Banks Recognize Financial Benefits

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Many companies across North America are recognizing the financial benefits of the integration of proactive indoor air quality (IAQ) audit procedures into their existing preventative maintenance programs for their building portfolios. A regional financial institution with over 60 branches and corporate offices in Metropolitan Vancouver and Victoria, British Columbia, has pioneered a proactive IAQ audit program since 2001.

The corporate proactive IAQ management program includes four components:

1. Walkthrough inspection and review of the operational configuration of the heating, ventilation and air conditioning (HVAC) systems.
2. Instantaneous IAQ measurements at multiple locations within a branch.
3. Continuous IAQ monitoring at a central location for a one week period.
4. Analysis and reporting, including comparison of IAQ conditions in a branch over time.

The IAQ audits are performed on a two year cycle, with additional retesting at locations in which IAQ-related problems are identified during the audits, and are subsequently mitigated.

The financial institution, which has a strong corporate commitment to environmental responsibility (including the indoor environment), has accrued multiple benefits from the IAQ audit program, including assurance that their staff and clients are working and doing business in healthy and comfortable spaces; their buildings are being effectively maintained; and are being operated in a cost effective and energy efficient manner.

Walkthrough Inspection and HVAC System Review

The initial component of the proactive IAQ audit program is a walkthrough inspection of the occupied space and inspection of accessible HVAC systems components to identify potential IAQ related concerns. Observations include inspection of outside air intake locations relative to possible contaminant sources; inspection of accessible HVAC system components such as dampers, filters, coils, fans, belts and ductwork for proper operation and cleanliness conditions; and review of thermostat locations and set-points.

Instantaneous IAQ Measurements

The walkthrough inspection is followed by objective IAQ measurements at multiple locations throughout the occupied space using a direct reading IAQ monitor (Airboxx IAQ Monitor from KD Engineering Ltd.). The instantaneous measurements are taken to assess spatial variations in IAQ conditions within a branch. Measurements are taken in the Tellers and Back Cash areas (which are typically the locations with the highest occupant density); Open Plan and Enclosed Offices; Meeting Room and Staff Lounges. In addition, outdoor data is recorded adjacent to the point of outside air intake, to provide a benchmark of comparison for the indoor data.

The following IAQ parameters are measured throughout a branch with the Airboxx monitor:

- **Carbon Dioxide** (CO_2) as an indicator of ventilation adequacy.
- **Carbon Monoxide** (CO) as an indicator of the presence of combustion related byproducts (primarily from the infiltration of vehicle exhaust).
- **Temperature** and **Relative Humidity** as indicators of thermal comfort.
- **Total Volatile Organic Compounds** (TVOC) as an indicator of the presence of chemical emissions from furnishings and finishes, and from solvent based products used in the space, such as from cleaning products.
- **Airborne Particulates** as an indicator of HVAC system filtration effectiveness and general dust loading of the indoor air. Particulate concentrations are determined using a direct reading light scattering instrument.

The data obtained from the instantaneous measurements is especially useful for identifying spatial variations in IAQ conditions. For example, in a recent audit, the walkthrough inspection showed that the branch was served by two rooftop air handing units (AHU's). The instantaneous measurements showed CO_2 concentrations of between 600 parts per million (ppm) and 700

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ppm in the zone served by one AHU, but CO_2 levels of between 1600 ppm and 1800 ppm in the area served by the other AHU. Given a comfort based criterion of 1000 ppm as an indicator of ventilation adequacy (derived from ASHRAE Ventilation Standard 62.1, and from Provincial workplace regulations and IAQ guidelines in British Columbia), the data immediately identified a ventilation related issue in a portion of the branch. Further inspection with the HVAC contractor for the building showed that the fan belt in the AHU had snapped, and therefore no outside air was being supplied to the space. When a new belt was installed, CO_2 concentrations in the zone quickly reduced to less than the 1000 ppm criterion for sufficient ventilation.

Continuous IAQ Monitoring

While the instantaneous IAQ data provides a useful "snapshot" of IAQ conditions and can highlight spatial variations, the addition of continuous IAQ monitoring to a proactive IAQ management program provides vital additional data regarding HVAC system performance and variations in IAQ conditions over time. It is not uncommon for an IAQ issue to be identified during the continuous monitoring portion of an audit, which was not picked up during the walkthrough inspection and instantaneous measurements.

The continuous monitoring is typically conducted for a one week period in a branch, and the Airboxx monitor is used to gather CO_2, CO, temperature, relative humidity and TVOC data. The specific location at which the continuous monitoring is performed is selected based on (a) information gathered during the walkthrough inspection; and (b) data from the instantaneous measurements. In most branches, the continuous monitor is placed in the Tellers/Back Cash area, which has the highest occupancy levels and therefore place the greatest demands on HVAC system performance.

