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Continuous Optimization for Commercial Buildings Program

Recommissioning Report

Version	Updated on	Phase
1	July 12, 2022	Investigation

Prepared for:

School District 69

Qualicum Beach Elementary School

699 Claymore Rd

Qualicum Beach, BC

Project: BCH-07836

Prism Project: 2021300

Prepared by:

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Burnaby, BC

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1.0 Introduction

Prism Engineering is pleased to present the results of the Investigation Phase that was conducted as part of BC Hydro's Continuous Optimization for Commercial Buildings Program for Qualicum Beach Elementary. The objective of an Investigation is to identify deficiencies and improvements in the operation of a facility's mechanical equipment, lighting, and related controls, and determine opportunities for corrective action that reduce energy consumption and preserve the indoor environmental quality.

This document is a complete record of the work performed at this facility, including the in-depth investigation of the building systems and the implementation of selected measures to optimize building performance.

The Recommissioning Investigation Report provides an overview of the recommendations for the implementation of measures. This information is not considered a specification or detailed sequence of operations. The intent is to provide an overview of the recommendation that can be built upon during the implementation phase as part of any detailed design that may be required. Certain measures may require further investigation and specification for the correct implementation by the owner or the DDC contractor.

Nine recommended retrofits were identified as a part of this investigation. The proposed measures will be reviewed in a meeting with SD69 and Prism Engineering representatives to determine which measures will be implemented.

- Measure 1: AHU heating coil valve passing
- Measure 2: AHU-1 runs continuously
- Measure 3: AHU-4 random operation
- Measure 4: Reheat valves blocked or passing
- Measure 5: Daily HVAC operation schedule
- Measure 6: Summer HVAC operation schedule
- Measure 7: DHW pumps run continuously
- Measure 8: Exhaust fan feedback
- Measure 9: AHU-4 damper issue

These measures are presented in the Investigation Summary Table (see Appendix A).

While the investigation focuses on low-cost improvements with short paybacks, some capital improvement opportunities may also be identified. Major retrofit measures are beyond the scope of this program, but other BC Hydro and FortisBC programs provide a variety of incentives to complete the retrofits. Retrofits were identified as a part of this investigation that could potentially qualify for other BC Hydro and FortisBC programs, these measures are described in Section 6.

Retrofits include:

- Measure 10: Replace AC-1 condensing unit with air-to-water heat pump
- Measure 11: Air source heat pump connected to boiler plant

2.0 Project Overview

Project Information

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RCx Project File #	**BCH-07836**		
Date of Workbook Update	12-Jul-2022		
Organization	School District 69		
Building Name	Qualicum Beach Elementary School		
Building Type	Large School		
Location (City)	Qualicum Beach, BC		
Owner Contact	Phil Munro		
Investigation Phase start date	01-Feb-2022		
Participated in previous BCH RCx program?	No		
Previous RCx File #			
Previous RCx completion date			

Building Information

Facility Area (ft2)	53,120		
Annual elec consumption (kWh)	260,356	4.9	kWh/ft^2
Annual elec costs ($)	$ 25,661	$ 0.10	Avg. $/kWh
Fuel type	Natural Gas		
Annual fuel consumption (GJ)	1,742	9.1	$ekWh/ft^2$
Annual fuel cost ($)	$ 21,118	$ 12.1	Avg. $/GJ
Total GHG emissions (tCO2e/yr)	90		
Total Energy Cost	$ 46,779	$ 0.88	$\$/ft^2$
Energy Use Intensity (ekWh/ft2)	14.0		
Year for energy data above	2021		

3.0 Savings Summary

Savings Summary	Previous, still working	New + Previous, rectify + Previous, documented					
		Identified		Selected		Implemented	
# of measures	0	11		9		9	
	Re-claim Savings	Total Savings	% Savings	Total Savings	% Savings	Total Savings	% Savings
Electrical savings (kWh/yr)	-	- 16,198	-6.2%	119,998	46.1%	119,998	46.1%
Fuel savings (GJ/yr)	-	2,191	125.8%	748	42.9%	748	42.9%
Cost savings ($)	$ -	$ 24,969	53.4%	$ 20,889	44.7%	$ 20,889	44.7%
GHG reduction (tCO2e/yr)	-	109.1	121.7%	38.6	43.0%	38.6	43.0%
# of Abandoned measures	**0**						

4.0 Brief Description of Existing System

This section contains a brief description of the existing HVAC and Controls system. The information is intended to provide a general overview only.

