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Canada

Existing Building Commissioning (EBCx) Case Study

Recommissioning of a B-Class office tower in downtown Vancouver, BC

PROJECT SUMMARY

Building Name/Type: 808 West Hastings St. Office building, circa 1982.

Location: Vancouver, BC

Project: BOMA BC (Building Owners and Managers Association) Building Tune-Up Program: a recommissioning program primarily targeting the building automation systems (BAS) of B & C class properties.

Commissioning Scope: Revisions to the HVAC*(see legend for list of acronyms) equipment sequencing through the building's DDC system, covering the whole building's central HVAC equipment (AHUs, rooftop units, boiler plant, chiller plant, and zone HVAC equipment (fan-coil units, VAV boxes, induction units). Building assessment and sequencing recommendations was undertaken by BOMA's selected contractor and implementation was completed by the building's preferred contractor.

The project was initiated in March 2019; being 'shoulder season' in Vancouver this would include assessment of both heating and cooling; and the project was completed (with testing verifications) in November 2019.

Size of Commissioned Area: 8,547 sq. m. (representing 100% of the building's total floor area)

Total Commissioning Investment: *$18,140 (BOMA BC / NRCan covered $13,000 of the cost)*

Energy Cost Savings: $12,600 (and 7 %) per year for electricity & gas combined (cost savings were based on the BC Hydro Large General Service Rate, and an assumed average natural gas cost of $10/GJ).

Simple Payback: 0.9 years

Energy Savings: 224 MWh/yr

GHG Emission Reductions: 30 tonnes (and 16%) per year

Quantified annual non-energy benefits: N/A

PROJECT OVERVIEW AND BACKGROUND

808 West Hastings is a multi-tenant office building located in Vancouver's central business district. It is an eleven storey B-class building, built in 1982, with approximately 600 occupants.

This building was fitting candidate for the BOMA BC Building Tune-Up program given its extensive controls system connected to aging mechanical equipment. While the building has a controls contractor, the building operator had made modifications to scheduling along with further adjustments to accommodate maintenance of the mechanical systems and the system had not been optimized to account for those changes for many years.

The building management did not enter into the project with any specific objective other than the suspicion that their building systems were not running at peak efficiency given they had not performed recommissioning in 10 years.

808 West Hastings St. Vancouver

PROJECT SCOPE OF WORK

ESC Automation Inc. was engaged by BOMA BC to provide recommissioning investigation and verification services for 808 W. Hastings as part of the Building Tune Up program.

The project's investigation phase took approximately six weeks and involved a thorough review of the BAS settings, sequences and trend logs to identify and assess optimization opportunities. A list of the identified opportunities are detailed below under Investigation and Opportunities Identified. ESC prepared a report for the building owner and manager outlining recommendations.

The project's implementation phase saw the building manager asking their existing controls contractor (Controls Solutions) to put into place the recommended adjustments and resequencing. This took approximately 10 weeks (from August to October 2019).

Finally, ESC revisited the site to measure and verify the adjustments and resequencing, as well as train the building operator. The project's verification phase lasted two to three weeks and concluded with a final building verification report.

WHAT IS COMMISSIONING?

Building commissioning is a systematic and documented process of ensuring that building systems perform according to the design intent and the owner's operational needs.

Existing Building Commissioning (EBCx):

- *Provides a better environment for occupants*
- *Reduces indoor air quality problems*
- *Reduces occupant complaints*
- *Reduces contractor call-backs and warranty issues*
- *Reduces energy consumption and operational costs*

PROJECT MANAGMENT

808 W. Hastings' motivation for participating was because they recognized a recommissioning of their systems was long overdue. Maintenance of the building's mechanical and controls systems are contracted to third party firms. The operations staff was not trained to undertake systems repairs nor did they know the extent of their building's systems' inefficiencies.

ESC was granted full access to the building and its systems. They also developed the systems reprogramming report and Controls Solutions (the building's existing BAS service provider) undertook the reprograming.

Budgeting was predetermined by BOMA BC for the assessment and verification phase of the project (at $10,000) and implementation costs for the project were $8,140.

Building operator training is included in BOMA BC's Building Tune-Up program. It ensures the building staff is comfortable with the changes and inspires them to maintain the building in its newly optimized state.

