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Better airflow, less energy, lower costs

Fume hood retrofits yield big benefits for National Research Council Canada Building M-12

Laboratories and research facilities can consume up to eight times the energy of a typical office building. With help from the Federal Buildings Initiative, the National Research Council Canada continued its tradition of leadership in finding efficiencies by upgrading the lab ventilation systems of an older facility at its Ottawa headquarters. The project yielded annual energy savings of $480,000 – exceeding original projections by 33 percent.

Project highlights

Duration:
March 2007–March 2009

Investment:
$3.7 million

Annual energy cost savings:
$480,000

Annual energy consumption savings:
34 400 GJ
(50% reduction)

Annual GHG emissions reduction:
2 950 tonnes

A matter of health and safety

Ventilation systems – in particular, air-exhausting fume hoods – are vital health and safety mechanisms in lab environments, protecting researchers from exposure to harmful gases or organisms. But they also make labs more energy-intensive than other types of buildings. Energy is needed to replace exhausted fumes with fresh outside air, which also has to be treated according to the requirements of the lab. In many cases, fume hoods run constantly, regardless of the nature of the experiments being conducted or whether the lab is occupied.

Retrofitting National Research Council Canada Building M-12

Built in 1950, Building M-12 is a five-storey, 11 600-square-metre structure on the National Research Council Canada's main campus in Ottawa. (It was formerly known as the Institute for Chemical Process & Environmental Technology.) An assessment of the facility's energy consumption zeroed in on the significant volume of air constantly circulating through it, leading the National Research Council Canada to suspect that changing fume hood operations could yield substantial energy savings.

Constant air volume fume hood modified to variable air volume

- ✔ modulating exhaust air valve
- ✔ sash position sensor
- ✔ occupancy sensor
- ✔ airflow monitor with alarm

To realize those savings, the National Research Council Canada entered into an energy performance contract to refurbish the lab ventilation systems and improve the efficiency of the fume hoods. The initiative was undertaken with assistance from the Federal Buildings Initiative of Natural Resources Canada's Office of Energy Efficiency.

"Implementing energy retrofit projects in a lab environment is challenging," explains Subash Vohra, Special Advisor to the Director General of National Research Council Canada's Administrative Services and Property Management branch. "But as lab equipment becomes more sophisticated, energy consumption steadily increases. Retrofitting is a necessary step to offset those increases."

Due diligence: Ensuring workers' safety

Because the retrofits involved reducing ventilation airflow rates, the National Research Council Canada researchers needed assurance that their health and safety would in no way be jeopardized – and that the timing of the retrofit work would not disrupt their ongoing experiments. To address these concerns, the project team consulted with the building's occupants before work began.

"Downstream" safety within the ventilation system was another important consideration. Unlike standard ventilation systems, which exhaust only stale air, fume hoods may potentially exhaust hazardous chemicals as well. Because the redesigned system was going to link multiple fume hoods in centralized plenums for optimal efficiency, the project team needed to ensure potentially volatile chemicals were not going to mix. Researchers provided a catalogue of chemicals that might be used within each fume hood; 16 had operational requirements involving dangerous chemicals that should not be mixed because of the risk of explosion or other harmful effects. As a result, those fume hoods were excluded from the project.

From constant to variable airflow

In the end, 92 fume hoods were replaced or upgraded. The replacement fume hoods contain fumes more effectively and at lower, more energy-efficient airflow rates than the older models. The upgraded fume hoods have sensors that continuously monitor face air velocity rates (how fast air is drawn in) and automatically adjust ventilation settings as necessary. This variable airflow approach conserves energy while ensuring that safety standards are met.

Sensors also trigger an alarm if a fume hood sash (a sliding glass door on the front of the fume hood) has been opened too wide to maintain the required face velocity rates that allow for containment or when face flow rates fall below a minimum threshold.

As part of the project, the ventilation control systems were also upgraded to accommodate the operational parameters of the new fume hoods. Sensors were installed in labs to monitor occupancy and air quality, and the control system automatically turns off lights and reduces ventilation rates when lab space is unoccupied. The centralized ventilation systems employ variable speed drives to optimize fan performance and efficiency, and heat-recovery systems were added to recover heat energy from exhaust air and use that energy to pre-heat (or pre-cool) fresh air intake.