4.1 Facility Description

The Qualicum Beach Elementary School was built 2002 and has a floor area of 53,120 sqft. The building contains classrooms, admin offices, gym, library, arts, music, drama, and technical teaching spaces.

Table 1: Schedules

	Area	Days	Start	End
Occupancy	Classes	All Days	8:50am	2:36pm
	Office hours	All Days	8am	3:30pm
Building operation	HVAC (main schedule)	Monday-Wednesday	4am	4pm
		Thursday-Friday	7am	4pm
	Gym (AHU2)	Monday-Friday	8am	4:30pm
	Boilers	Monday-Friday	6:30am	7pm

While the HVAC operating calendars allow for different operation on holidays, no holidays have been defined for air handlers. Boilers are shut down in July and August.

4.2 Heating System

Heating is provided by four 399 MBH (input) IBC condensing boilers. Each has a dedicated circulating pump. The primary boiler loop is connected to the secondary loop via a low loss header.

The supply water temperature is reset between 40 and 82°C depending on outdoor air temperature and building load (determined by the difference between building loop supply and return water). Boilers are disabled above 17°C outdoor air temperatures.

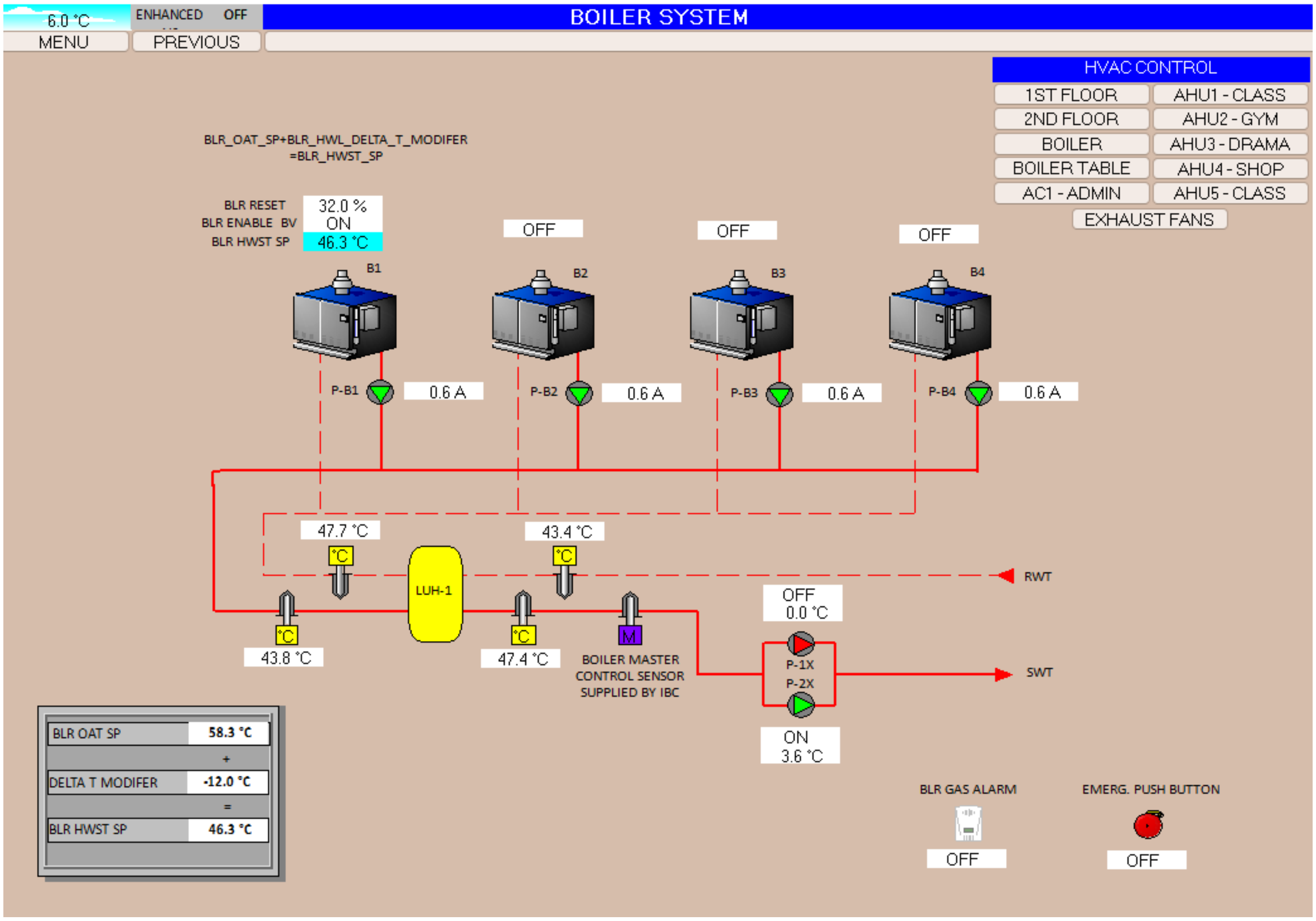

Figure 1: Boilers in the DDC

Heating water is distributed to heating coils in air handlers, duct reheat coils, fan coil units, radiant panels, and a unit heater.

Table 2: Building Pumps

Tag	Serves	Size	VSD	Flow (GPM)	Head (Ft)
BP1 to BP4	Boiler pumps	157W @ 1.4A (0.6A on DDC)	No		
P-7 P-8	Heating loop Lead-lag	1.5 HP each	No	93 GPM	32 Ft
P-9	DHW boiler/tank circulation	1/6 HP 3.6 FLA	No		
P-10	DHW recirculation	58 W	No		

4.3 Ventilation System

