JANUARY 18, 2024

Investigation Phase Essentials for Existing Building Commissioning (EBCx) Projects

Part 2

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Agenda - Part 1 (January 11th)

- Save on Energy program updates
- Planning phase
  - Pre-screening
  - Initial assessment
- Investigation phase
  - Diagnostic monitoring
- Q&A

Agenda - Part 2

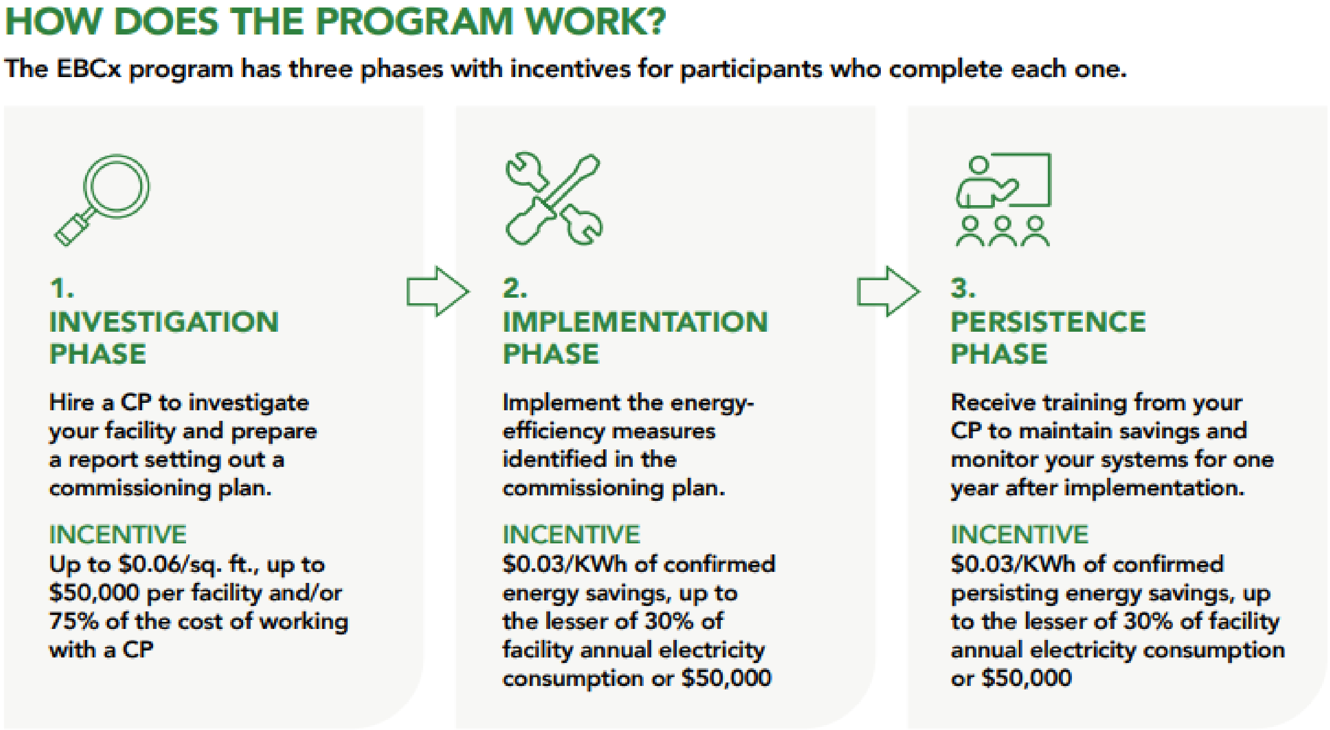
- Save on Energy program updates
- Investigation phase cont’d
  - Functional testing
  - Document findings
  - Estimate savings and implementation costs
  - Investigation report
  - Implementation methods
- Q&A

Save on Energy Capability Building – EBCx resources

- Designed to enhance knowledge and develop skills in organizations and communities to increase awareness and participation in energy-efficiency opportunities across Ontario, including Save on Energy programs
- Our dedicated EBCx resources include:
  - Webinars (*EBCx in a Nutshell*, *Key Measures*)
  - practical guide for building owners and managers
  - information sheets: condos, medical buildings, office buildings and warehouses
  - incentives for ~20 training courses

EBCx resources on Save on Energy website

Save on Energy - EBCx Program



HOW DOES THE PROGRAM WORK?

The EBCx program has three phases with incentives for participants who complete each one.

1.
INVESTIGATION PHASE

Hire a CP to investigate your facility and prepare a report setting out a commissioning plan.

INCENTIVE

Up to $0.06/sq. ft., up to $50,000 per facility and/or 75% of the cost of working with a CP

2.
IMPLEMENTATION PHASE

Implement the energy-efficiency measures identified in the commissioning plan.

INCENTIVE

$0.03/KWh of confirmed energy savings, up to the lesser of 30% of facility annual electricity consumption or $50,000

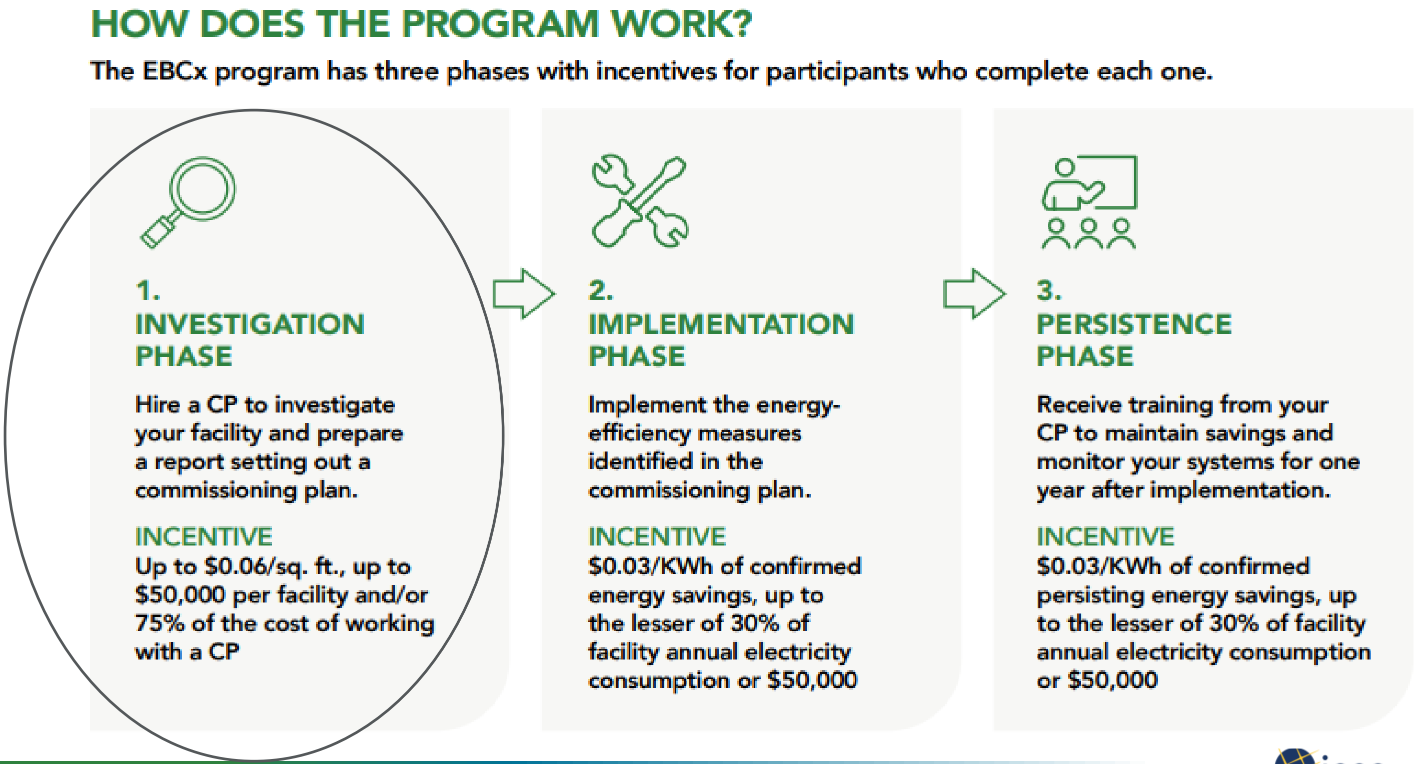
3.
PERSISTENCE PHASE

Receive training from your CP to maintain savings and monitor your systems for one year after implementation.

INCENTIVE

$0.03/KWh of confirmed persisting energy savings, up to the lesser of 30% of facility annual electricity consumption or $50,000

Save on Energy – EBCx Program



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Investigation phase

The investigation phase allows the EBCx team to analyze the system operations in detail, carry out diagnostic tests and propose measures to optimize operations. These measures are presented in the Findings Log, an integral part of the Investigation Report.

Investigation activities

WEBINAR PART 1

Planning/Pre-screening

- Select a building
- Define EBCx objectives
- Define current facility requirements (CFR)
- Define scope and roles

Planning/Initial Assessment

- Review building documentation
- Develop initial EBCx Plan
- Analyze energy data
- Conduct kick-off meeting
- Perform initial walk-through
- Conduct staff interviews
- Document findings (preliminary)
- Meet with owner to focus work for investigation
- Update EBCx Plan and scope

WEBINAR PART 2

Investigation and report

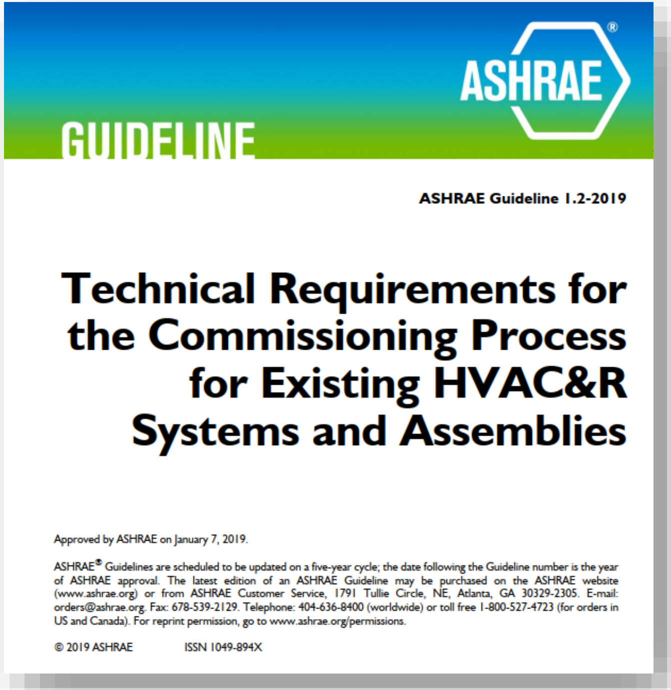
- Run and analyze trends and monitoring
- Conduct further document review/staff interviews/deeper field inspections
- Conduct functional testing
- Document findings (Findings log)
- Estimate savings and implementation costs
- Investigation report
- Review findings with owner
- Select findings to implement
- Update EBCx Plan for implementation and hand-off

Reference : BCxA – Existing Building Commissioning Best Practices (bcxa.org)

Investigation

The objective of the Investigation Phase is to understand and document existing conditions and performance to identify improvements that bring the facility into compliance with the CFR (Current Facility Requirements).

Reference: ASHRAE Guideline 1.2-2019 (Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies)



ASHRAE

GUIDELINE

ASHRAE Guideline 1.2-2019

Technical Requirements for the Commissioning Process for Existing HVAC&R Systems and Assemblies

Approved by ASHRAE on January 7, 2019.

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Investigation

There are four types of investigation for HVAC systems:

- Analysis of existing data
- Spot measurements
- Short-term performance monitoring
- Longer-term performance testing (seasonal testing)

Functional testing

EBCx functional testing has several objectives:

- Validate that all components function well and are in good condition.
- Recommend repair or replacement.
- Validate the actual sequence of operation and compare to original as-built sequences.
- Identify opportunities to improve operation and energy efficiency.

Functional testing

Develop functional performance test (FPT) procedures for systems identified in the project scope. FPT should confirm actual system operation and evaluate systems performance under different operating conditions:

- **At shutdown**
- **At start-up**
- **Normal operation** (heating mode, cooling mode, free-cooling mode)
- **Operation during off-hours**
- Typically not included: alarms, failure and standby modes

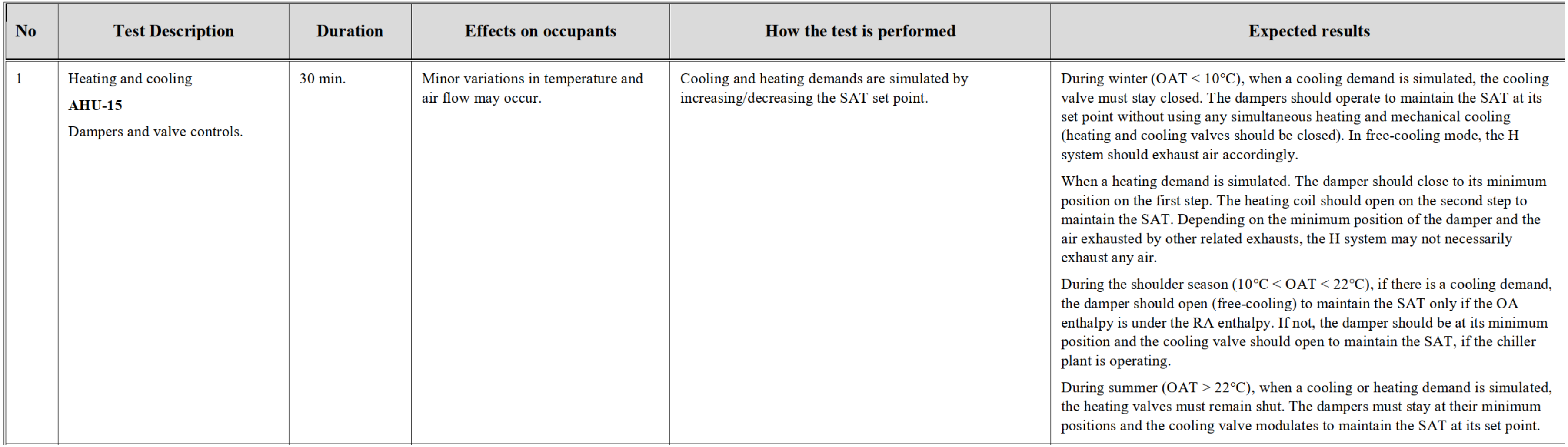
Functional testing can be **passive** (detailed trend and Building Automation System (BAS)/on-site observations) or **active** (setpoint manual overrides or physical alteration on site).

Functional testing

Ideally, functional testing covers every operation mode:

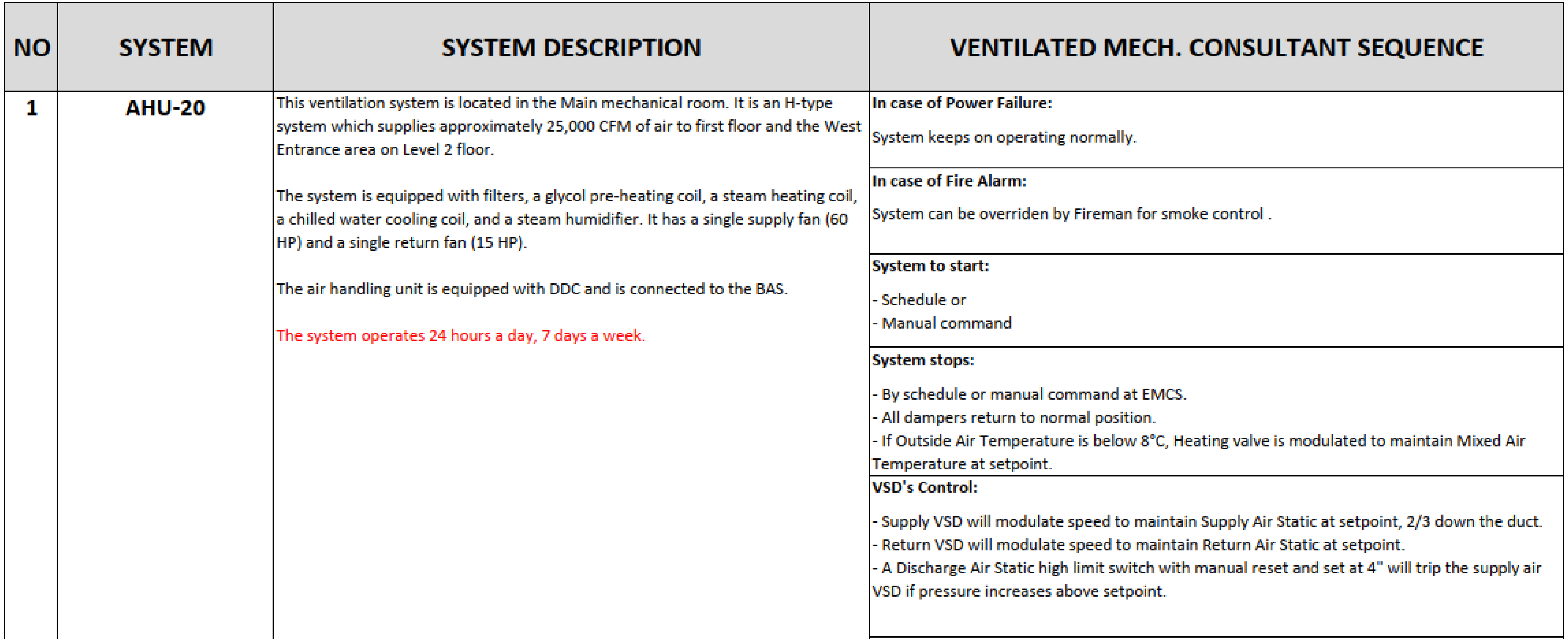
- **Winter functional tests** on heating production and distribution (boilers, furnaces, geothermal systems, air source heat pump, pumps, etc.).
- **Summer functional tests** on cooling production and distribution (chillers, cooling towers, pumps, etc.).
- **Over three seasons** on ventilation systems (air handling units, dedicated outdoor air systems, air-to-air heat recovery, etc.).
- **Over one season** on terminal units (Variable Air Volume (VAV) boxes, fan coils, convectors, lighting, room sensors, etc.).

