricity and 713,000 m^3 of gas. Comparing the dual fan system with other conventional CAV systems, the dual fan system is the most profitable, either in terms of energy or financial costs.

Costs were controlled by relying on low cost technology and equipment optimisation for dependability, low maintenance and maximum efficiency. Dual duct systems maintain a comfortable environment in all rooms served, despite different load requirements (perimeter vs. interior zone). The systems need not be zoned at AHU level. This makes them flexible and adaptable, at low cost, to interior layout modifications during the building's life.

Concepts to lower capital costs result in lower energy costs.

Large differences in temperature between inlet and outlet water, for heating ($\Delta T = 28°C$) and for cooling ($\Delta T = 8°C$), result in smaller pipes and valves, less insulation and smaller pumps. Air economiser-free cooling AHUs, as opposed to systems with heat recovery chillers, mean simpler control strategies and piping, easier operation and lower compressor run times, hence less maintenance and increased savings.

The Organisation

The John H. Chapman Space Centre is located in St Hubert, Quebec, southeast of Montreal, and employs about 500 people. Shaped somewhat like the future International Space Station, the headquarters of the Canadian Space Agency houses facilities for astronaut training, a control centre for Canada's Radarsat satellite and the future International Space Station robotic arm systems, and laboratories for work in material and life sciences, robotics, space systems, optics and computer technology.

Economics

The total energy cost for the dual air duct system was CAD 531,622 (cost of electricity: CAD 0.069/kWh; cost of gas: CAD 0.212/m3), as opposed to CAD 639,545 for a conventional system (cost of electricity: CAD 0.069/kWh; cost of gas: CAD 0.2/m^3), giving total savings of CAD 107,923. The entire ventilation system cost approximately CAD 5.2 million, giving a payback period of 2 years.

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* IEA: International Energy Agency
OECD: Organisation for Economic Co-operation and Development

IEA

The IEA was established in 1974 within the framework of the OECD to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among the 24 IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology, and research and development (R&D).

This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 40 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 15 member countries.

This project can now be repeated in CADDET Energy Efficiency member countries. Parties interested in adopting this process can contact their National Team or CADDET Energy Efficiency.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET Energy Efficiency 'Demo' or 'Result' respectively, for ongoing and finalised projects.