The building has five heating-only air handlers, and one unit with heating and cooling. HV-4 and HV-5 are in the mechanical room at the East end of the building. The other units are on the roof, at the East end of the building.

Table 3: Air handlers

Tag	Service	Airflow (cfm)	Supply Fan Power (hp)	Return Fan Power (hp)	Coils	Outdoor air
AC-1	Admin/Office, Tech, Library	8,110	7.5	3	Heating 20 ton 2-stage DX	Mixed Min 20%
HV-1 / AHU-1*	General Offices and Classrooms	14,000**	10**	5**	Heating	Mixed Min 30%
HV-2 / AHU-2*	Gymnasium	21,600	15 VSD	7.5** VSD	Heating	Mixed Min 20%
HV-3 / AHU-3*	Music / Multi-purpose	7,930	5	3	Heating	Mixed Min 20%
HV-4 / AHU-4*	Construction	4,000**	3**	2	Heating	Mixed Min 30%
HV-5 / AHU-5*	North Classrooms	11,345	7.5	3	Heating	Mixed Min 15%

* Both IDs are used interchangeable in the DDC and other documentation.

** Estimated based on area served and sizing of similar units

Table 4: Exhaust fans

Tag	Service
EF-1	Gym change rooms
EF-2	Storage (104,112)
EF-3	Kitchen range hood
EF-4	Storage (116)
EF-5	Copy 125
EF-6	Washroom 143
EF-7	Elevator 122
EF-8	Kitchen range 126
EF-9	Main washrooms
EF-10	Science 209

EF-11	207, 211, 213
EF-12	Science 215
EF-13	Fume Hood 209
EF-14	Fume hood 215
EF-5	Home Ec. 163
EF-16	Room 159
EF-17	Hood 159
EF-18	221, 165, 167, 171
EF-19	Rm 169
EF-20	Telecom 217
EF-21	Staff Room 123
EF=22	Telecom 145A

4.4 Domestic Hot Water System

Domestic hot water is provided by a 399 MBH input AO Smith atmospheric water heater with an external storage tank. Pump P-9 circulates water between boiler and tank. Pump P-10 recirculates domestic hot water through the building.