Functional testing - example



No	Test Description	Duration	Effects on occupants	How the test is performed	Expected results
1	Heading and cooling **AHU-15** Dampers and valve controls.	30 min.	Minor variations in temperature and air flow may occur.	Cooling and heating demands are simulated by increasing/decreasing the SAT set point.	During winter (OAT < 10°C), when a cooling demand is simulated, the cooling valve must stay closed. The dampers should operate to maintain the SAT at its set point without using any simultaneous heating and mechanical cooling (heating and cooling valves should be closed). In free-cooling mode, the H system should exhaust air accordingly. When a heating demand is simulated. The damper should close to its minimum position on the first step. The heating coil should open on the second step to maintain the SAT. Depending on the minimum position of the damper and the air exhausted by other related exhausts, the H system may not necessarily exhaust any air. During the shoulder season (10°C < OAT < 22°C), if there is a cooling demand, the damper should open (free-cooling) to maintain the SAT only if the OA enthalpy is under the RA enthalpy. If not, the damper should be at its minimum position and the cooling valve should open to maintain the SAT, if the chiller plant is operating. During summer (OAT > 22°C), when a cooling or heating demand is simulated, the heating valves must remain shut. The dampers must stay at their minimum positions and the cooling valve modulates to maintain the SAT at its set point.

Functional testing – example verification checklist

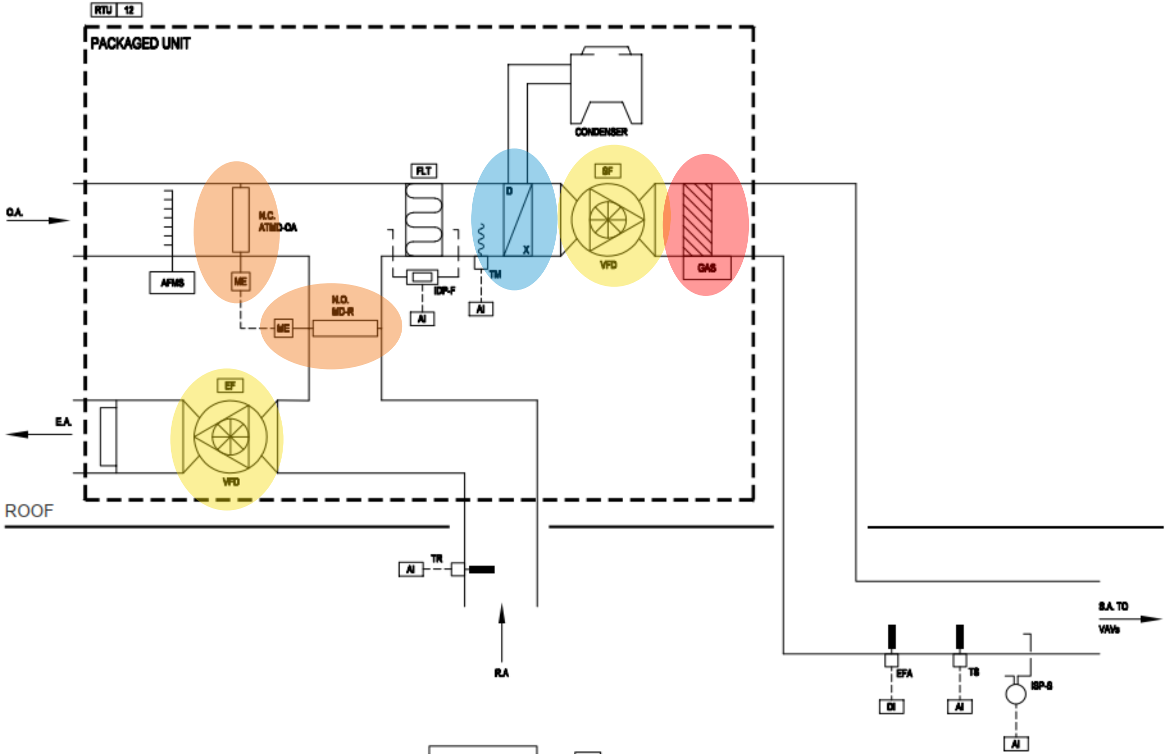


NO	SYSTEM	SYSTEM DESCRIPTION	VENTILATED MECH. CONSULTANT SEQUENCE
1	**AHU-20**	This ventilation system is located in the Main mechanical room. It is an H-type system which supplies approximately 25,000 CFM of air to first floor and the West Entrance area on Level 2 floor. The system is equipped with filters, a glycol pre-heating coil, a steam heating coil, a chilled water cooling coil, and a steam humidifier. It has a single supply fan (60 HP) and a single return fan (15 HP). The air handling unit is equipped with DDC and is connected to the BAS. The system operates 24 hours a day, 7 days a week.	**In case of Power Failure:** System keeps on operating normally.
			In case of Fire Alarm: System can be overriden by Fireman for smoke control .
			System to start: - Schedule or - Manual command
			System stops: - By schedule or manual command at EMCS. - All dampers return to normal position. - If Outside Air Temperature is below 8°C, Heating valve is modulated to maintain Mixed Air Temperature at setpoint.
			VSD's Control: - Supply VSD will modulate speed to maintain Supply Air Static at setpoint, 2/3 down the duct. - Return VSD will modulate speed to maintain Return Air Static at setpoint. - A Discharge Air Static high limit switch with manual reset and set at 4" will trip the supply air VSD if pressure increases above setpoint.

Functional testing – ventilation

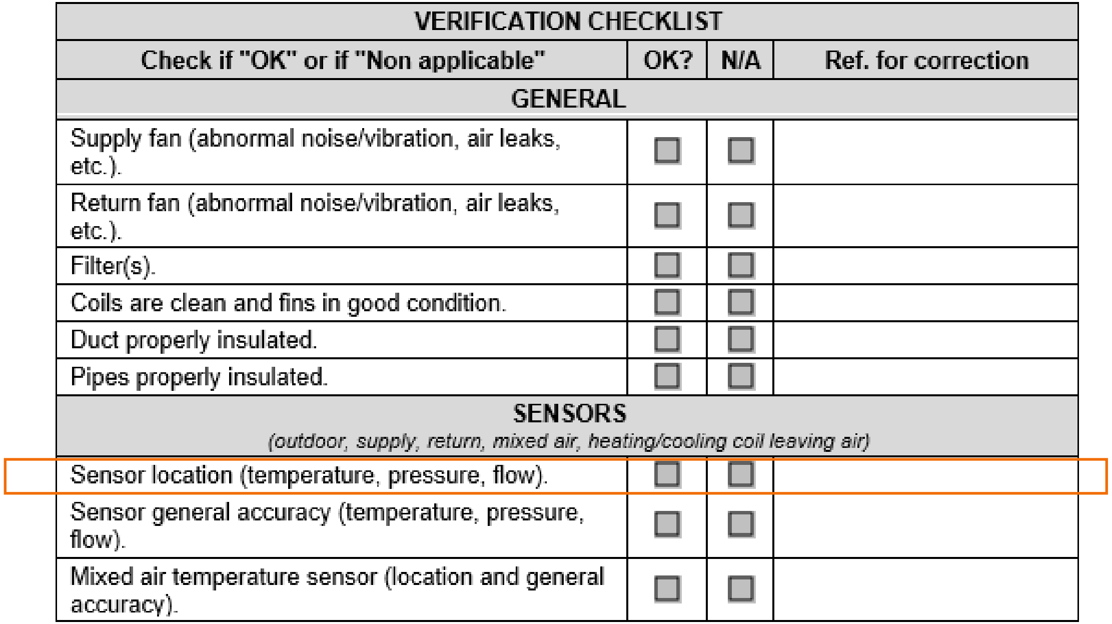
Systems and components to verify/test:

- fans and VFD
- coils
- heating/cooling coils
- dampers
- valves
- sensors
- filters



Functional testing – ventilation

Verification checklist example



VERIFICATION CHECKLIST

Check if "OK" or if "Non applicable"	OK?	N/A	Ref. for correction
GENERAL			
Supply fan (abnormal noise/vibration, air leaks, etc.).	☐	☐	
Return fan (abnormal noise/vibration, air leaks, etc.).	☐	☐	
Filter(s).	☐	☐	
Coils are clean and fins in good condition.	☐	☐	
Duct properly insulated.	☐	☐	
Pipes properly insulated.	☐	☐	
SENSORS *(outdoor, supply, return, mixed air, heating/cooling coil leaving air)*			
Sensor location (temperature, pressure, flow).	☐	☐	
Sensor general accuracy (temperature, pressure, flow).	☐	☐	
Mixed air temperature sensor (location and general accuracy).	☐	☐	

Functional testing – ventilation

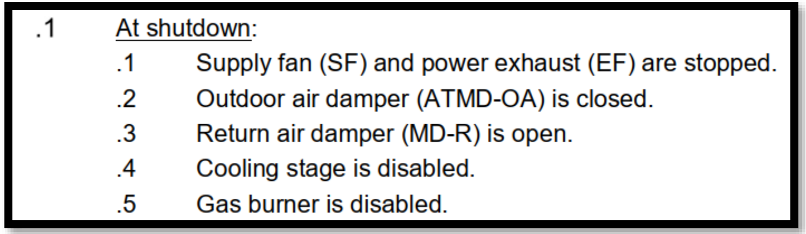
Test description:

Simulate a shutdown by modifying schedule and/or by manual override.

Expected result:

- Fans are stopped.
- All dampers return to normal position (Outdoor Air Damper (OAD) closed, Return Air Damper (RAD) open).
- Cooling/heating are disabled.

Sequence of operation (original as-built sequences)



.1 At shutdown:
  .1 Supply fan (SF) and power exhaust (EF) are stopped.
  .2 Outdoor air damper (ATMD-OA) is closed.
  .3 Return air damper (MD-R) is open.
  .4 Cooling stage is disabled.
  .5 Gas burner is disabled.

Observations/Recommendations:

Example: Outdoor air damper is stuck fully open. Repairs required.

Functional testing – ventilation

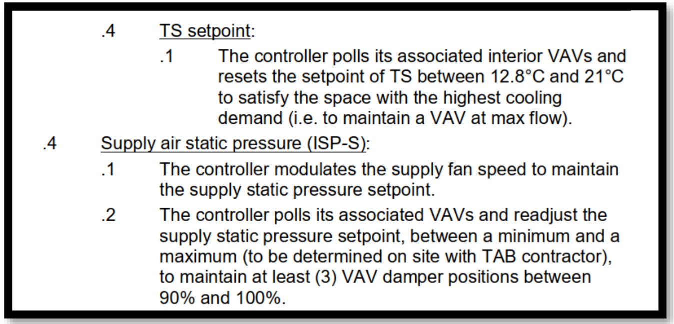
Test description:

Simulate a high cooling demand by overriding 2 or 3 room temperatures (25°C manual override).

Expected results:

- Supply air temperature setpoint is reset to 12.8°C. Cooling coil is enabled and supply air temperature reach setpoint.
- Supply air static pressure setpoint is reset. Variable Frequency Drive (VFD) modulates to reach setpoint.

Sequence of operation (original as-built sequences)



.4 TS setpoint:

.1 The controller polls its associated interior VAVs and resets the setpoint of TS between 12.8°C and 21°C to satisfy the space with the highest cooling demand (i.e. to maintain a VAV at max flow).

.4 Supply air static pressure (ISP-S):

.1 The controller modulates the supply fan speed to maintain the supply static pressure setpoint.

.2 The controller polls its associated VAVs and readjust the supply static pressure setpoint, between a minimum and a maximum (to be determined on site with TAB contractor), to maintain at least (3) VAV damper positions between 90% and 100%.

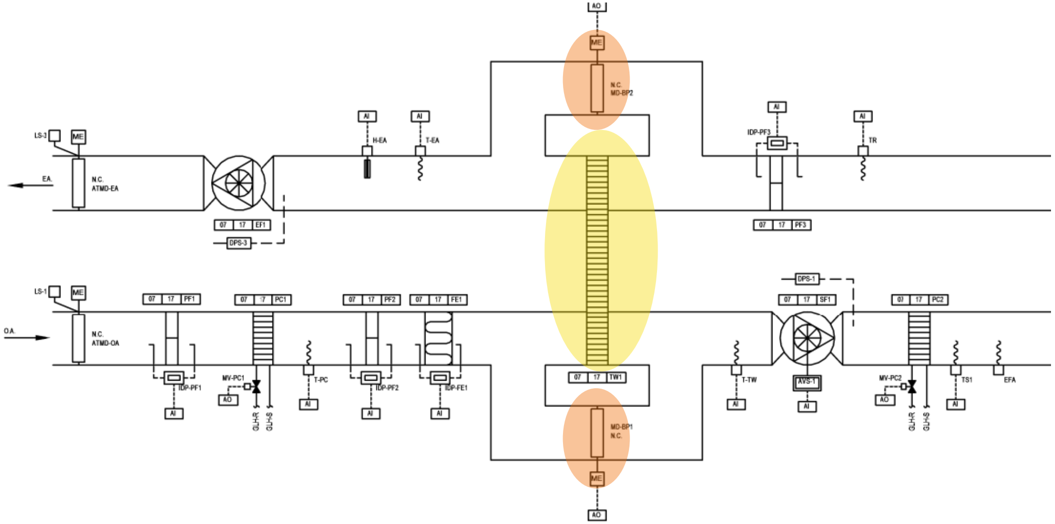
Observations/Recommendations:

Example: Supply air T° setpoint was set to 19°C (manual override). Re-establish automatic setpoint and perform further tests.

Functional testing – heat recovery

Systems and components to verify/test:

- thermal wheel
- bypass dampers
- sensors (before/after thermal wheel)
- fans
- heating and cooling coils



Functional testing – heat recovery

Test description:

Simulate a heating demand by modifying supply air temperature setpoint.

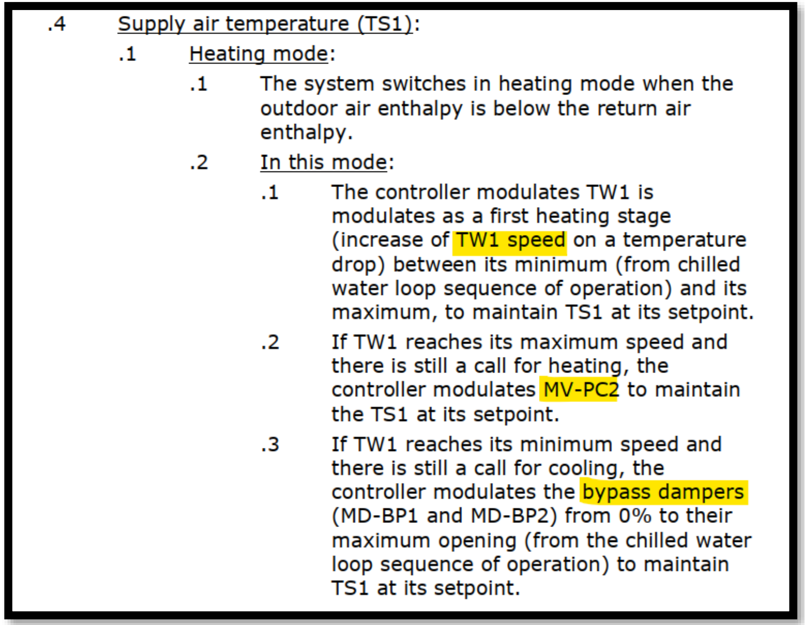
Expected results:

- Thermal wheel is used as a first stage heating.
- Pre-heating coil is disabled.
- Thermal wheel speed modulates from minimum to maximum.
- Bypass dampers are closed.

Observations/Recommendations :

Example: No control sequences set up for bypass dampers. Dampers closed.

Sequence of operation (original as-built sequences)



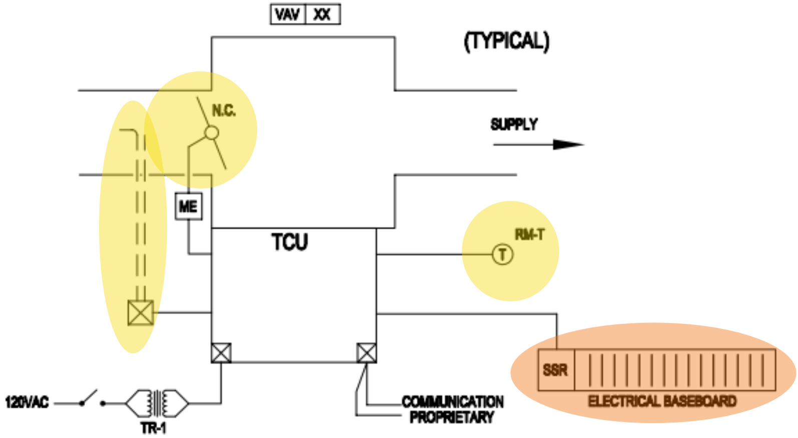
.4 Supply air temperature (TS1):

- .1 Heating mode:
  - .1 The system switches in heating mode when the outdoor air enthalpy is below the return air enthalpy.
  - .2 In this mode:
    - .1 The controller modulates TW1 is modulates as a first heating stage (increase of TW1 speed on a temperature drop) between its minimum (from chilled water loop sequence of operation) and its maximum, to maintain TS1 at its setpoint.
    - .2 If TW1 reaches its maximum speed and there is still a call for heating, the controller modulates MV-PC2 to maintain the TS1 at its setpoint.
    - .3 If TW1 reaches its minimum speed and there is still a call for cooling, the controller modulates the bypass dampers (MD-BP1 and MD-BP2) from 0% to their maximum opening (from the chilled water loop sequence of operation) to maintain TS1 at its setpoint.