INVESTIGATION AND OPPORTUNITIES IDENTIFIED

The key opportunities identified during the assessment of 808 W. Hastings were:

1. Resolve boiler short-cycling
2. Set AHU-1 and MUA-1 heating set points to 9°C
3. Implement floor by floor HVAC schedules, night setback and optimum start
4. Implement dual maximum VAV controls and optimize pressure reset
5. Reduce excessive cooling through zone and AHU adjustments
6. Implement a demand-based CHW temperature reset

LEGEND

AHU – Air Handling Unit

CHW – Chilled Water

DDC – Direct Digital Controls

HVAC – Heating, Ventilation, Air Conditioning

MUA – Make-Up Air (unit)

SAT – Supply Air Temperature

VFD – Variable Frequency Drive

VAV – Variable Air Volume

IMPLEMENTATION AND RESULTS

ESC visited 808 W. Hastings one month after implementation of the recommendations for verification of the work and energy savings results. The following chart details the recommended actions and the resulting savings:

Facility Improvement Measure (FIM)	Energy Savings (MWh/yr)	CO2 Savings (tonnes)	Cost Savings ($/yr)	FIM Cost ($)	Simple Payback (years)
Resolve boiler short-cycling	15	2.9	$540	$0	0.0
Set AHU-1 and MUA-1 heating set points to 9°C	46	8.5	$1,700	$0	0.0
Implement floor by floor HVAC schedules, night setback and optimum start controls	81	11.6	$3,650	$3,890	1.1
Implement dual maximum VAV controls and optimize pressure reset	49	4.3	$2,740	$3,740	1.4
Reduce excessive cooling through zone and AHU adjustments	33	2.7	$2,700	$2,240	0.8
Implement a demand-based CHW temperature reset	11	0.3	$1,260	$520	0.4
TOTAL RECOMMENDED FIMs	**224**	**30.3**	**$12,590**	**$10,390**	**0.9**
FIMs NOT COMPLETED					
Resolve boiler short-cycling	15	2.9	$540	$0	0.0
TOTAL COMPLETED FIMs	**209**	**27.4**	**$12,050**	**$10,390**	**0.9**

PROJECT BENEFITS

ESC identified these benefits once the recommended changes were implemented:

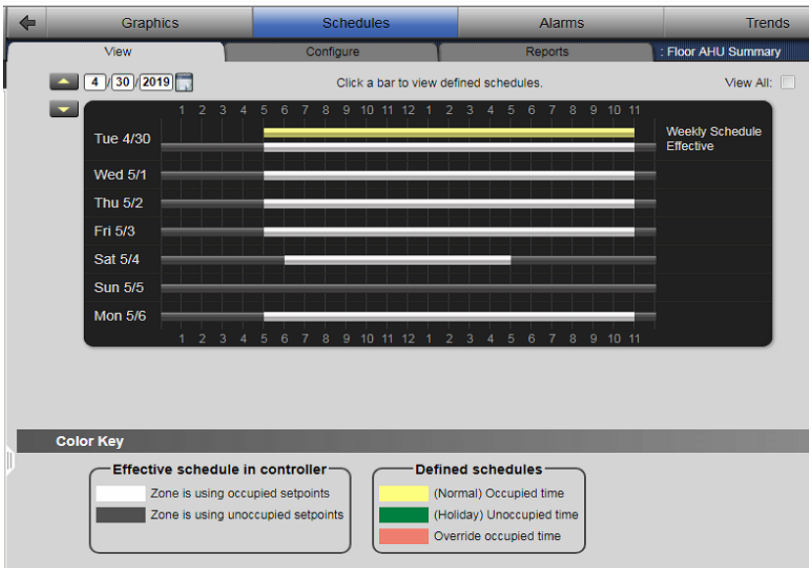
1. **Set AHU-1 and MUA-1 heating set points to 9°C, achieving an annual energy savings of $1,700**

   Reducing this SAT set-point increases free cooling to the building and reduces simultaneous heating and cooling. Comfort will not be compromised by bringing colder ventilation air into the building since the air is mixed with return air before reaching the occupied spaces.

2. **Implemented floor by floor HVAC schedules, night setback and optimized start-up controls, achieving an annual energy savings of $3,650**

   This measure saves energy by reducing the overall run-time of the building HVAC systems, which impacts the ventilation and heating and cooling systems.