4.5 Controls System (includes Lighting Controls if Applicable)

The HVAC system is controlled by a Delta Controls DDC, using ORCAView 3.40. Remote access to the system is available.

4.6 Others

The school has a 60 kW roof-mounted solar photovoltaic system, installed in 2021. It has a Tesla backup battery.

5.0 Measures Selected for Implementation (Under C.Op. Program)

This section provides an overview of each measure, recommendations for implementation, and update after implementation.

For each measure, costs, savings and payback calculations can be referenced in the *Investigation Summary Table* (see Appendix A).

5.1 Measure 1: AHU heating coil valve passing

5.1.1 Description of Finding

AHU-1

AHU-1 supply air temperate is consistently 4-5°C higher than mixed air temperature when its heating valve is commanded closed. This was the case when Figure 8 was captured.

As a result, additional outdoor air must be brought in as cooling to keep the supply air at setpoint. During unoccupied operation, when outdoor air dampers are kept shut, it can also lead to overheating.

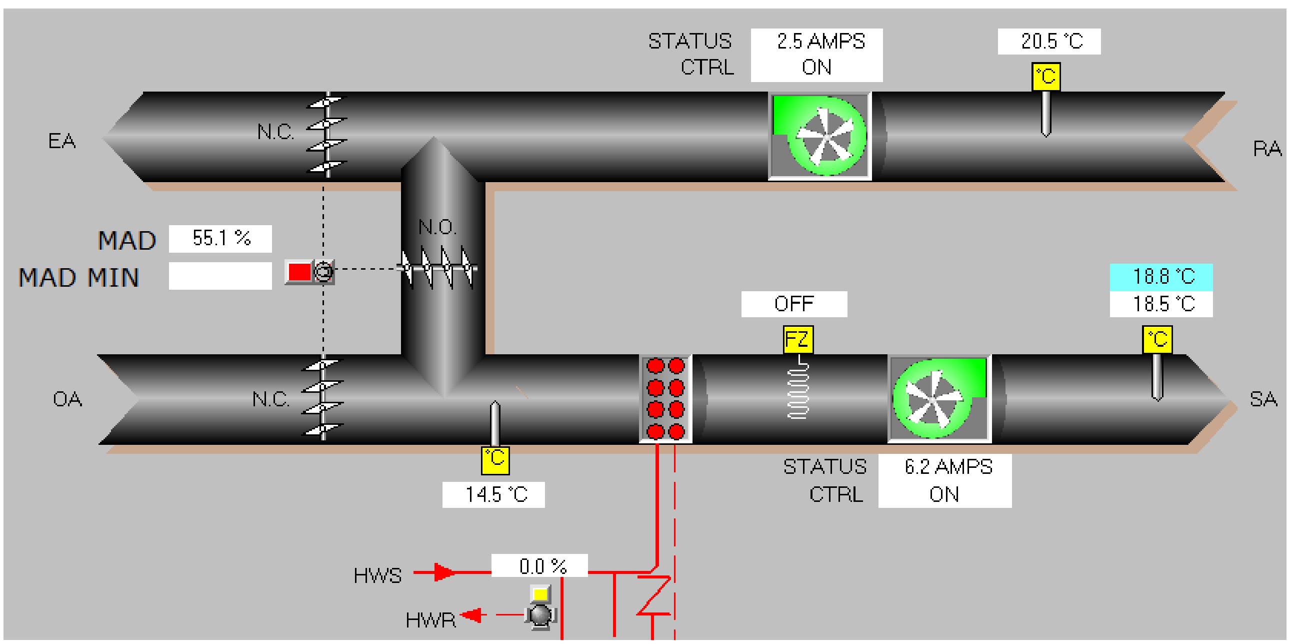

Figure 2: AHU-1, SAT is 5°C higher than MAT, with HCV at 0%

AHU-5

Figure 3 shows AHU-5 heating supply air by 2.5°C despite its control valve being fully closed. This suggests the valve is passing. Figure 4 shows the supply air temperature exceeds 30°C overnight (when AHU-5 is off), which also indicates passing.