Functional testing – local controls

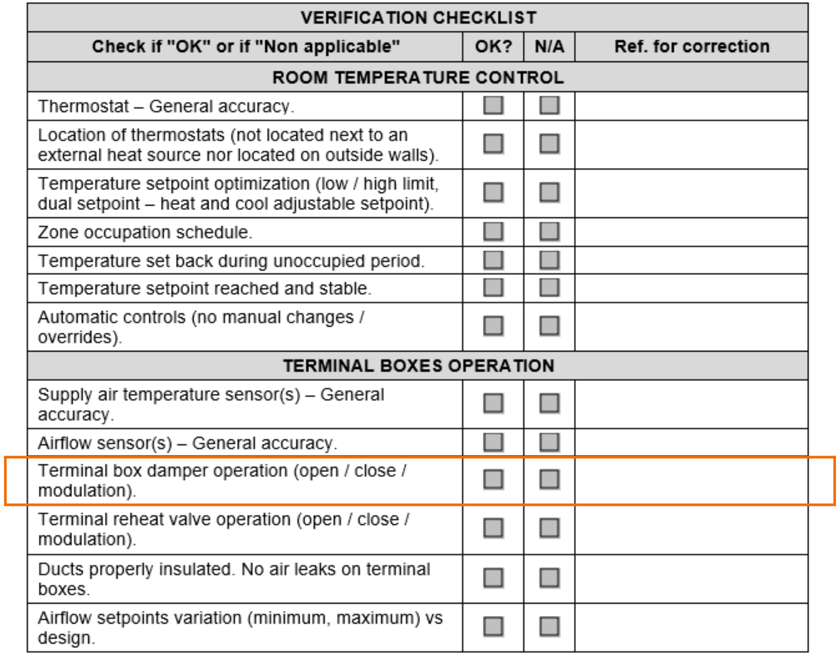
Systems and components to verify/test:

- VAV (Variable Air Volume) box
- terminal reheat (if applicable)
- perimeter heating
- air flow sensor
- room temperature sensor



Functional testing – local controls

Verification checklist example



VERIFICATION CHECKLIST			
Check if "OK" or if "Non applicable"	**OK?**	**N/A**	**Ref. for correction**
ROOM TEMPERATURE CONTROL			
Thermostat – General accuracy.	☐	☐	
Location of thermostats (not located next to an external heat source nor located on outside walls).	☐	☐	
Temperature setpoint optimization (low / high limit, dual setpoint – heat and cool adjustable setpoint).	☐	☐	
Zone occupation schedule.	☐	☐	
Temperature set back during unoccupied period.	☐	☐	
Temperature setpoint reached and stable.	☐	☐	
Automatic controls (no manual changes / overrides).	☐	☐	
TERMINAL BOXES OPERATION			
Supply air temperature sensor(s) – General accuracy.	☐	☐	
Airflow sensor(s) – General accuracy.	☐	☐	
Terminal box damper operation (open / close / modulation).	☐	☐	
Terminal reheat valve operation (open / close / modulation).	☐	☐	
Ducts properly insulated. No air leaks on terminal boxes.	☐	☐	
Airflow setpoints variation (minimum, maximum) vs design.	☐	☐	

Functional testing – local controls

Test description:

Simulate a heating demand during unoccupied hours.

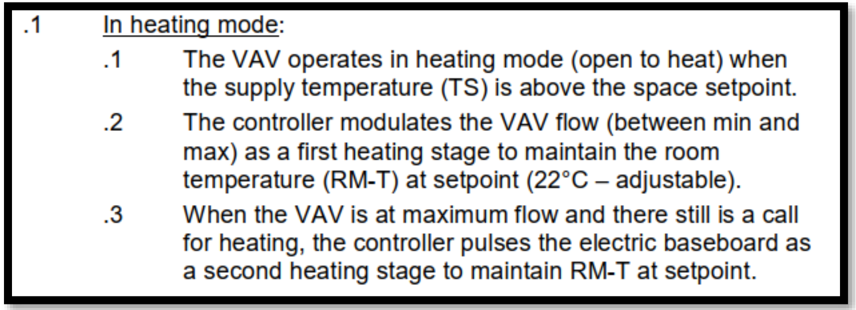
Expected results:

- VAV modulates to maintain room temperature setpoint - 20°C.
- Electric baseboard modulates to maintain room temperature setpoint minus 2°C - 18°C.

Observations/Recommendations:

Example: For room 203, simultaneous heating and cooling is observed during unoccupied period. Review sequences of operation.

Sequence of operation (original as-built sequences)

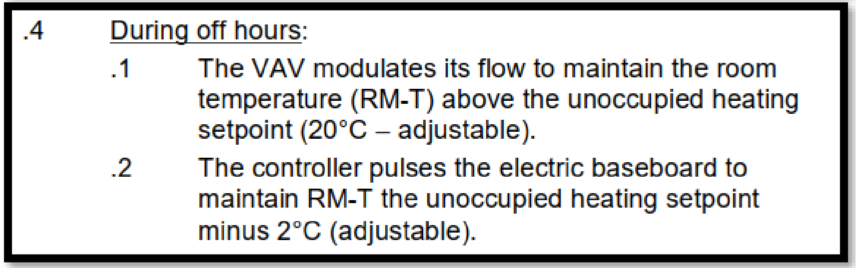


.1 In heating mode:

  .1 The VAV operates in heating mode (open to heat) when the supply temperature (TS) is above the space setpoint.

  .2 The controller modulates the VAV flow (between min and max) as a first heating stage to maintain the room temperature (RM-T) at setpoint (22°C – adjustable).

  .3 When the VAV is at maximum flow and there still is a call for heating, the controller pulses the electric baseboard as a second heating stage to maintain RM-T at setpoint.



.4 During off hours:

  .1 The VAV modulates its flow to maintain the room temperature (RM-T) above the unoccupied heating setpoint (20°C – adjustable).

  .2 The controller pulses the electric baseboard to maintain RM-T the unoccupied heating setpoint minus 2°C (adjustable).

Functional testing – lighting controls

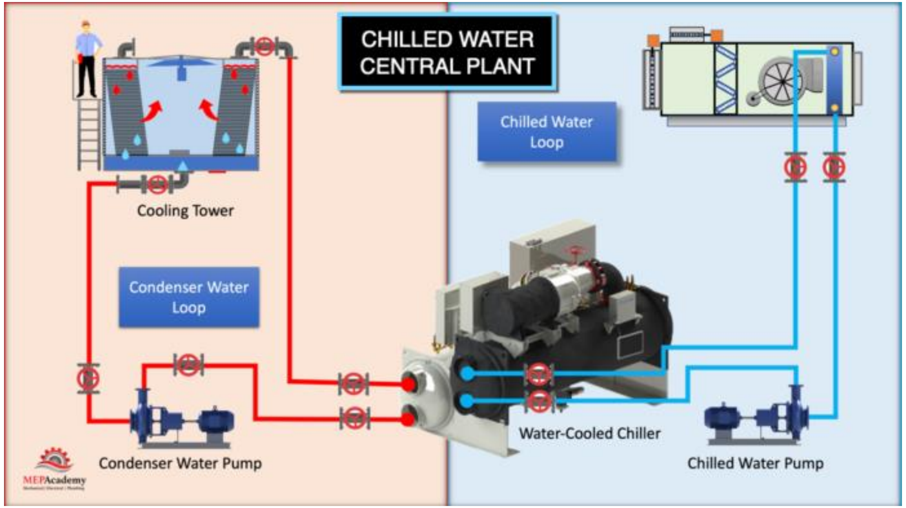
Systems and components to verify/test:

- occupancy sensors – timeout, sensitivity, location (sampling method)
- daylight sensors (photocells) – calibration and location (sampling method)
- lighting controls – sweeps and schedules
- lighting control zones
- lighting levels

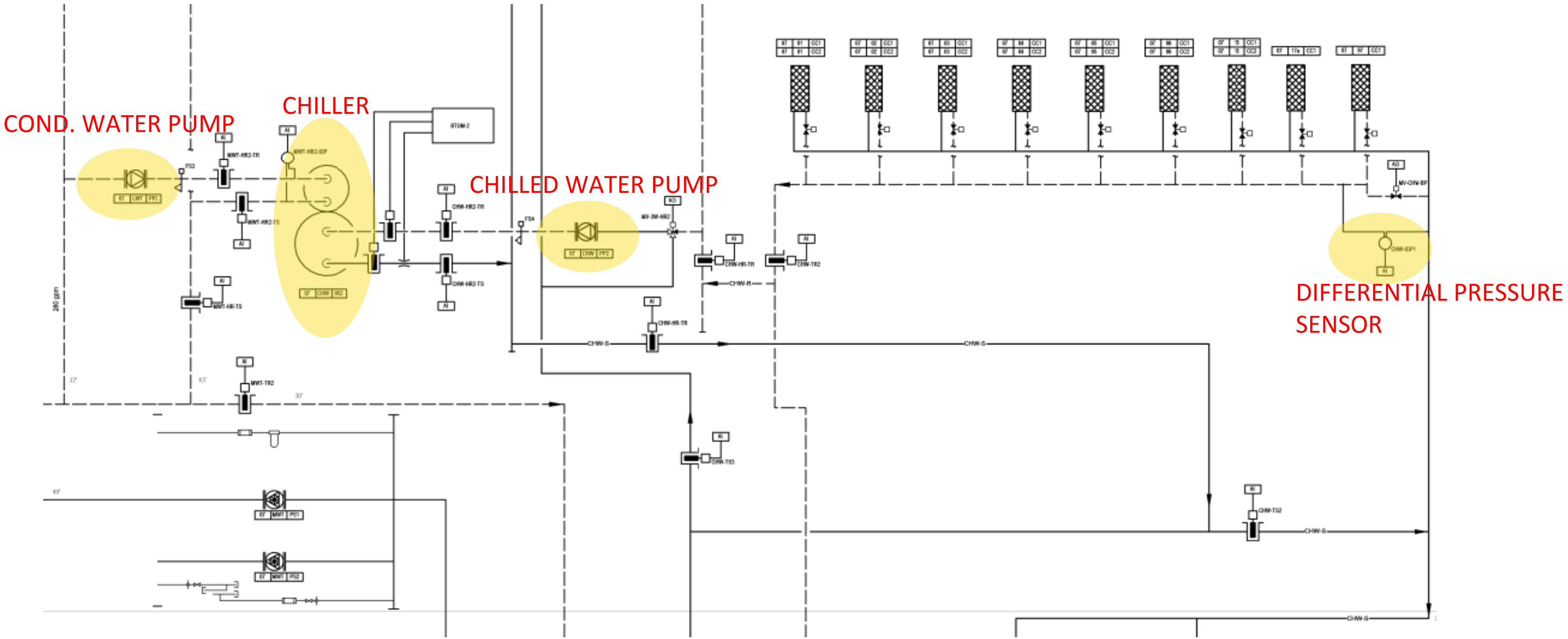
Functional testing – central cooling plant

Systems and components to verify/test:

- General condition:
  - chillers
  - cooling towers
  - primary/secondary pumps
- Primary chilled water loop operation
- Secondary chilled water loop operation
- Heat rejection operation (cooling tower/dry cooler/heat recovery)

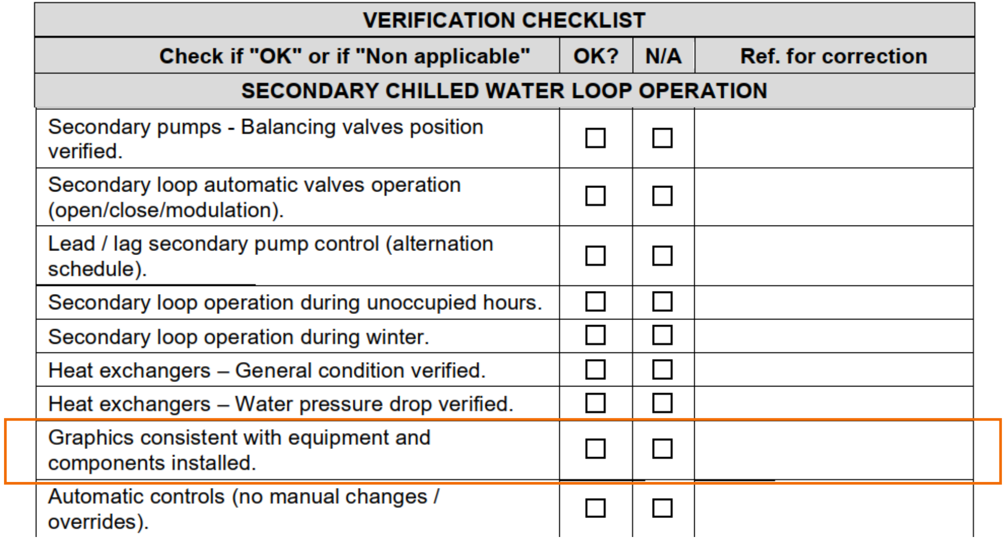


Functional testing – central cooling plant



Functional testing – central cooling plant

Verification checklist example



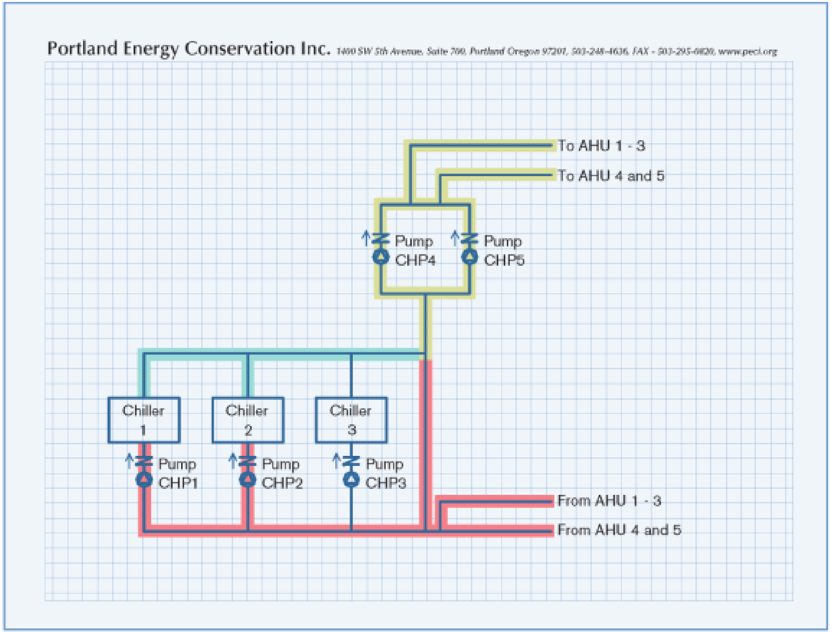
VERIFICATION CHECKLIST			
Check if "OK" or if "Non applicable"	**OK?**	**N/A**	**Ref. for correction**
SECONDARY CHILLED WATER LOOP OPERATION			
Secondary pumps - Balancing valves position verified.	☐	☐	
Secondary loop automatic valves operation (open/close/modulation).	☐	☐	
Lead / lag secondary pump control (alternation schedule).	☐	☐	
Secondary loop operation during unoccupied hours.	☐	☐	
Secondary loop operation during winter.	☐	☐	
Heat exchangers – General condition verified.	☐	☐	
Heat exchangers – Water pressure drop verified.	☐	☐	
Graphics consistent with equipment and components installed.	☐	☐	
Automatic controls (no manual changes / overrides).	☐	☐	

Functional testing – central cooling plant

Order of connections may be important.

Diagram based on design documents :

All air handling units (AHU) receive the same water supply temperature.

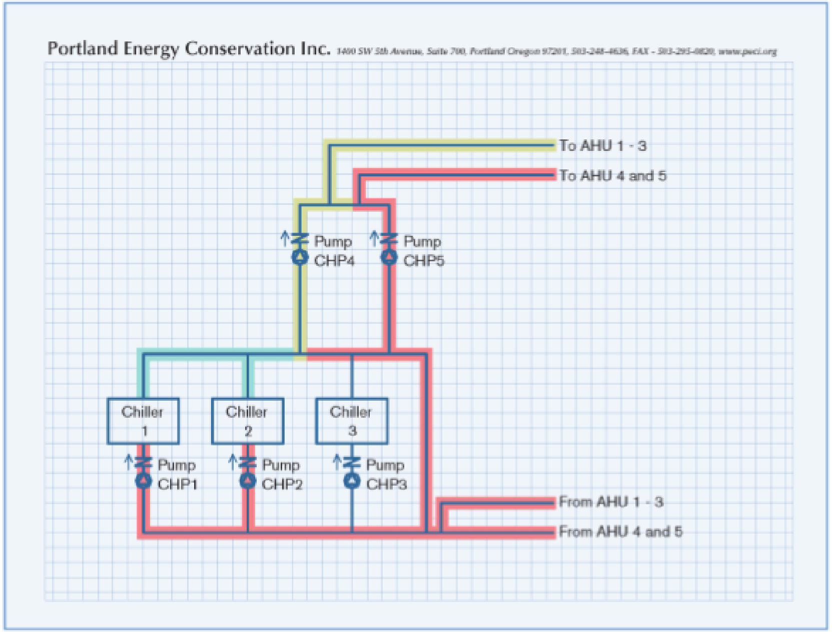


Functional testing – central cooling plant

Order of connections may be important.