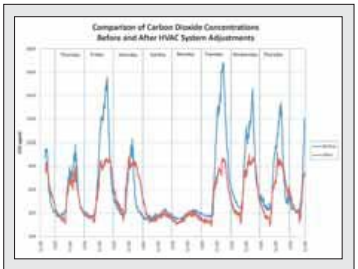

Figure 1

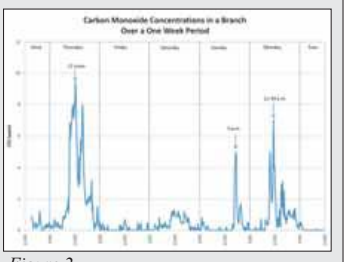

Figure 2

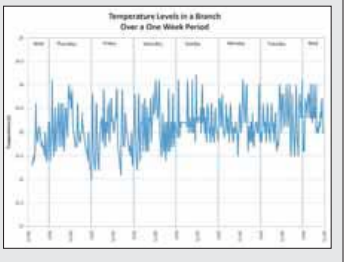

Figure 3

Analysis, Reporting and Follow-up

Once the on-site information gathering is completed, the collected data is analyzed and a standardized reporting format is used for consistency. The IAQ data from each branch is evaluated through comparison with workplace regulatory requirements, and established IAQ standards, such as the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standards 55 and 62.1, and IAQ guideline documents such as Heath Canada's Technical Guide for IAQ in Office Buildings. For branches in which IAQ related problems are identified, mitigation actions are recommended, which are most commonly HVAC-related adjustments and changes.

In addition, a database of IAQ conditions over time has been developed, allowing ongoing comparison of measured conditions over time.

For those branches where IAQ-related problems are identified by the proactive IAQ audits, the recommended mitigation actions are typically implemented, and then follow-up IAQ testing is performed to determine the effectiveness of the implemented actions.

Why Are Proactive IAQ Audits So Beneficial?

The Vancouver based Financial Institution has made a commitment to the implementation of this multi-year proactive IAQ audit program because it has recognized the social and economic importance of maintaining a healthy and comfortable workplace for their staff and their clients. The proactive IAQ audits have also provided a method of quality assurance to verify that their building portfolio is being effectively operated and maintained over time. This is especially important because many of the branches are in leased buildings, and HVAC system maintenance is performed by third party contractors. The periodic IAQ inspections and measurements provide a means for evaluating the effectiveness and completeness of the services provided by these third party contractors.

As part of their commitment to environmental issues, the Financial Institution also recog-

nizes the need for improved energy efficiency, but also recognizes that a balance must be found between optimal IAQ conditions and energy performance. The operational data provided by the continuous monitoring provides important feedback on HVAC systems operational schedules and set points.

Some of the practical benefits of a proactive IAQ management program are best illustrated through the following case study examples and field data.

Example One: Identification and Mitigation of Insufficient Ventilation

Figure One shows the CO_2 concentrations before and after changes to the HVAC system configuration in a branch.

The findings from continuous CO_2 monitoring in a branch during the initial proactive IAQ audit showed daily maximum CO_2 concentrations ranging between 1300 ppm and 1700 ppm, which were far in excess of the comfort based criterion for ventilation adequacy of 1000 ppm. This finding was communicated to the landlord and their HVAC system maintenance contractor, who subsequently made adjustments to the HVAC systems, including a change to the minimum outside air damper positions.

Following the completion of the adjustments to the HVAC systems, follow-up continuous monitoring was conducted to assess the effectiveness of the changes to the HVAC systems. The findings from the follow-up monitoring showed a substantial reduction in CO_2 concentrations, with daily maximum levels ranging between 800 ppm and 890 ppm. These findings clearly showed improved ventilation conditions in the branch, with the measured CO_2 levels during the follow-up monitoring below the comfort based criterion for sufficient ventilation of 1000 ppm.

Example Two: The Intermittent Presence of Combustion Byproducts

Figure Two shows CO concentrations in another branch over a one week period.

The findings from instantaneous CO measurements in the branch taken on the first Wednesday of the monitoring period showed consistently low CO levels of less than 1 ppm. However, the data from the seven day continuous monitoring identified a series of short term increases in CO levels with peak levels of between 5 ppm and 10 ppm.

While these recorded CO concentrations were far below workplace regulatory exposure limits, which for workplaces under Provincial jurisdiction in British Columbia are 25 ppm as an 8 hour time weighted average, and 100 ppm as a short term 15 minute period, the CO levels were much higher than typical for most branches, and suggested the infiltration of combustion byproducts into the branch. In follow-up, the HVAC contractor identified a potential for reentry of exhausted combustion gases from an adjacent rooftop unit into the outside air intakes of the AHU serving the branch under certain wind conditions. An extension was added to the exhaust vent, and the CO infiltration issue was resolved.

Example Three: Improved Energy Performance

Figure Three displays the continuous temperature data at a branch over a one week period.

The graph shows consistent temperature levels in the branch of between 22°C and 24.2°C, which are consistently within the thermal comfort criteria recommended in ASHRAE Standard 55-2004. However, the trends in Figure Three show that the HVAC systems were operating on a 24 hour per day, seven days per week basis, even though the branch is typically occupied five days a week from 9 a.m. to 6 p.m. In this case, the findings from the proactive IAQ audit identified clear opportunities for energy savings through an adjustment to the operational schedule of the HVAC systems.

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