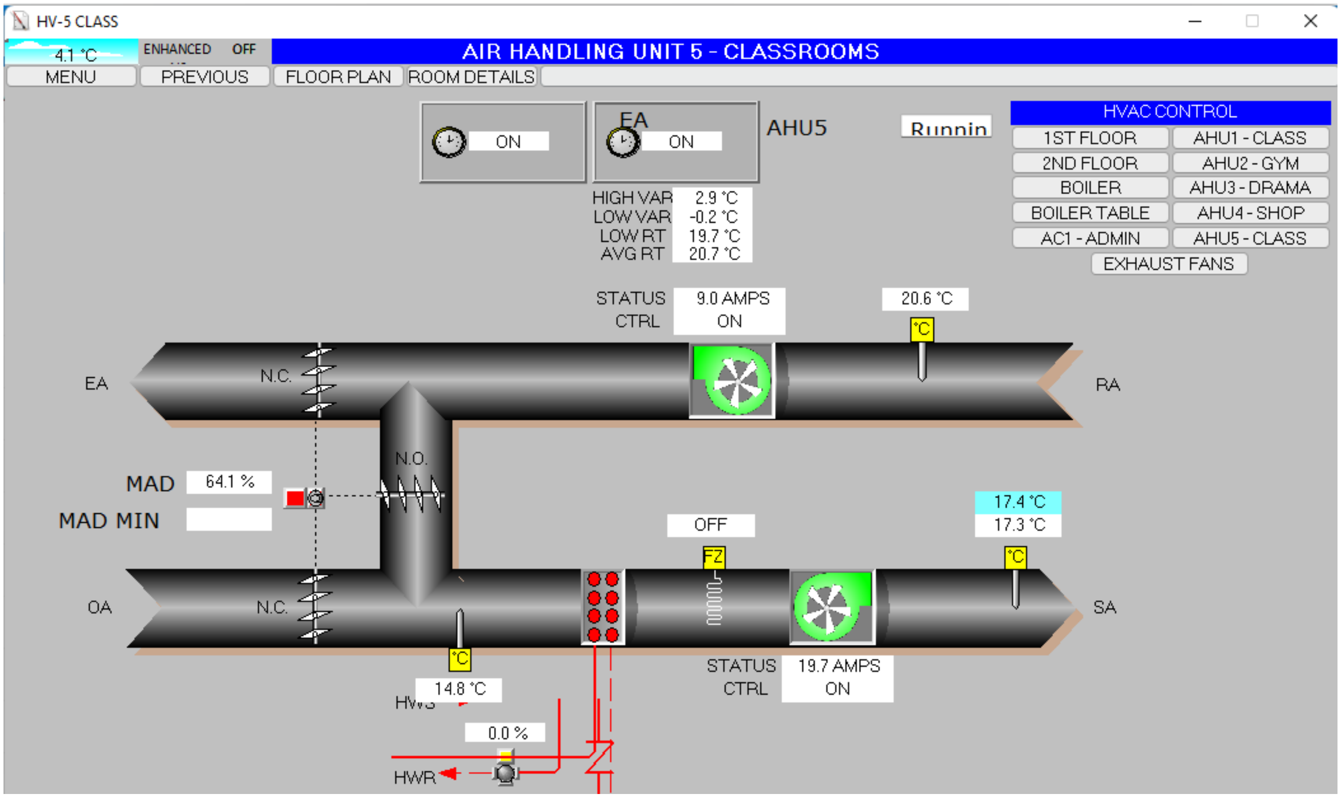

Figure 3: AHU-5 heating despite the control valve closed.