Diagram based on "as piped" field conditions :

AHU 4 and 5 receive warmer water if there is bypass flow from the return.



Functional testing – central cooling plant

Test description:

Verify secondary chilled water loop operation during summer season.

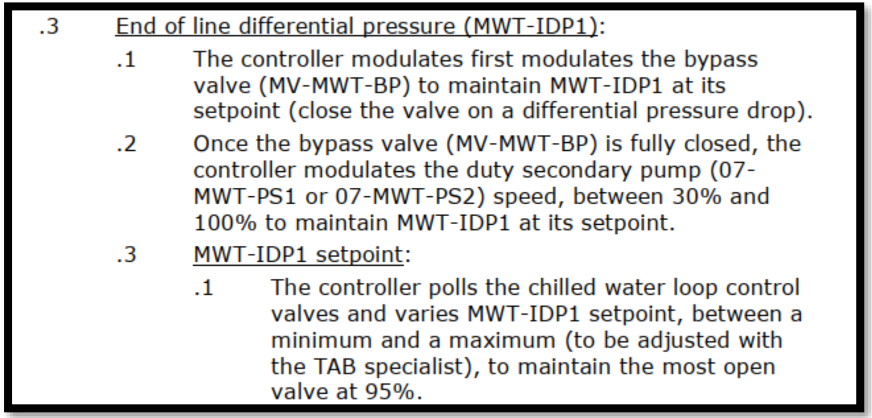
Expected results:

- Bypass valves are closed.
- Speed pump modulates to maintain the most open valve at 95%.

Observations / Recommendations:

Example: On cooling demand (outdoor air temperature 27°C), all valves are opened at 50% or less. Optimize differential pressure setpoint to reduce pump speed.

Sequence of operation (original as-built sequences)



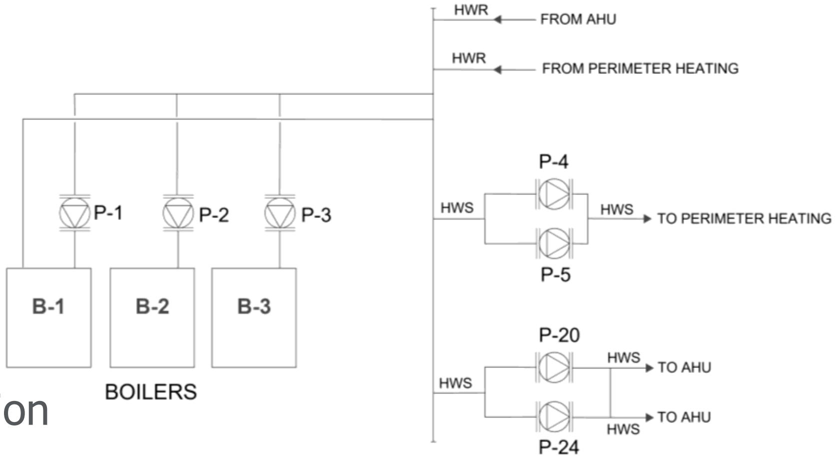
.3 End of line differential pressure (MWT-IDP1):

- .1 The controller modulates first modulates the bypass valve (MV-MWT-BP) to maintain MWT-IDP1 at its setpoint (close the valve on a differential pressure drop).
- .2 Once the bypass valve (MV-MWT-BP) is fully closed, the controller modulates the duty secondary pump (07-MWT-PS1 or 07-MWT-PS2) speed, between 30% and 100% to maintain MWT-IDP1 at its setpoint.
- .3 MWT-IDP1 setpoint:
  - .1 The controller polls the chilled water loop control valves and varies MWT-IDP1 setpoint, between a minimum and a maximum (to be adjusted with the TAB specialist), to maintain the most open valve at 95%.

Functional testing – central heating plant

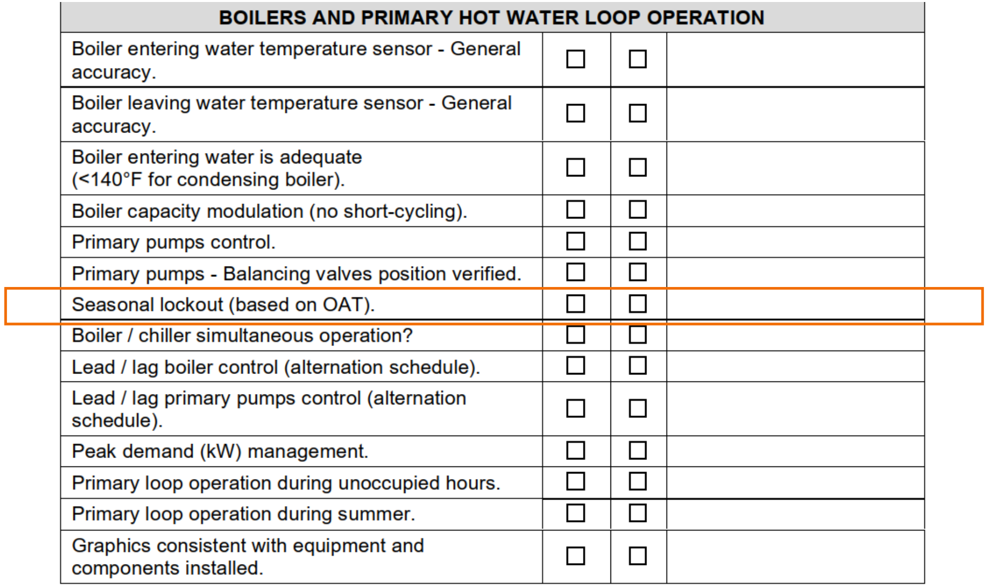
Systems and components to verify/test:

- General condition:
    - boilers
    - primary and secondary heating pumps
    - heat exchangers (if applicable)
- Boilers and primary hot water loop operation
- Secondary hot water loop operation



Functional testing – central heating plant

Verification checklist example



BOILERS AND PRIMARY HOT WATER LOOP OPERATION			
Boiler entering water temperature sensor - General accuracy.	☐	☐	
Boiler leaving water temperature sensor - General accuracy.	☐	☐	
Boiler entering water is adequate (<140°F for condensing boiler).	☐	☐	
Boiler capacity modulation (no short-cycling).	☐	☐	
Primary pumps control.	☐	☐	
Primary pumps - Balancing valves position verified.	☐	☐	
Seasonal lockout (based on OAT).	☐	☐	
Boiler / chiller simultaneous operation?	☐	☐	
Lead / lag boiler control (alternation schedule).	☐	☐	
Lead / lag primary pumps control (alternation schedule).	☐	☐	
Peak demand (kW) management.	☐	☐	
Primary loop operation during unoccupied hours.	☐	☐	
Primary loop operation during summer.	☐	☐	
Graphics consistent with equipment and components installed.	☐	☐	

Functional testing – central heating plant

Test description:

Verify lead/lag sequence for boilers and pumps during winter season.

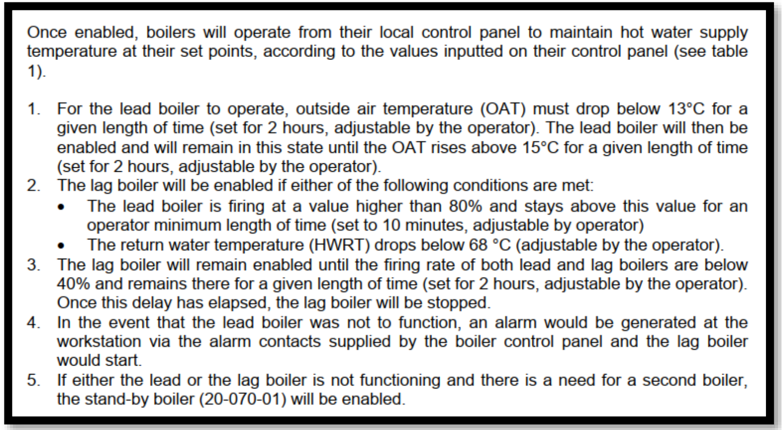
Expected results:

- Lead boiler will start automatically (if outdoor air temperature < 13°C). Lag boiler will start automatically (if lead boiler > 80%).
- Lead/Lag boilers will stop automatically under several conditions.

Observations / Recommendations :

Example: Boiler 1 and Boiler 2 are observed at 20% for more than 2 hours. Review sequences for lag boiler. Alternation schedule for lead boiler selection is disabled (manual override).

Sequence of operation (original as-built sequences)



Once enabled, boilers will operate from their local control panel to maintain hot water supply temperature at their set points, according to the values inputted on their control panel (see table 1).

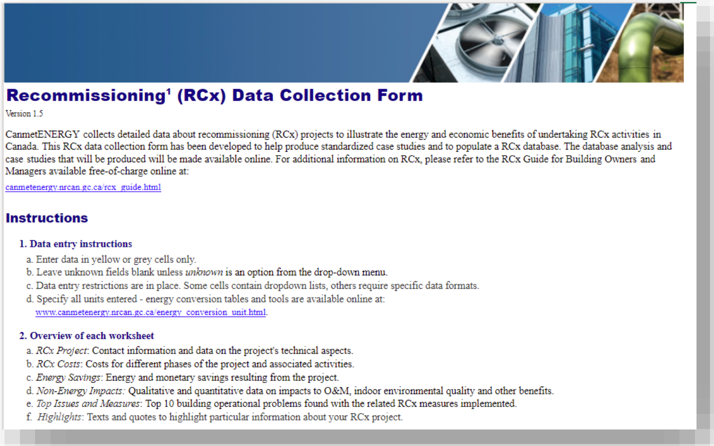
1. For the lead boiler to operate, outside air temperature (OAT) must drop below 13°C for a given length of time (set for 2 hours, adjustable by the operator). The lead boiler will then be enabled and will remain in this state until the OAT rises above 15°C for a given length of time (set for 2 hours, adjustable by the operator).
2. The lag boiler will be enabled if either of the following conditions are met:
   - The lead boiler is firing at a value higher than 80% and stays above this value for an operator minimum length of time (set to 10 minutes, adjustable by operator)
   - The return water temperature (HWRT) drops below 68 °C (adjustable by the operator).
3. The lag boiler will remain enabled until the firing rate of both lead and lag boilers are below 40% and remains there for a given length of time (set for 2 hours, adjustable by the operator). Once this delay has elapsed, the lag boiler will be stopped.
4. In the event that the lead boiler was not to function, an alarm would be generated at the workstation via the alarm contacts supplied by the boiler control panel and the lag boiler would start.
5. If either the lead or the lag boiler is not functioning and there is a need for a second boiler, the stand-by boiler (20-070-01) will be enabled.

Document findings in a findings log

A findings log is an important deliverable and a decision-making tool for the building owner. It should include, at minimum:

- description of findings
- measure descriptions
- estimated energy savings
- implementation cost
- simple payback
- recommendations for implementation

NRCan offers a free tool for EBCx data collection:



Recommissioning[1] (RCx) Data Collection Form

Version 1.5

CanmetENERGY collects detailed data about recommissioning (RCx) projects to illustrate the energy and economic benefits of undertaking RCx activities in Canada. This RCx data collection form has been developed to help produce standardized case studies and to populate a RCx database. The database analysis and case studies that will be produced will be made available online. For additional information on RCx, please refer to the RCx Guide for Building Owners and Managers available free-of-charge online at:

canmetenergy.nrcan.gc.ca/rcx_guide.html

Instructions

1. Data entry instructions

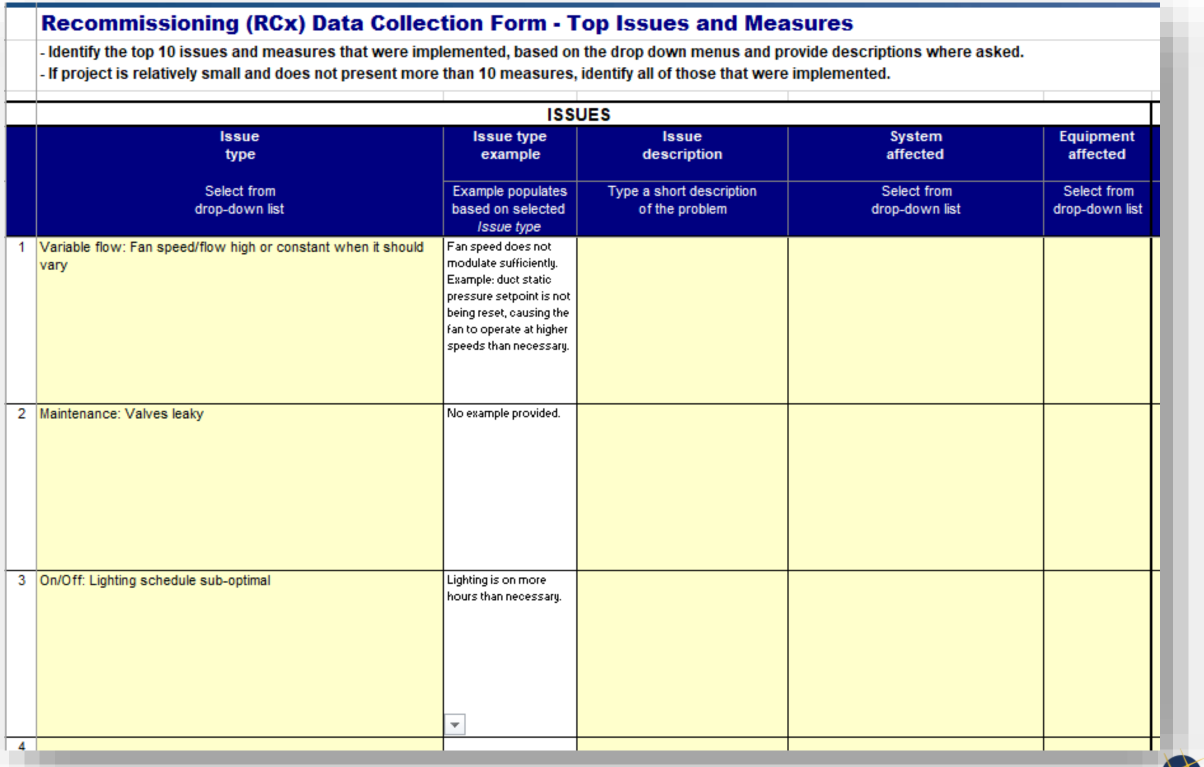
a. Enter data in yellow or grey cells only.
b. Leave unknown fields blank unless *unknown* is an option from the drop-down menu.
c. Data entry restrictions are in place. Some cells contain dropdown lists, others require specific data formats.
d. Specify all units entered - energy conversion tables and tools are available online at: www.canmetenergy.nrcan.gc.ca/energy_conversion_unit.html.

2. Overview of each worksheet

a. *RCx Project*: Contact information and data on the project's technical aspects.
b. *RCx Costs*: Costs for different phases of the project and associated activities.
c. *Energy Savings*: Energy and monetary savings resulting from the project.
d. *Non-Energy Impacts:* Qualitative and quantitative data on impacts to O&M, indoor environmental quality and other benefits.
e. *Top Issues and Measures*: Top 10 building operational problems found with the related RCx measures implemented.
f. *Highlights*: Texts and quotes to highlight particular information about your RCx project.

Available at: https://natural-resources.canada.ca/sites/nrcan/files/files/excel/NRCan_RCx_Data_Form.xls

Findings log example



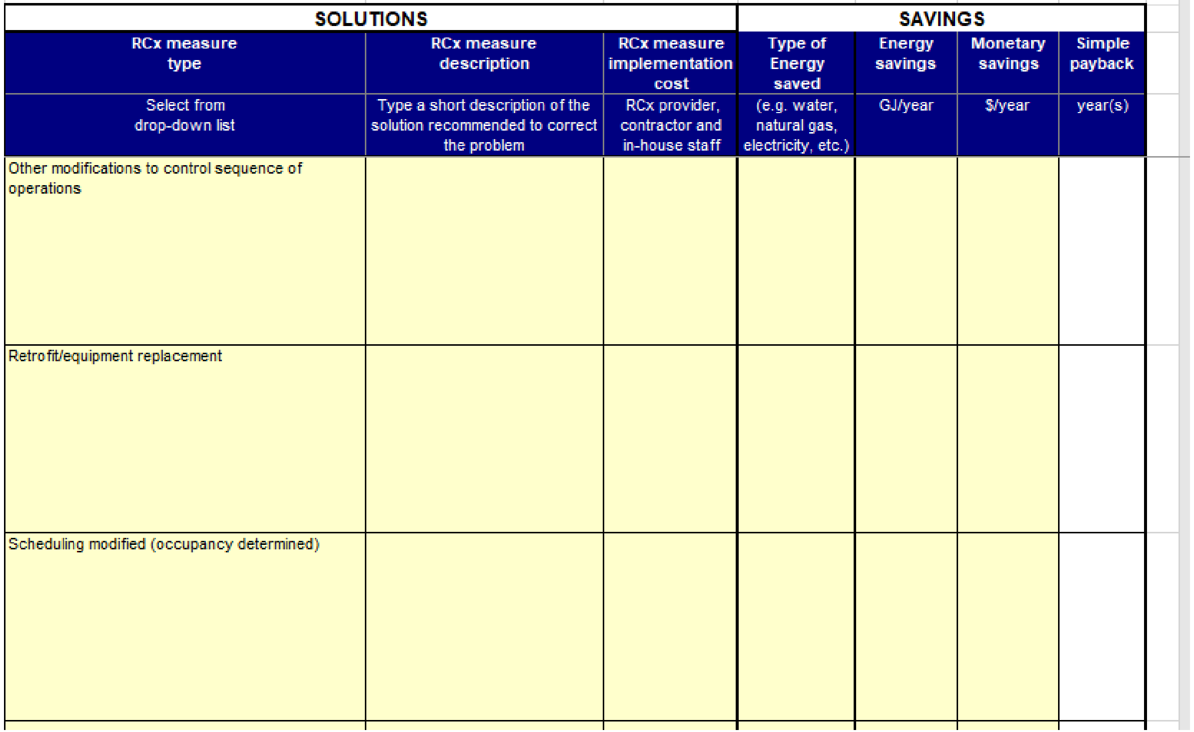
Recommissioning (RCx) Data Collection Form - Top Issues and Measures

- Identify the top 10 issues and measures that were implemented, based on the drop down menus and provide descriptions where asked.
- If project is relatively small and does not present more than 10 measures, identify all of those that were implemented.