   Reduced AHU and Fan-Coil run-times saves fan electrical energy, and heating and cooling energy for space conditioning. Boiler, chiller and pump run-times are reduced.



Graphic Showing 1 Master Schedule for all Floors

   The central ventilation systems are intentionally kept off during after-hours or warm-up periods to minimize unnecessary ventilation air heating.

   This measure should also reduce or eliminate the excessive chiller short- cycling.

3. **Implemented dual maximum VAV controls and optimized pressure reset for an annual energy savings of $2,740.**

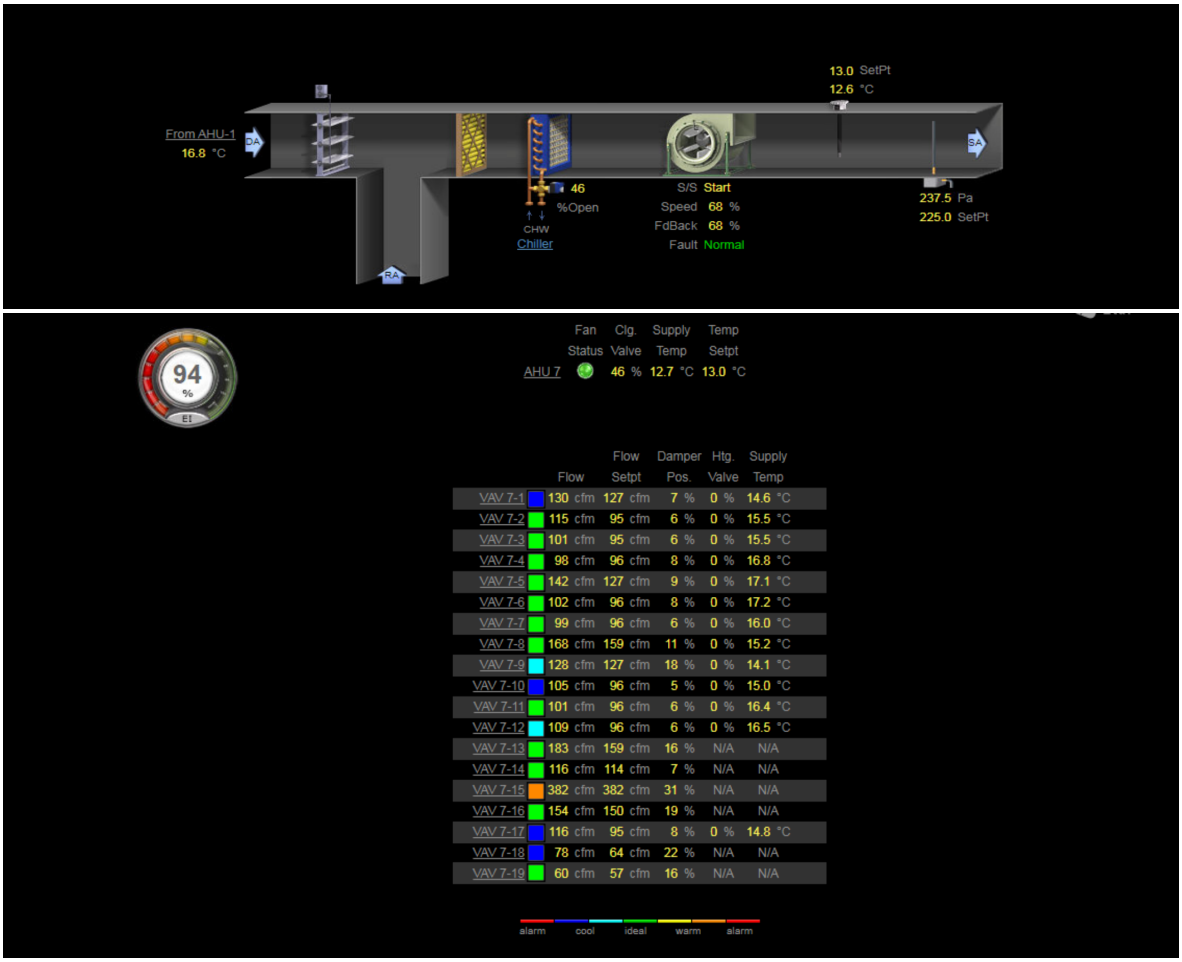
   This measure predominately saves fan energy by reducing the airflow

requirement at the zone level, but also by ensuring that the zone dampers are as wide open as possible and the fan pressures are as low as possible while still meeting required zone airflows.