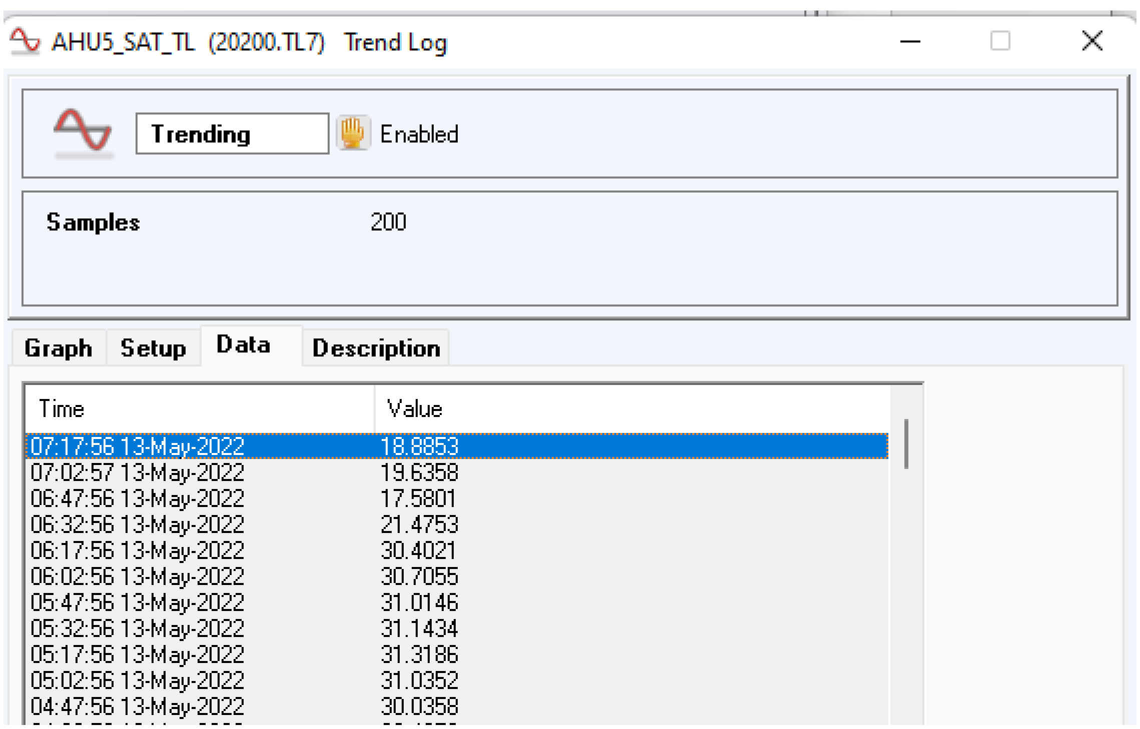

Figure 4: High supply air temperature overnight (before unit starts at 6:30am)

5.1.2 Measure Description

Validate the mixed air and supply air temperature sensor readings with a manual temperature reading in the field.

Operate the affected airhandlers with the supply fan enabled and the heating coil control valve commanded fully closed (0%). Manually measure the air temperature at the coil inlet and outlet. A temperature rise indicates a passing valve. Furthermore, the heating coil inlet and outlet pipes should be cold after the control valve is closed for several minutes.

Measure costs assume the control valve needs to be replaced.

5.1.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.2 Measure 2: AHU-1 runs continuously

5.2.1 Description of Finding

AHU-1 was observed to run during its scheduled unoccupied period. Several different causes were identified during the investigation period.

Return fan feedback sensor

The return fan feedback sensor reports that the fan runs, even when commanded off. Figure 6 shows the supply fan is programmed to operate whenever the return fan's status is on. Figure 7 shows AHU-1 is programmed to operate its mixed air damper in occupied mode whenever the supply fan operates.