ISSUES

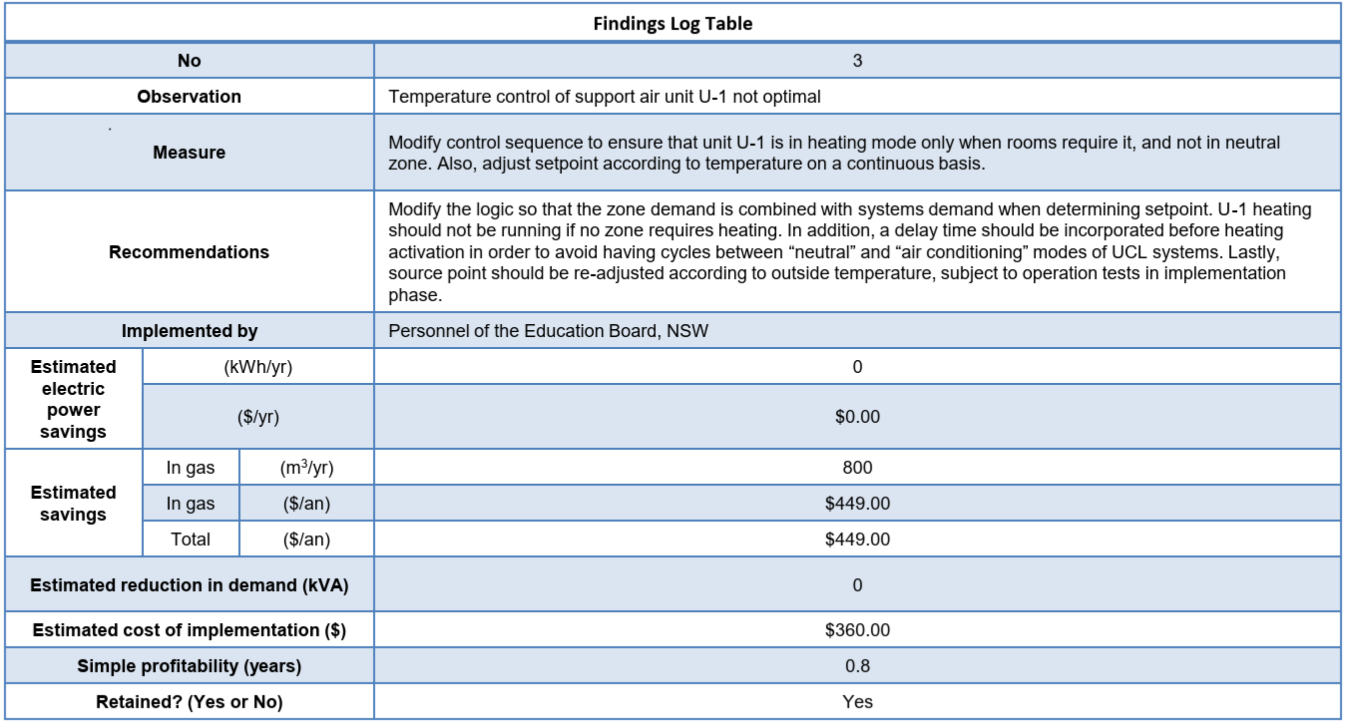
	Issue type Select from drop-down list	Issue type example Example populates based on selected *Issue type*	Issue description Type a short description of the problem	System affected Select from drop-down list	Equipment affected Select from drop-down list
1	Variable flow: Fan speed/flow high or constant when it should vary	Fan speed does not modulate sufficiently. Example: duct static pressure setpoint is not being reset, causing the fan to operate at higher speeds than necessary.			
2	Maintenance: Valves leaky	No example provided.			
3	On/Off: Lighting schedule sub-optimal	Lighting is on more hours than necessary.			
4					

Findings log example



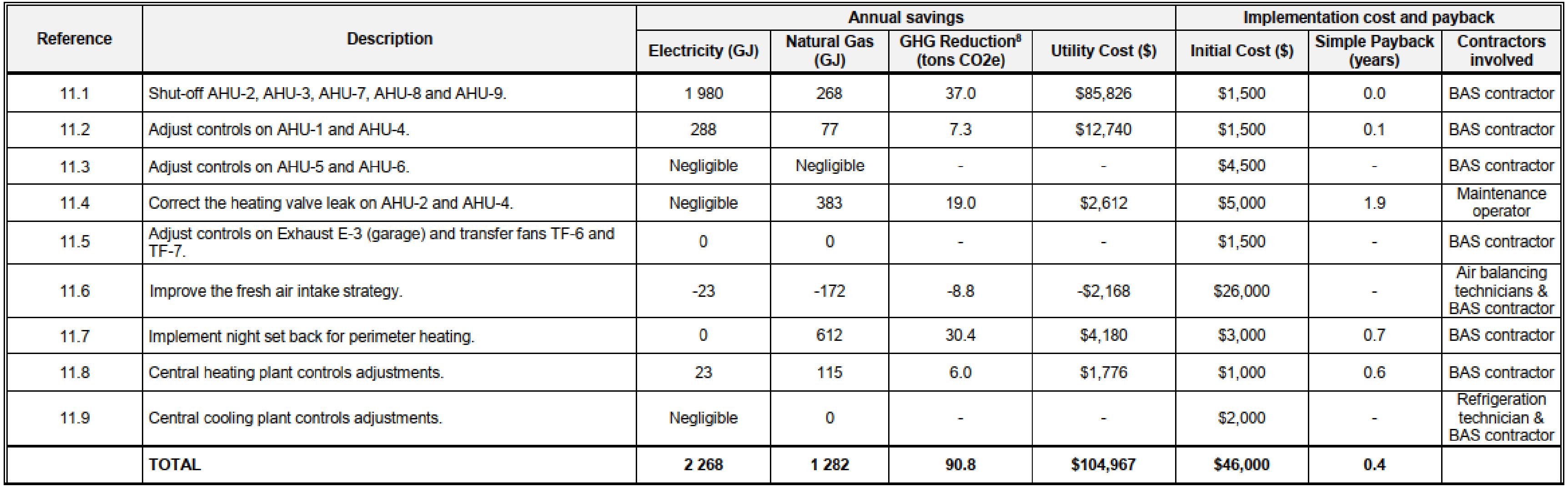
SOLUTIONS			SAVINGS			
RCx measure type	**RCx measure description**	**RCx measure implementation cost**	**Type of Energy saved**	**Energy savings**	**Monetary savings**	**Simple payback**
Select from drop-down list	Type a short description of the solution recommended to correct the problem	RCx provider, contractor and in-house staff	(e.g. water, natural gas, electricity, etc.)	GJ/year	$/year	year(s)
Other modifications to control sequence of operations						
Retrofit/equipment replacement						
Scheduling modified (occupancy determined)						

Findings log – detailed list example



Findings Log Table			
No			3
Observation			Temperature control of support air unit U-1 not optimal
Measure			Modify control sequence to ensure that unit U-1 is in heating mode only when rooms require it, and not in neutral zone. Also, adjust setpoint according to temperature on a continuous basis.
Recommendations			Modify the logic so that the zone demand is combined with systems demand when determining setpoint. U-1 heating should not be running if no zone requires heating. In addition, a delay time should be incorporated before heating activation in order to avoid having cycles between “neutral” and “air conditioning” modes of UCL systems. Lastly, source point should be re-adjusted according to outside temperature, subject to operation tests in implementation phase.
Implemented by			Personnel of the Education Board, NSW
Estimated electric power savings	(kWh/yr)		0
	($/yr)		$0.00
Estimated savings	In gas	(m^3/yr)	800
	In gas	($/an)	$449.00
	Total	($/an)	$449.00
Estimated reduction in demand (kVA)			0
Estimated cost of implementation ($)			$360.00
Simple profitability (years)			0.8
Retained? (Yes or No)			Yes

Findings log – summary list example



Reference	Description	Annual savings				Implementation cost and payback		
		Electricity (GJ)	Natural Gas (GJ)	GHG Reduction[8] (tons CO2e)	Utility Cost ($)	Initial Cost ($)	Simple Payback (years)	Contractors involved
11.1	Shut-off AHU-2, AHU-3, AHU-7, AHU-8 and AHU-9.	1 980	268	37.0	$85,826	$1,500	0.0	BAS contractor
11.2	Adjust controls on AHU-1 and AHU-4.	288	77	7.3	$12,740	$1,500	0.1	BAS contractor
11.3	Adjust controls on AHU-5 and AHU-6.	Negligible	Negligible	-	-	$4,500	-	BAS contractor
11.4	Correct the heating valve leak on AHU-2 and AHU-4.	Negligible	383	19.0	$2,612	$5,000	1.9	Maintenance operator
11.5	Adjust controls on Exhaust E-3 (garage) and transfer fans TF-6 and TF-7.	0	0	-	-	$1,500	-	BAS contractor
11.6	Improve the fresh air intake strategy.	-23	-172	-8.8	-$2,168	$26,000	-	Air balancing technicians & BAS contractor
11.7	Implement night set back for perimeter heating.	0	612	30.4	$4,180	$3,000	0.7	BAS contractor
11.8	Central heating plant controls adjustments.	23	115	6.0	$1,776	$1,000	0.6	BAS contractor
11.9	Central cooling plant controls adjustments.	Negligible	0	-	-	$2,000	-	Refrigeration technician & BAS contractor
	TOTAL	**2 268**	**1 282**	**90.8**	**$104,967**	**$46,000**	**0.4**	

Estimate savings

- EBCx projects energy savings: average of 10-20%.
- EBCx projects simple payback: average of 1.5 years.

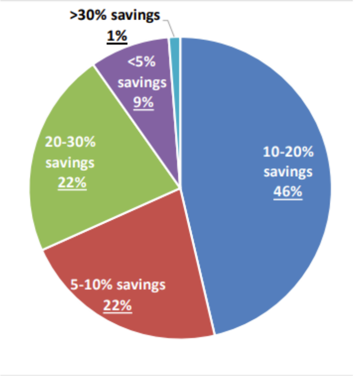


Figure 27. Range of verified EBCx energy savings (BCxA Market Study)

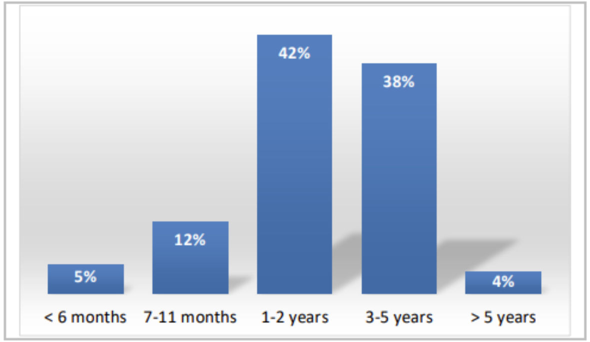


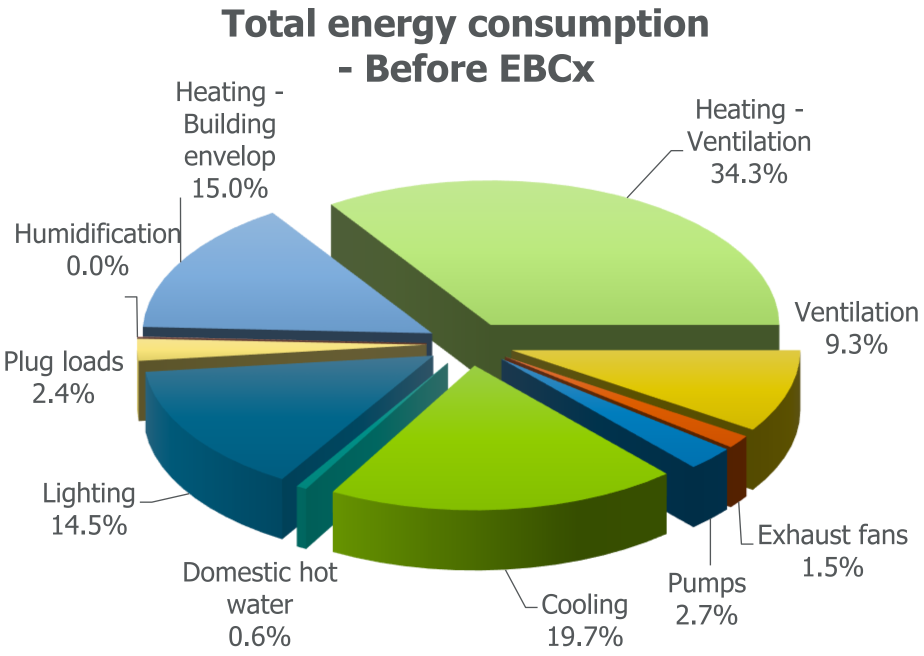
Figure 29. Estimated Simple Payback (BCxA Market Study)

Reference : BCxA Value of Commissioning – 2018 Market Survey.
Available at : https://www.bcxa.org/resources/bcxa-value-of-commissioning-market-survey-report.html

Estimate savings

- Establish the performance baseline.
- Individual equipment-level energy use.
- The more accurate the baseline = the more accurate future savings calculations.
- Equipment baseline for large energy using equipment (chiller, cooling towers, larger pumps and larger air handling units).
- Baseline should be correlated to outside air temperature.

Reference: BCxA – Existing Building Commissioning Best Practices (bcxa.org)



Energy Use Intensity (EUI) =2.35 GJ/m²

Estimate savings

Do not spend excessive time in improving savings accuracy at the expense of the other important activities.

- Adapt calculation methods and level of effort according to: utility program requirements, owner expectations, level of investment (implementation cost $$$ = higher savings accuracy).
- Adjust savings calculations to account for interactive effects between measures so they are not overestimated (example: lighting measures have impact on heating load).

Reference : BCxA – Existing Building Commissioning Best Practices (bcxa.org)

Estimate savings

There are different savings calculation methods, all of them valuable depending on the measure:

- hourly computer simulation
- BIN method: custom weather « BIN » spreadsheet
- basic engineering calculations
- rough estimate (%)
- simulation software (rarely used for EBCx)

Estimate savings – BIN method

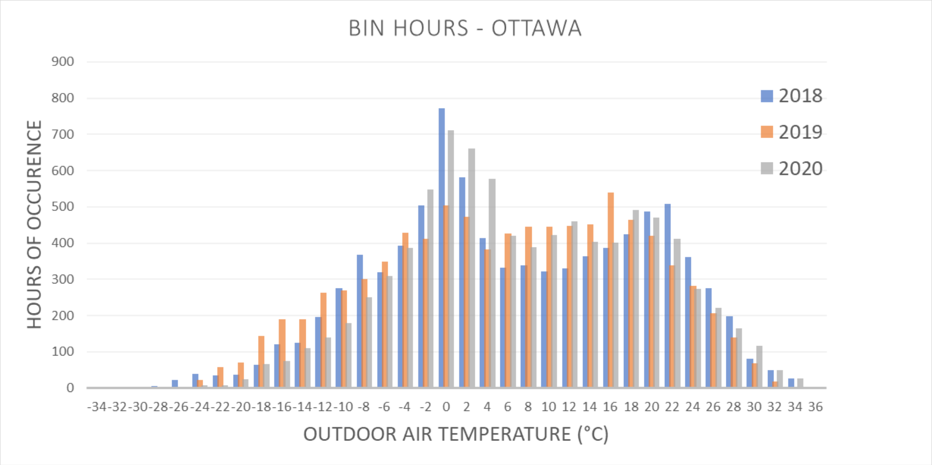
The BIN method calculates the building load by determining the number of hours per year the average outdoor temperature of the location under study was contained in a temperature band or "Bin".

Adding the load (kW) for each of these temperature bins (hours) determines the yearly energy requirement (kWh).