New high efficiency/low airflow fume hood

- ✔ **two-position exhaust air valve**
- ✔ **occupancy sensor**
- ✔ **airflow monitor with alarm**
- ✔ **sash slides vertically and horizontally**

Changing technology . . . and behaviour

The amount of energy required to maintain minimum face air velocity rates is significantly affected by the position of a fume hood sash, which must be open when researchers are conducting experiments. Closing the sash when a lab is unoccupied or access to experiments is not required minimizes ventilation requirements and related energy consumption. Yet it is not feasible for the ventilation control system to automatically close the sash because doing so could interfere with experiments.

Consequently, researchers in Building M-12 have been trained to ensure sashes are closed when labs are unoccupied. Control systems monitor the position of fume hood sashes and trigger notifications if they are left open for extended periods when researchers are not present. Supplementing the new technology with new behaviour in the lab is helping the organization maximize its energy savings.

Laboratory room supply air valve

The room supply airflow is controlled less than the exhaust airflow to create slight negative pressure.

Extending the benefits

The National Research Council Canada project not only resulted in energy savings related to the fume hood ventilation system – it also allowed the organization to complete other renewal measures that improved the comfort and safety of people working within the facility.

For example, fume hood exhaust ductwork was inspected as part of the retrofit process, prompting repairs to any areas in poor condition. Given that the ductwork can also be used to vent hazardous chemicals, deteriorated ducts could have posed a significant health risk. Also, cooling system upgrades were implemented to address occupant complaints about ongoing humidity and condensation issues.

The importance of an in-house champion

Any successful energy retrofit project involves clear communication and cooperation among all stakeholders: building occupants, managers, service contractors and operations staff. Having an in-house champion who can maintain communication and trust between the groups – someone with an in-depth knowledge of building systems who can help make decisions about its operations – is essential.

Subash Vohra has long been a champion of energy efficiency. Under his watch, the National Research Council Canada has implemented seven energy performance contract retrofit projects, and an eighth is underway. Vohra says one of the main reasons the National Research Council Canada has been able to successfully implement these projects is its ability to choose and develop a healthy working relationship with the right energy service company for each project. In the National Research Council Canada context, this means finding partners that have a solid understanding of the operational requirements of a lab. Vohra also emphasizes the importance of knowing your own requirements: how an energy performance contract works and how your building functions.

“Having an energy manager that is an engineer is essential,” says Vohra. “You need to be able to understand what you are dealing with when negotiating with the energy service companies.”

Building on success

Before the Building M-12 project began, the National Research Council Canada estimated it would realize approximately $360,000 in annual energy savings from the retrofits. In fact, the facility's energy costs have been cut by $480,000 each year – exceeding the original projections by 33 percent.

Based on the success of the fume hood project at Building M-12, the National Research Council Canada is implementing similar retrofits at its Sussex Drive research facility in Ottawa through an energy performance contract project launched in 2011. Many of the Building M-12 elements are replicable at the Sussex Drive location, where 144 fume hoods are being upgraded. These retrofits also include lighting upgrades and the addition of high-efficiency natural gas boilers for the facility's heating and hot water distribution system. Ongoing as of summer 2013, this $8.6-million project is expected to yield energy savings of $870,000 a year.

Always looking ahead, the National Research Council Canada is planning further energy performance contract projects throughout its national portfolio – potentially including multiple lab upgrades involving the modernization of fume hood operations consistent with the work recently completed at Building M-12.

About the Federal Buildings Initiative

The Federal Buildings Initiative facilitates energy efficiency retrofit projects in Canadian federal buildings at no upfront cost through third-party energy performance contracts.

Under an energy performance contract, an energy service company is hired to implement and finance the retrofit project. Labour, equipment and service charges are paid for over time by using the energy savings generated by the project. When the payout period is over, the building owner benefits from all future energy savings.

Many federal organizations have used the Federal Buildings Initiative program since 1991 to implement energy performance contracts, reducing their operating costs and greenhouse gas emissions.

For more information on how the Federal Buildings Initiative can help you plan an energy efficiency project, contact:

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