This measure also reduces heating energy use by reducing the zone minimum airflows at the point where heating starts, and reduces cooling energy use by reducing overall AHU airflow rates.

4. **Reduced cooling demand through zone and AHU adjustments for an annual energy savings of $2,700.**

This measure reduces the annual AHU cooling loads by allowing the units to operate more often at moderated supply air temperatures (SAT's) instead of typically operating at minimum SATs.



AHU-7 Over-Pressurization Example (Low Zone VAV Damper Positions)

Reheat energy is also reduced since zone reheat loads are reduced due to the higher AHU SATs (which results in a smaller temperature change across the reheat coil).

5. **Implemented a demand-based CHW temperature reset for an annual energy savings of $1,260.**

   Chillers operate more efficiently with higher chilled water supply temperatures (CHW), which reduce compressor 'lift' (the differential pressure between the condenser and evaporator). Allowing the CHW supply temperature to vary dynamically based on the building load ensures the chiller is operating as efficiently as possible throughout the year.

6. **Trained building operators on the benefits of controls systems optimization and the specific opportunities identified at the building.**

   This serves to align the building operators' interest in maintaining the optimized systems and increase their awareness of inconsistencies going forward.

FUTURE OPPORTUNITIES

While the Building Tune-Up Program focused on low-cost BAS adjustments to achieve energy savings, two further promising energy retrofit measures were also identified for 808 W. Hasting for their future consideration:

1. **Retrofit Cooling Tower Fan with Variable Frequency Drive (VFD)** – The cooling tower operates with a constant speed fan, and cycles on and off at full load to maintain the plant condensing water temperature (30-40 cycles per day). Retrofitting the fan with a variable frequency drive would allow the unit to operate continuously at a reduced speed that matches the plant load, saving energy and reducing unnecessary wear on the fan motor. The motor should also be replaced with an 'inverter-ready' model. Savings were roughly estimated at $2,400 annually., based upon $15,000 cost and 5.7 year payback (est.).

2. **Re-balance AHU-1 and MUA-1 to Match Ventilation Rates to Occupancy** – The maximum building occupancy is about 625 people, which requires a ventilation rate of about 12,500 cfm/5,900 L/s (based on a ventilation rate of 20 cfm/person as per ASHRAE 62.1. The actual ventilation rate from AHU-1 and MUA-1 is likely

much higher. The ventilation rate of these units could be reduced to match the design occupancy requirement. This can be done by adjusting the fan and motor sheaves of MUA-1 to reduce the fan speeds while measuring the supply airflow, and reducing the VFD speed of AHU-1. Since the occupancy varies significantly floor-to-floor, it is advisable to balance the floor-level flow rates as well via the local balancing dampers. The actual savings need to be confirmed, but for a 20% flow reduction this measure will save about $3,900 annually, based upon an estimated $10,000 cost and 2.56 years payback.

LESSONS LEARNED

1. Minor barriers were encountered with 808 W. Hastings related to scheduling. The initial site assessment and opportunities report were completed in a timely manner, however arrangements to have the building's preferred building controls contractor perform the implementation was slow to complete. It would appear there could be potential for streamlining the process through better communication or alignment of services at the onset of the project.

2. The building manager and building operator's knowledge about their systems was not extensive. This may have constrained their full understanding of the recommendations and ability to maintain the systems at their optimized levels going forward. Training was undertaken at the site, with the building operator, but any staff changes could hinder sustaining the BAS optimization.

    a. A recommendation would be for the Property Manager to initiate a schedule of annual site visits by the contracted controls company (that undertook implementation of the recommended recommissioning actions) or ESC Automation Inc. to review the building's controls settings for assurance of ongoing alignment with the recommissioning recommendations and to provide a Q&A and training session with the onsite building operator.

PROJECT PARTNERS/TEAM:

Building Owner/Manager:	Martello Properties
Commissioning Provider:	ESC Automation
Project Sponsor:	BOMA BC
Controls contractor:	Controls Solutions