Bin hours will depend on:

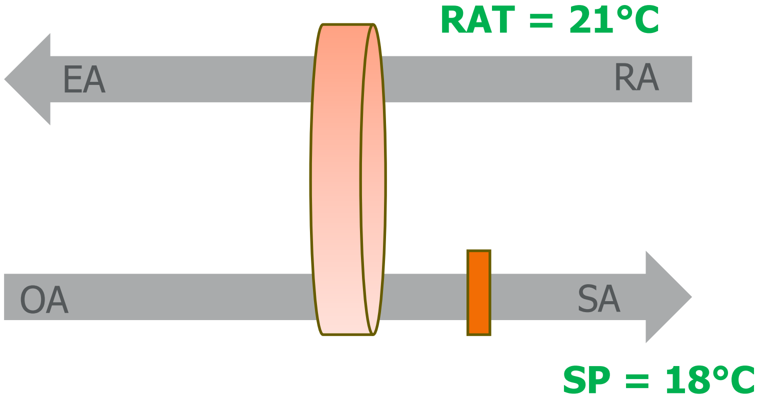
- Building location
- Reference year
- Systems schedule*

*filter weather data to consider operating hours only



Estimate savings – BIN method example

- System type: dedicated outdoor air system
- System capacity: 2000 L/s
- Return air temperature (RAT): 21°C
- Supply temperature setpoint (SP): 18°C
- Thermal wheel (70% efficiency)
- Electric heating coil (100% efficiency)
- Location: Ottawa, ON
- Reference year: 2020



Estimate savings – BIN method example

Measure: schedule optimization

Before EBCx: 24/24, 7 days a week (continuous operation).

After EBCx: Monday to Friday, 6am to 6 pm.

Savings calculation for electrical heating

For each BIN-hour, calculate energy required for supplemental heating (electric coil):

Heating consumption (kWh) = Heating required (kW) x BIN (h)

Energy savings (kWh) = Consumption before (kWh) – Consumption after (kWh)

Energy cost ($) = Energy savings (kWh) x Average electricity rate ($/kWh)

Estimate savings – BIN method example

	BIN hours - Ottawa - Year 2020				Heating consumption (kWh)	
OAT (°C)	**Before**	**After**	**T° after THW (°C)**	**Heating (kW)**	**Before**	**After**
16	401	150	18	0	0	0
14	403	140	18	0	0	0
12	460	173	18	0	0	0
10	423	129	17,7	1	305	93
8	389	125	17,1	2	840	270
6	420	153	16,5	4	1512	551
4	578	204	15,9	5	2913	1028
2	661	216	15,3	6	4283	1400
0	712	244	14,7	8	5639	1932
-2	548	175	14,1	9	5129	1638
-4	386	106	13,5	11	4169	1145
-6	309	114	12,9	12	3782	1395
-8	251	94	12,3	14	3434	1286
-10	180	65	11,7	15	2722	983
-12	140	44	11,1	17	2318	729
-14	111	29	10,5	18	1998	522
-16	74	20	9,9	19	1439	389
-18	66	20	9,3	21	1378	418
-20	25	8	8,7	22	558	179
-22	8	1	8,1	24	190	24
-24	8	4	7,5	25	202	101
-26	1	0	6,9	27	27	0
-28	0	0	6,3	28	0	0
-30	0	0	5,7	30	0	0
-32	0	0	5,1	31	0	0
-34	0	0	4,5	32	0	0
TOTAL	**8783**	**3144**			**42 837**	**14 081**
					SAVINGS (kWh)	**28 756**

Energy savings: 28,756 kWh

(42,837 kWh – 14,081 kWh)

Cost savings: $4,400
(28,756 kWh x 0.153 $/kWh)

Implementation costs:

In-house deployment (no cost)

Estimate savings – basic engineering calculation

Measure: verify and re-establish occupancy sensors for lighting, conference rooms.

Lighting fixture	100	units
Lighting power	64	W/fixture
Total power	6.4	kW
Actual schedule	10	hours per day
	250	days per year
Current occupancy	2	hours per day
	250	days per year

Implementation :		
Occupancy sensors to check	15	units
Time per sensor	1.5	h
Labor costs	125	$/h

	Actual	Future
Operating time (h)	2,500	500
Energy consumption (kWh)	16,000	3,200
Energy cost ($)	2,448	490

Total savings (kWh)*	12,800
Total savings ($)	1,958
Implementation cost ($)	2,813
Simple payback (year)	1.4

*no interactive effects with heating load, internal area.

Estimate savings

Using a simulation software:

If a calibrated model already exists, it could be used for simple measures (e.g. schedule on ventilation systems).

However, simulation software is not intended to simulate operation problems. Many EBCx measures savings cannot be calculated (e.g. simultaneous heating and cooling).

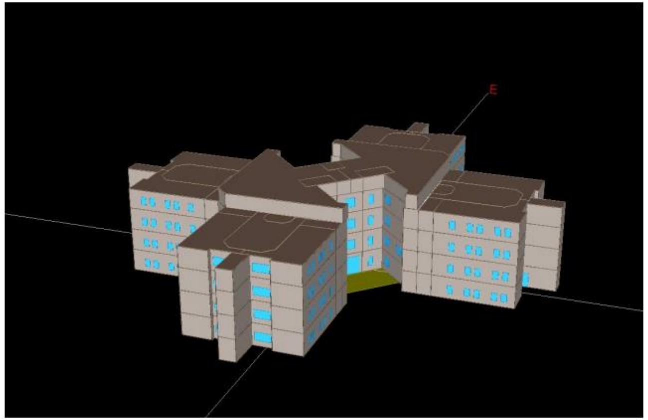
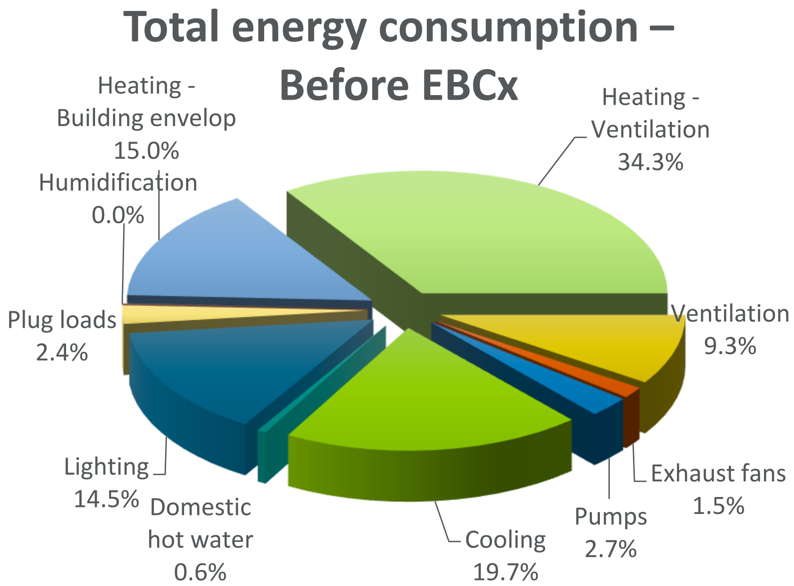
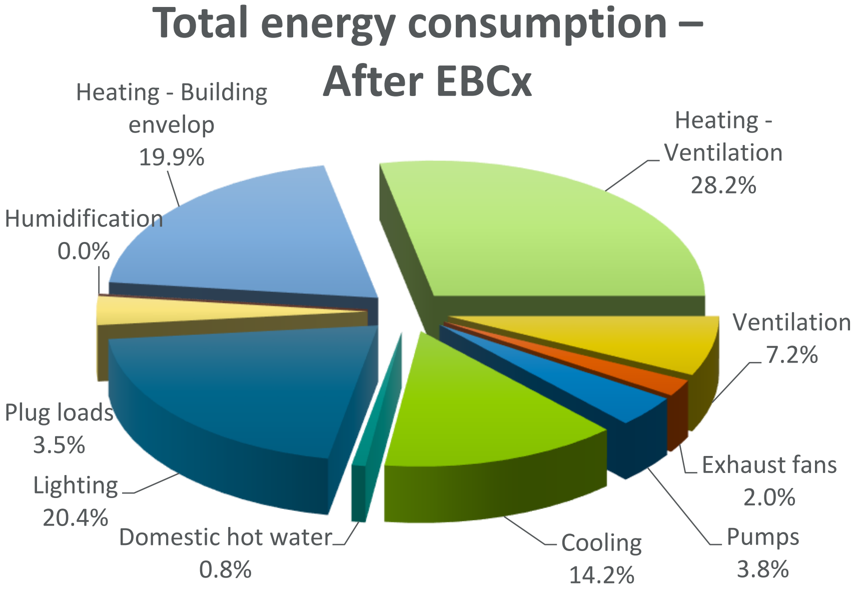


Image: Building simulated by eQuest

Comparison



EUI=2.35 GJ/m²



EUI=1.69 GJ/m²

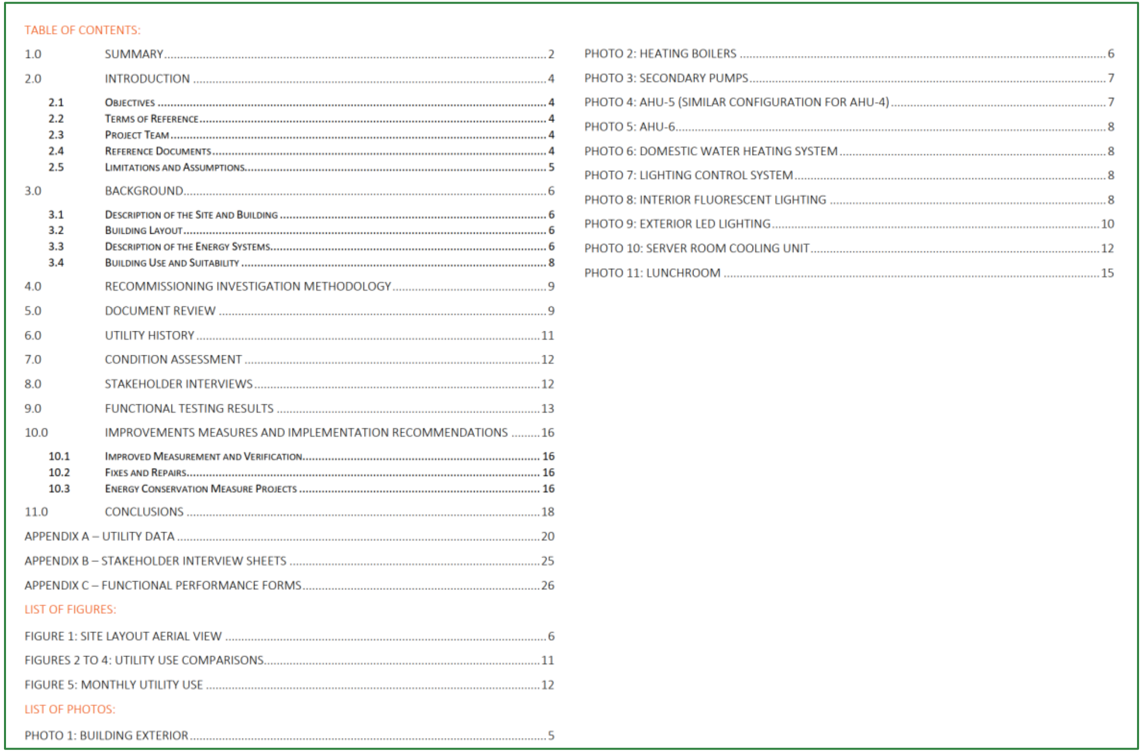
Investigation report

Rigorous documentation is essential for savings' persistence in an EBCx project.

The investigation report usually contains all the information, observations, measurements, and tests conducted during the investigation.

- Building site and facilities' description
- Building documentation's review
- Current facility requirements (CFR)
- Utility bills analysis
- Findings log
- Summary of the investigation:
  - Detailed findings
  - Summary of on-site observations
  - Diagnostic monitoring results – in appendix
  - Functional tests results – in appendix

Investigation report – Table of contents



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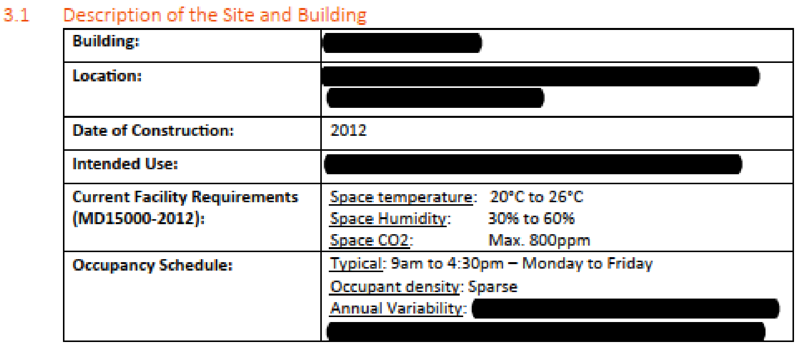
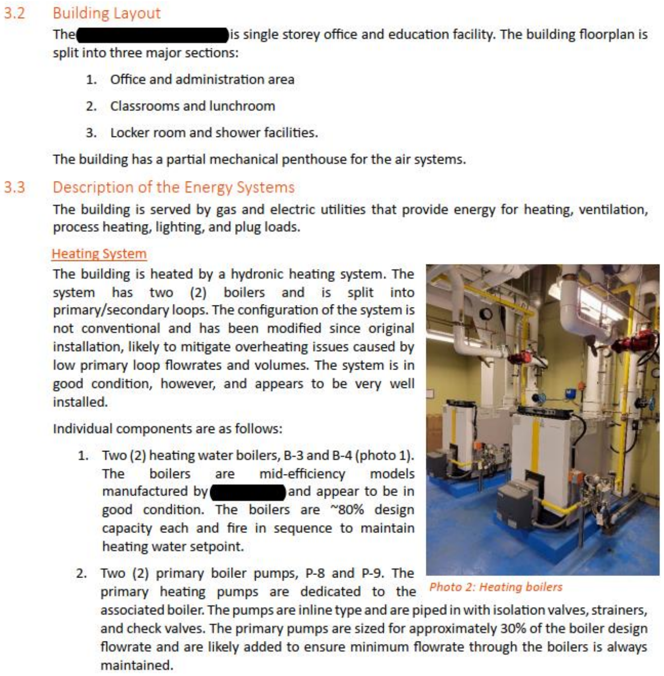
Investigation report



3.1 Description of the Site and Building

Building:	[redacted]
Location:	[redacted]
Date of Construction:	2012
Intended Use:	[redacted]
Current Facility Requirements (MD15000-2012):	Space temperature: 20°C to 26°C Space Humidity: 30% to 60% Space CO2: Max. 800ppm
Occupancy Schedule:	Typical: 9am to 4:30pm – Monday to Friday Occupant density: Sparse Annual Variability: [redacted]



3.2 Building Layout

The [redacted] is single storey office and education facility. The building floorplan is split into three major sections:

1. Office and administration area
2. Classrooms and lunchroom
3. Locker room and shower facilities.

The building has a partial mechanical penthouse for the air systems.

3.3 Description of the Energy Systems

The building is served by gas and electric utilities that provide energy for heating, ventilation, process heating, lighting, and plug loads.

Heating System

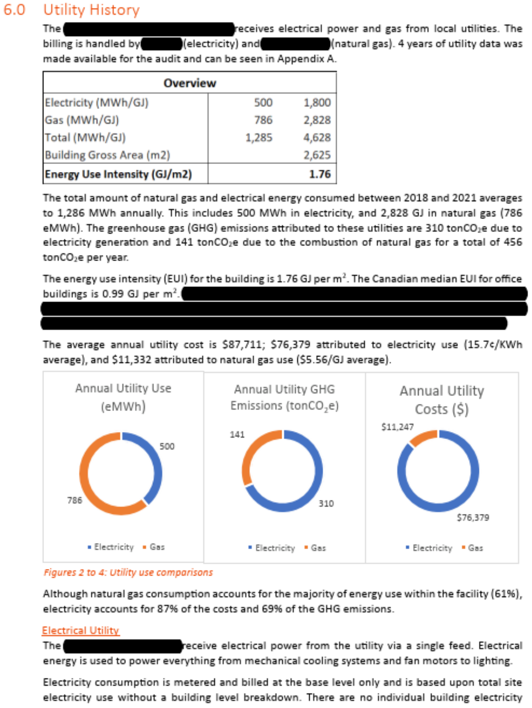
The building is heated by a hydronic heating system. The system has two (2) boilers and is split into primary/secondary loops. The configuration of the system is not conventional and has been modified since original installation, likely to mitigate overheating issues caused by low primary loop flowrates and volumes. The system is in good condition, however, and appears to be very well installed.

Individual components are as follows:

1. Two (2) heating water boilers, B-3 and B-4 (photo 1). The boilers are mid-efficiency models manufactured by [redacted] and appear to be in good condition. The boilers are ~80% design capacity each and fire in sequence to maintain heating water setpoint.
2. Two (2) primary boiler pumps, P-8 and P-9. The primary heating pumps are dedicated to the associated boiler. The pumps are inline type and are piped in with isolation valves, strainers, and check valves. The primary pumps are sized for approximately 30% of the boiler design flowrate and are likely added to ensure minimum flowrate through the boilers is always maintained.

Photo 2: Heating boilers

Investigation report



6.0 Utility History

The [redacted] receives electrical power and gas from local utilities. The billing is handled by [redacted] (electricity) and [redacted] (natural gas). 4 years of utility data was made available for the audit and can be seen in Appendix A.

Overview		
Electricity (MWh/GJ)	500	1,800
Gas (MWh/GJ)	786	2,828
Total (MWh/GJ)	1,285	4,628
Building Gross Area (m2)		2,625
Energy Use Intensity (GJ/m2)		**1.76**

The total amount of natural gas and electrical energy consumed between 2018 and 2021 averages to 1,286 MWh annually. This includes 500 MWh in electricity, and 2,828 GJ in natural gas (786 eMWh). The greenhouse gas (GHG) emissions attributed to these utilities are 310 $tonCO_2e$ due to electricity generation and 141 $tonCO_2e$ due to the combustion of natural gas for a total of 456 $tonCO_2e$ per year.

The energy use intensity (EUI) for the building is 1.76 GJ per m^2. The Canadian median EUI for office buildings is 0.99 GJ per m^2. [redacted]

The average annual utility cost is $87,711; $76,379 attributed to electricity use (15.7¢/KWh average), and $11,332 attributed to natural gas use ($5.56/GJ average).

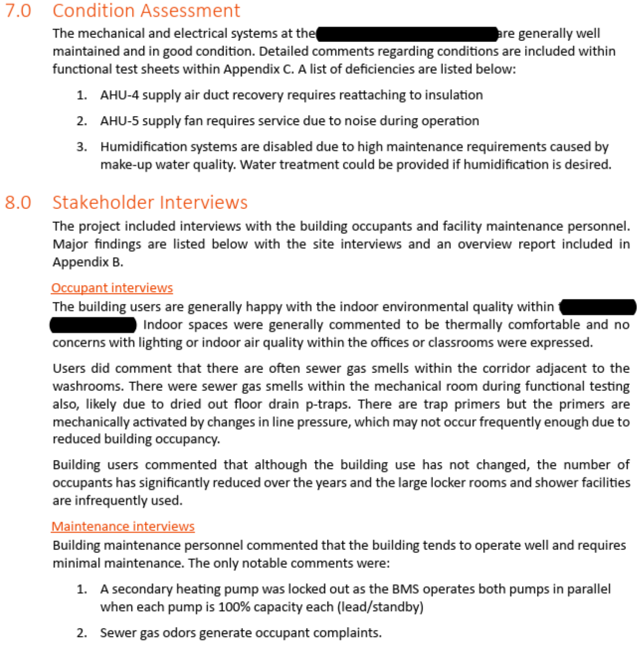
Figures 2 to 4: Utility use comparisons

Although natural gas consumption accounts for the majority of energy use within the facility (61%), electricity accounts for 87% of the costs and 69% of the GHG emissions.

Electrical Utility

The [redacted] receive electrical power from the utility via a single feed. Electrical energy is used to power everything from mechanical cooling systems and fan motors to lighting.

Electricity consumption is metered and billed at the base level only and is based upon total site electricity use without a building level breakdown. There are no individual building electricity



7.0 Condition Assessment

The mechanical and electrical systems at the [redacted] are generally well maintained and in good condition. Detailed comments regarding conditions are included within functional test sheets within Appendix C. A list of deficiencies are listed below:

1. AHU-4 supply air duct recovery requires reattaching to insulation
2. AHU-5 supply fan requires service due to noise during operation
3. Humidification systems are disabled due to high maintenance requirements caused by make-up water quality. Water treatment could be provided if humidification is desired.

8.0 Stakeholder Interviews

The project included interviews with the building occupants and facility maintenance personnel. Major findings are listed below with the site interviews and an overview report included in Appendix B.

Occupant interviews

The building users are generally happy with the indoor environmental quality within [redacted] Indoor spaces were generally commented to be thermally comfortable and no concerns with lighting or indoor air quality within the offices or classrooms were expressed.

Users did comment that there are often sewer gas smells within the corridor adjacent to the washrooms. There were sewer gas smells within the mechanical room during functional testing also, likely due to dried out floor drain p-traps. There are trap primers but the primers are mechanically activated by changes in line pressure, which may not occur frequently enough due to reduced building occupancy.

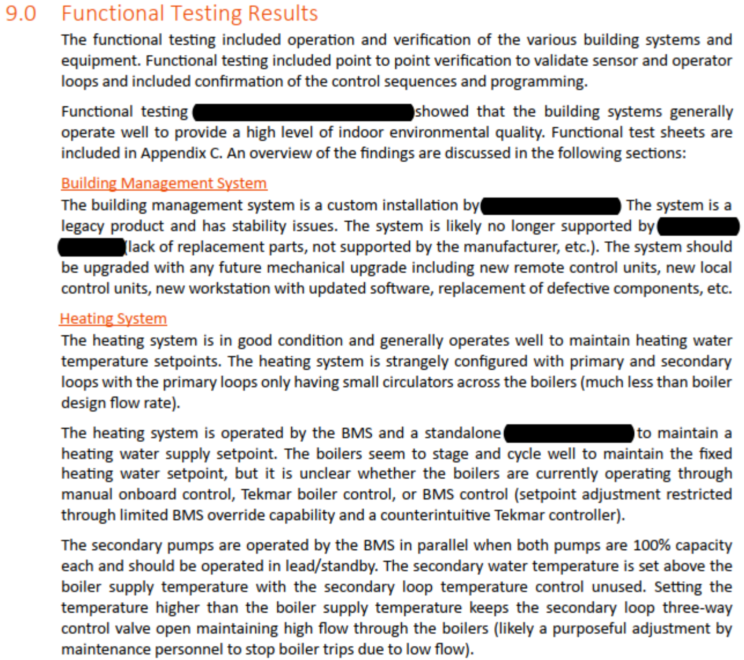
Building users commented that although the building use has not changed, the number of occupants has significantly reduced over the years and the large locker rooms and shower facilities are infrequently used.

Maintenance interviews

Building maintenance personnel commented that the building tends to operate well and requires minimal maintenance. The only notable comments were:

1. A secondary heating pump was locked out as the BMS operates both pumps in parallel when each pump is 100% capacity each (lead/standby)
2. Sewer gas odors generate occupant complaints.

Investigation report



9.0 Functional Testing Results

The functional testing included operation and verification of the various building systems and equipment. Functional testing included point to point verification to validate sensor and operator loops and included confirmation of the control sequences and programming.

Functional testing [redacted] showed that the building systems generally operate well to provide a high level of indoor environmental quality. Functional test sheets are included in Appendix C. An overview of the findings are discussed in the following sections:

Building Management System

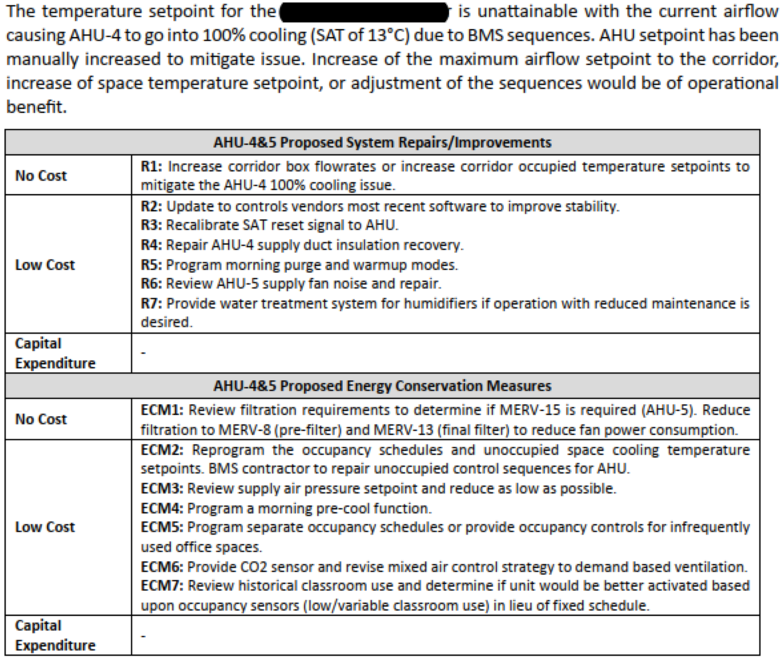
The building management system is a custom installation by [redacted] The system is a legacy product and has stability issues. The system is likely no longer supported by [redacted] (lack of replacement parts, not supported by the manufacturer, etc.). The system should be upgraded with any future mechanical upgrade including new remote control units, new local control units, new workstation with updated software, replacement of defective components, etc.

Heating System

The heating system is in good condition and generally operates well to maintain heating water temperature setpoints. The heating system is strangely configured with primary and secondary loops with the primary loops only having small circulators across the boilers (much less than boiler design flow rate).

The heating system is operated by the BMS and a standalone [redacted] to maintain a heating water supply setpoint. The boilers seem to stage and cycle well to maintain the fixed heating water setpoint, but it is unclear whether the boilers are currently operating through manual onboard control, Tekmar boiler control, or BMS control (setpoint adjustment restricted through limited BMS override capability and a counterintuitive Tekmar controller).

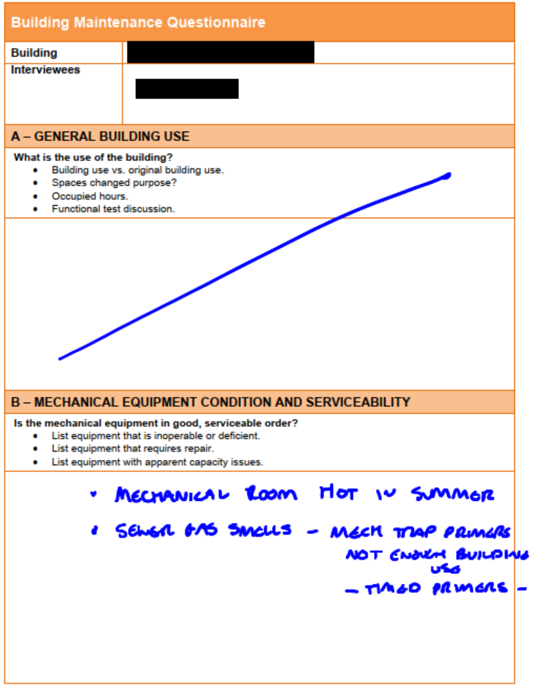
The secondary pumps are operated by the BMS in parallel when both pumps are 100% capacity each and should be operated in lead/standby. The secondary water temperature is set above the boiler supply temperature with the secondary loop temperature control unused. Setting the temperature higher than the boiler supply temperature keeps the secondary loop three-way control valve open maintaining high flow through the boilers (likely a purposeful adjustment by maintenance personnel to stop boiler trips due to low flow).



The temperature setpoint for the [redacted] is unattainable with the current airflow causing AHU-4 to go into 100% cooling (SAT of 13°C) due to BMS sequences. AHU setpoint has been manually increased to mitigate issue. Increase of the maximum airflow setpoint to the corridor, increase of space temperature setpoint, or adjustment of the sequences would be of operational benefit.

AHU-4&5 Proposed System Repairs/Improvements	
No Cost	**R1:** Increase corridor box flowrates or increase corridor occupied temperature setpoints to mitigate the AHU-4 100% cooling issue.
Low Cost	**R2:** Update to controls vendors most recent software to improve stability. **R3:** Recalibrate SAT reset signal to AHU. **R4:** Repair AHU-4 supply duct insulation recovery. **R5:** Program morning purge and warmup modes. **R6:** Review AHU-5 supply fan noise and repair. **R7:** Provide water treatment system for humidifiers if operation with reduced maintenance is desired.
Capital Expenditure	-
AHU-4&5 Proposed Energy Conservation Measures	
No Cost	**ECM1:** Review filtration requirements to determine if MERV-15 is required (AHU-5). Reduce filtration to MERV-8 (pre-filter) and MERV-13 (final filter) to reduce fan power consumption.
Low Cost	**ECM2:** Reprogram the occupancy schedules and unoccupied space cooling temperature setpoints. BMS contractor to repair unoccupied control sequences for AHU. **ECM3:** Review supply air pressure setpoint and reduce as low as possible. **ECM4:** Program a morning pre-cool function. **ECM5:** Program separate occupancy schedules or provide occupancy controls for infrequently used office spaces. **ECM6:** Provide CO2 sensor and revise mixed air control strategy to demand based ventilation. **ECM7:** Review historical classroom use and determine if unit would be better activated based upon occupancy sensors (low/variable classroom use) in lieu of fixed schedule.
Capital Expenditure	-

Investigation report – Appendices (1)



Building Maintenance Questionnaire

Building	[redacted]
Interviewees	[redacted]

A – GENERAL BUILDING USE

What is the use of the building?

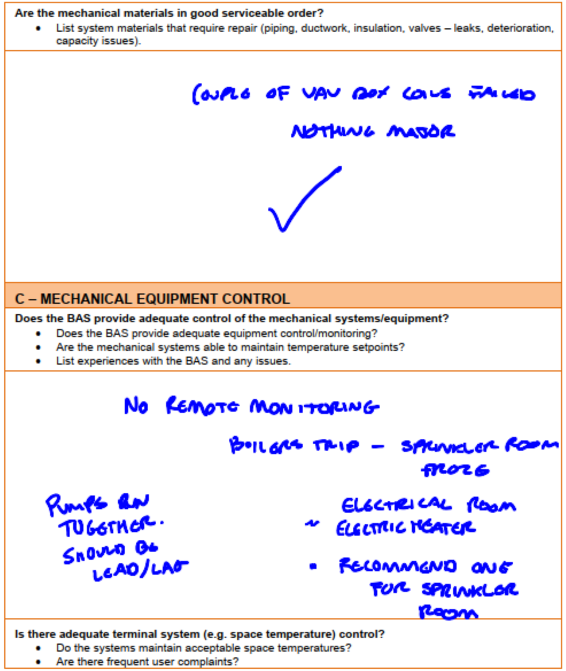
- Building use vs. original building use.
- Spaces changed purpose?
- Occupied hours.
- Functional test discussion.

B – MECHANICAL EQUIPMENT CONDITION AND SERVICEABILITY

Is the mechanical equipment in good, serviceable order?

- List equipment that is inoperable or deficient.
- List equipment that requires repair.
- List equipment with apparent capacity issues.

- MECHANICAL ROOM HOT IN SUMMOR
- SEWER GAS SMELLS – MECH TRAP PRIMERS
  NOT ENOUGH BUILDING USE
  – TIMED PRIMERS –



Are the mechanical materials in good serviceable order?

- List system materials that require repair (piping, ductwork, insulation, valves – leaks, deterioration, capacity issues).

COUPLE OF VAV BOX COILS FAILED
NOTHING MAJOR
✓

C – MECHANICAL EQUIPMENT CONTROL

Does the BAS provide adequate control of the mechanical systems/equipment?

- Does the BAS provide adequate equipment control/monitoring?
- Are the mechanical systems able to maintain temperature setpoints?
- List experiences with the BAS and any issues.

NO REMOTE MONITORING

BOILERS TRIP – SPRINKLER ROOM FROZE

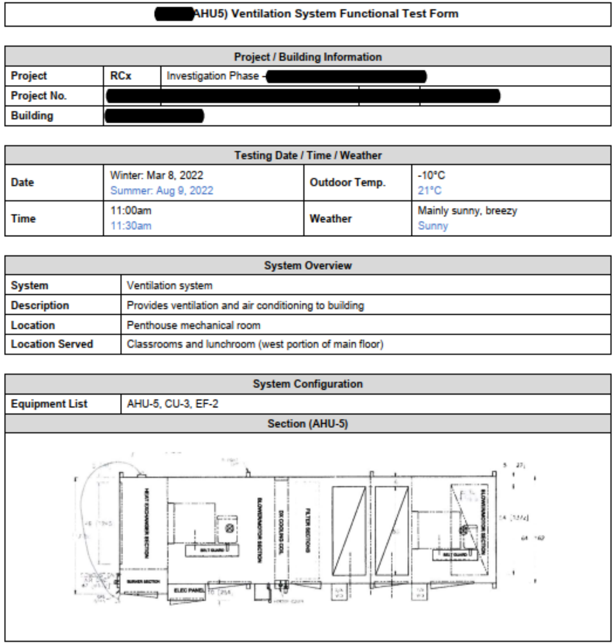
PUMPS RUN TOGETHER. SHOULD BE LEAD/LAG

- ELECTRICAL ROOM ELECTRIC HEATER
- RECOMMEND ONE FOR SPRINKLOR ROOM

Is there adequate terminal system (e.g. space temperature) control?

- Do the systems maintain acceptable space temperatures?
- Are there frequent user complaints?

Investigation report – Appendices (2)



[redacted]AHU5) Ventilation System Functional Test Form

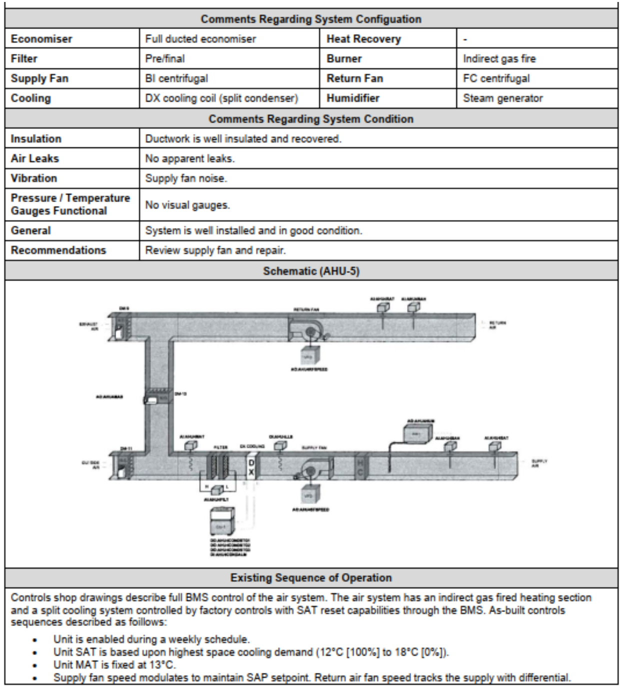
Project / Building Information		
Project	**RCx**	Investigation Phase - [redacted]
Project No.	[redacted]	
Building	[redacted]	

Testing Date / Time / Weather			
Date	Winter: Mar 8, 2022 Summer: Aug 9, 2022	**Outdoor Temp.**	-10°C 21°C
Time	11:00am 11:30am	**Weather**	Mainly sunny, breezy Sunny

System Overview	
System	Ventilation system
Description	Provides ventilation and air conditioning to building
Location	Penthouse mechanical room
Location Served	Classrooms and lunchroom (west portion of main floor)

System Configuration	
Equipment List	AHU-5, CU-3, EF-2

Section (AHU-5)



Comments Regarding System Configuation			
Economiser	Full ducted economiser	**Heat Recovery**	-
Filter	Pre/final	**Burner**	Indirect gas fire
Supply Fan	BI centrifugal	**Return Fan**	FC centrifugal
Cooling	DX cooling coil (split condenser)	**Humidifier**	Steam generator

Comments Regarding System Condition	
Insulation	Ductwork is well insulated and recovered.
Air Leaks	No apparent leaks.
Vibration	Supply fan noise.
Pressure / Temperature Gauges Functional	No visual gauges.
General	System is well installed and in good condition.
Recommendations	Review supply fan and repair.

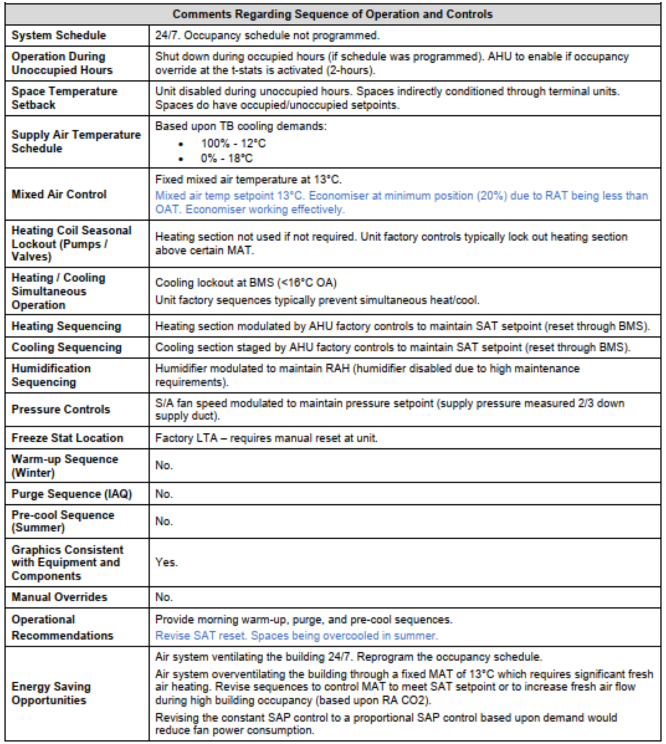
Schematic (AHU-5)

Existing Sequence of Operation

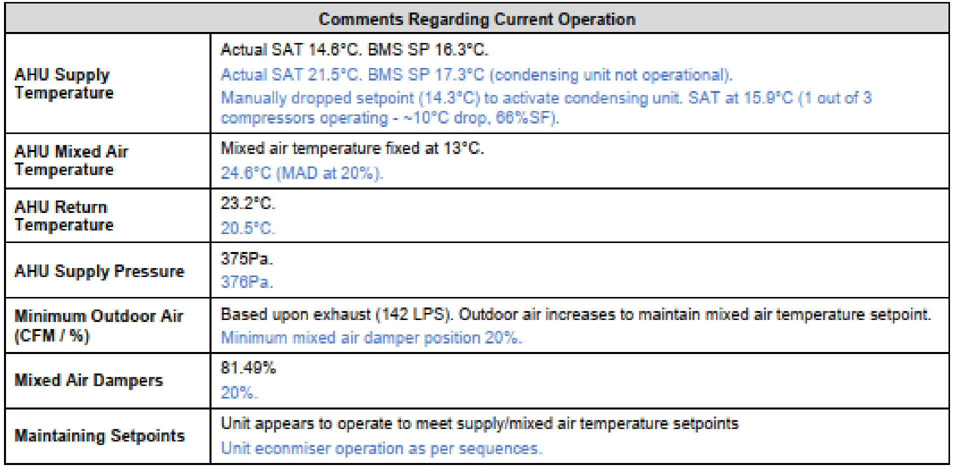
Controls shop drawings describe full BMS control of the air system. The air system has an indirect gas fired heating section and a split cooling system controlled by factory controls with SAT reset capabilities through the BMS. As-built controls sequences described as follows:

- Unit is enabled during a weekly schedule.
- Unit SAT is based upon highest space cooling demand (12°C [100%] to 18°C [0%]).
- Unit MAT is fixed at 13°C.
- Supply fan speed modulates to maintain SAP setpoint. Return air fan speed tracks the supply with differential.

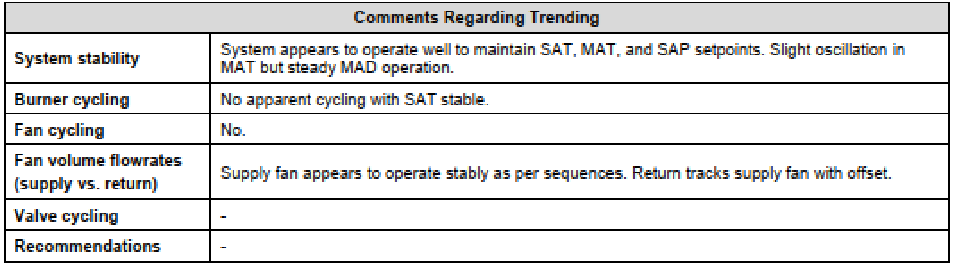
Investigation report – Appendices (3)



Comments Regarding Sequence of Operation and Controls	
System Schedule	24/7. Occupancy schedule not programmed.
Operation During Unoccupied Hours	Shut down during occupied hours (if schedule was programmed). AHU to enable if occupancy override at the t-stats is activated (2-hours).
Space Temperature Setback	Unit disabled during unoccupied hours. Spaces indirectly conditioned through terminal units. Spaces do have occupied/unoccupied setpoints.
Supply Air Temperature Schedule	Based upon TB cooling demands: • 100% - 12°C • 0% - 18°C
Mixed Air Control	Fixed mixed air temperature at 13°C. Mixed air temp setpoint 13°C. Economiser at minimum position (20%) due to RAT being less than OAT. Economiser working effectively.
Heating Coil Seasonal Lockout (Pumps / Valves)	Heating section not used if not required. Unit factory controls typically lock out heating section above certain MAT.
Heating / Cooling Simultaneous Operation	Cooling lockout at BMS (<16°C OA) Unit factory sequences typically prevent simultaneous heat/cool.
Heating Sequencing	Heating section modulated by AHU factory controls to maintain SAT setpoint (reset through BMS).
Cooling Sequencing	Cooling section staged by AHU factory controls to maintain SAT setpoint (reset through BMS).
Humidification Sequencing	Humidifier modulated to maintain RAH (humidifier disabled due to high maintenance requirements).
Pressure Controls	S/A fan speed modulated to maintain pressure setpoint (supply pressure measured 2/3 down supply duct).
Freeze Stat Location	Factory LTA – requires manual reset at unit.
Warm-up Sequence (Winter)	No.
Purge Sequence (IAQ)	No.
Pre-cool Sequence (Summer)	No.
Graphics Consistent with Equipment and Components	Yes.
Manual Overrides	No.
Operational Recommendations	Provide morning warm-up, purge, and pre-cool sequences. Revise SAT reset. Spaces being overcooled in summer.
Energy Saving Opportunities	Air system ventilating the building 24/7. Reprogram the occupancy schedule. Air system overventilating the building through a fixed MAT of 13°C which requires significant fresh air heating. Revise sequences to control MAT to meet SAT setpoint or to increase fresh air flow during high building occupancy (based upon RA CO2). Revising the constant SAP control to a proportional SAP control based upon demand would reduce fan power consumption.



Comments Regarding Current Operation	
AHU Supply Temperature	Actual SAT 14.6°C. BMS SP 16.3°C. Actual SAT 21.5°C. BMS SP 17.3°C (condensing unit not operational). Manually dropped setpoint (14.3°C) to activate condensing unit. SAT at 15.9°C (1 out of 3 compressors operating - ~10°C drop, 66%SF).
AHU Mixed Air Temperature	Mixed air temperature fixed at 13°C. 24.6°C (MAD at 20%).
AHU Return Temperature	23.2°C. 20.5°C.
AHU Supply Pressure	375Pa. 376Pa.
Minimum Outdoor Air (CFM / %)	Based upon exhaust (142 LPS). Outdoor air increases to maintain mixed air temperature setpoint. Minimum mixed air damper position 20%.
Mixed Air Dampers	81.49% 20%.
Maintaining Setpoints	Unit appears to operate to meet supply/mixed air temperature setpoints Unit econmiser operation as per sequences.



Comments Regarding Trending	
System stability	System appears to operate well to maintain SAT, MAT, and SAP setpoints. Slight oscillation in MAT but steady MAD operation.
Burner cycling	No apparent cycling with SAT stable.
Fan cycling	No.
Fan volume flowrates (supply vs. return)	Supply fan appears to operate stably as per sequences. Return tracks supply fan with offset.
Valve cycling	-
Recommendations	-

Implementation phase

Implementation activities:

- Complete additional investigation and engineering
- Develop implementation plan
- Hire subcontractors, as needed
- Implement selected findings
- Verify successful measures’ implementation
- Adjust energy savings estimates and costs
- Update EBCx documentation and prepare implementation phase summary report
- Plan for ongoing commissioning

Implementation approaches

The main deliverables of this phase are an implementation plan and an implementation report.

The Owner will need to choose an implementation approach:

- Turn-key project
- With the help of an EBCx provider
- Owner-led implementation

The choice will depend on internal resources skills/availability but also type of measures.

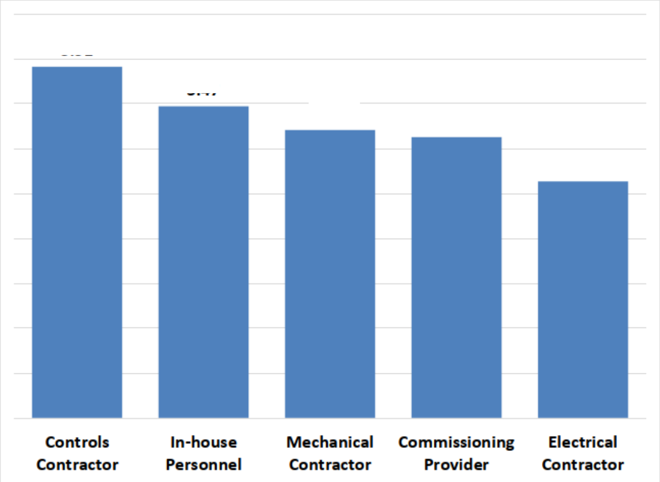


Figure 25. Who implements EBCx recommendations?

Reference : BCxA – Value of commissioning – 2018 Market Survey

Turnkey implementation

When should the owner choose this approach?

Operation staff is not available or does not have necessary skills to implement measures.

Example: EBCx measures include new VFD on pumps and new hardware control equipment.

- EBCx Provider manages and oversees implementation activities.
- Owner has only one contract with EBCx Provider.
- EBCx provider hires and deals with subcontractors (if needed).
- EBCx provider implements selected measures and verifies results.

With the help of an EBCx provider (consulting option)

When should the Owner choose this approach?

In-house staff can implement most of measures and/or the Owner has time/expertise to manage implementation.

Example: EBCx measures include simple programing, sensor calibration and schedule optimization.

- EBCx Provider offers support and oversight for implementation activities.
- In-house staff and/or subcontractors implement selected measures.
- The owner manages the contracts with various firms.
- EBCx provider verifies and documents results.

Owner-led implementation

The Owner manages and oversees all aspects of implementation.

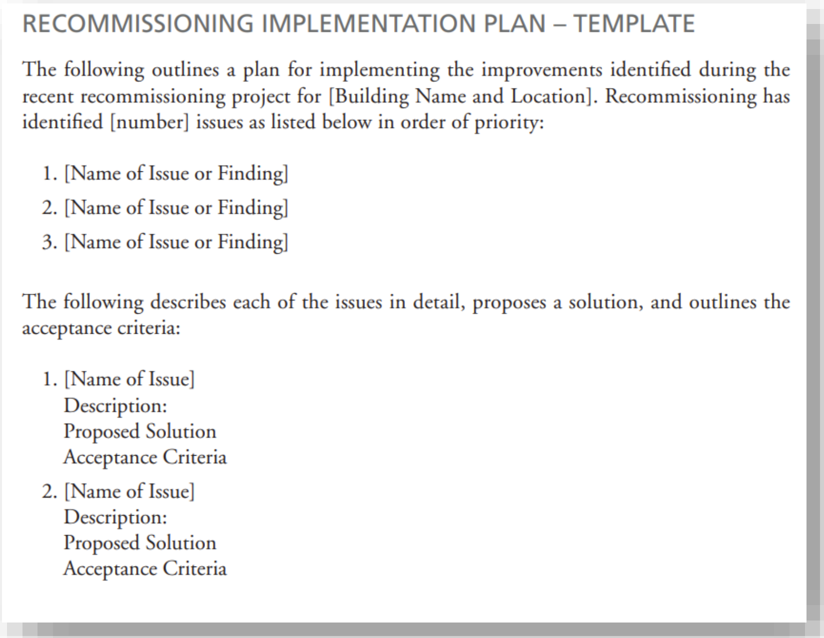
Example: The owner has implemented energy efficiency measures within his building portfolio and has high technical skills internal resources.

- Owner calls in his service contractor (established relationship) or has an in-house engineer who can implement and verify measures.
- This approach requires significant commitment from the owner.

Implementation plan

Table of contents:

- Detailed description of measures
    - Scope of work
    - Implementation method
    - Expected results
    - Verification method
- Order of implementation
- O&M requirements (optional)



RECOMMISSIONING IMPLEMENTATION PLAN – TEMPLATE

The following outlines a plan for implementing the improvements identified during the recent recommissioning project for [Building Name and Location]. Recommissioning has identified [number] issues as listed below in order of priority:

1. [Name of Issue or Finding]
2. [Name of Issue or Finding]
3. [Name of Issue or Finding]

The following describes each of the issues in detail, proposes a solution, and outlines the acceptance criteria:

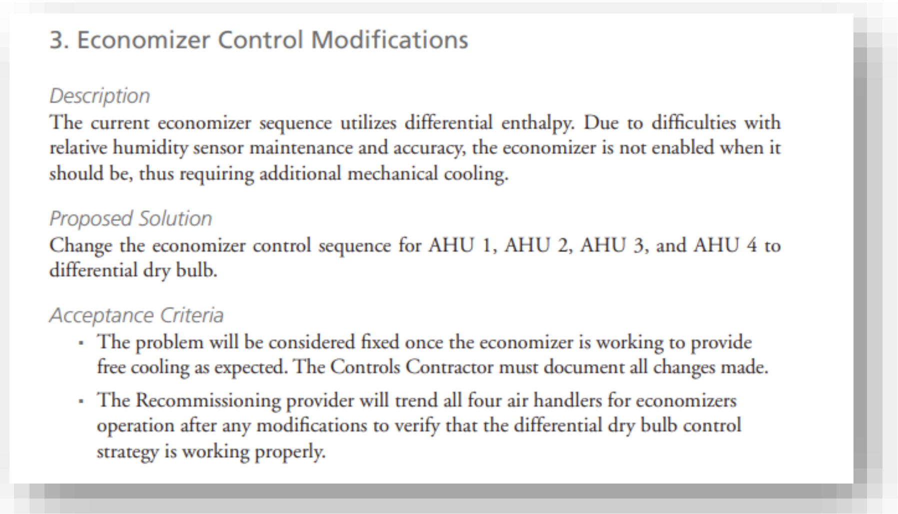
1. [Name of Issue]
   Description:
   Proposed Solution
   Acceptance Criteria
2. [Name of Issue]
   Description:
   Proposed Solution
   Acceptance Criteria

Reference: NRCan CanmetENERGY – Recommissioning Guide For Building Owners and Managers.
Available at: https://natural-resources.canada.ca/sites/nrcan/files/canmetenergy/pdf/fichier.php/codectec/En/2008-167/NRCan_RCx_Guide.pdf

Implementation report

Complete implementation plan by adding those elements:

- Implementation status
- Implementation summary
- Verification of results
- Future recommendations



3. Economizer Control Modifications

Description

The current economizer sequence utilizes differential enthalpy. Due to difficulties with relative humidity sensor maintenance and accuracy, the economizer is not enabled when it should be, thus requiring additional mechanical cooling.

Proposed Solution

Change the economizer control sequence for AHU 1, AHU 2, AHU 3, and AHU 4 to differential dry bulb.

Acceptance Criteria

- The problem will be considered fixed once the economizer is working to provide free cooling as expected. The Controls Contractor must document all changes made.
- The Recommissioning provider will trend all four air handlers for economizers operation after any modifications to verify that the differential dry bulb control strategy is working properly.

Reference: NRCan CanmetENERGY – Recommissioning Guide For Building Owners and Managers.

Discussion

Thank you for participating!

Questions: trainingandsupport@ieso.ca

Information, events, courses: https://saveonenergy.ca/For-Business-and-Industry/Training-and-support

EBCx program: https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Existing-Building-Commissioning-Program

Thank you!

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