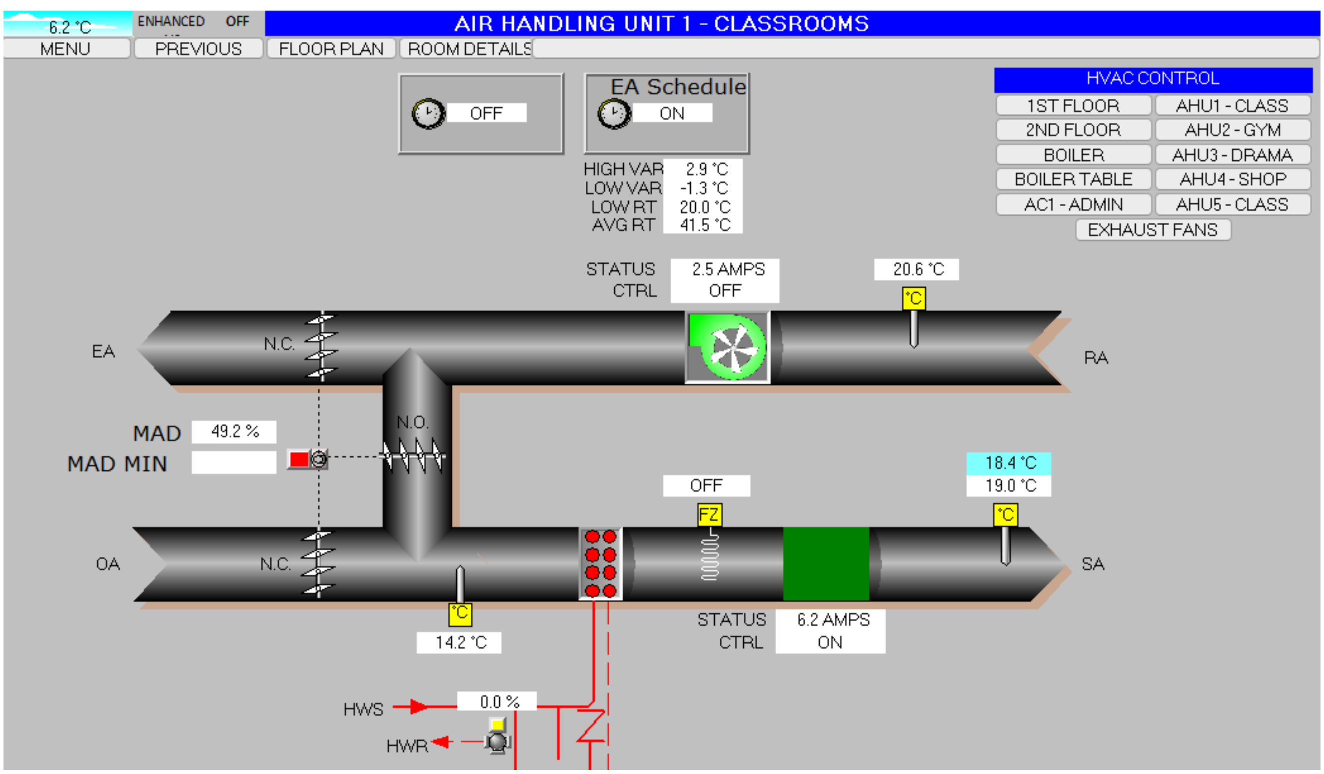

Figure 5: AHU-1 runs with open mixed air dampers even when the main schedule is OFF

```
If (AHU1_RFS > 2) OnFor 10S Then
  AHU1_SFC 20301.AI2 = 2.46937 A
Else
  AHU1_SFC = Off
End If
```

Figure 6: Return fan status enables the supply fan

```
If AHU1_SFS > 5 Then
 DoEve 20301.AI1 = 6.12943 A
   AHU1_MAD_RAMP = Limit (AHU1_MAD_RAMP + (AHU1_RAT - 18), 0, 100)
 End Do
 AHU1_MAD_GV = (2 * AHU1_SAT_CO) - 100
 AHU1_MAD_GV = Limit (AHU1_MAD_GV, 0, 100)
 AHU1_MAD_GV = Max (AHU1_MAD_GV, AHU1_MAD_MIN)
 AHU1_MAD_GV = Min (AHU1_MAD_GV, AHU1_MAD_LL_CO, AHU1_MAD_RAMP)

 If AHU1_NSB_GV On Then
  AHU1_MAD_GV = 0
 End If

 AHU1_HCV_GV = - 2 * AHU1_SAT_CO + 100
 AHU1_HCV_GV = Limit (AHU1_HCV_GV, 0, 100)
Else
```

Figure 7: Enabling the supply fan triggers normal damper and heating coil operation

Low room temperature calculation

AHU-1 is programmed to start during unoccupied hours if the lowest room temperature (*AHU1_LOW_RT*) is less than 16°C per Figure 9. However, the lowest room temperature is often a random negative value. This causes AHU-1 to run continuously.

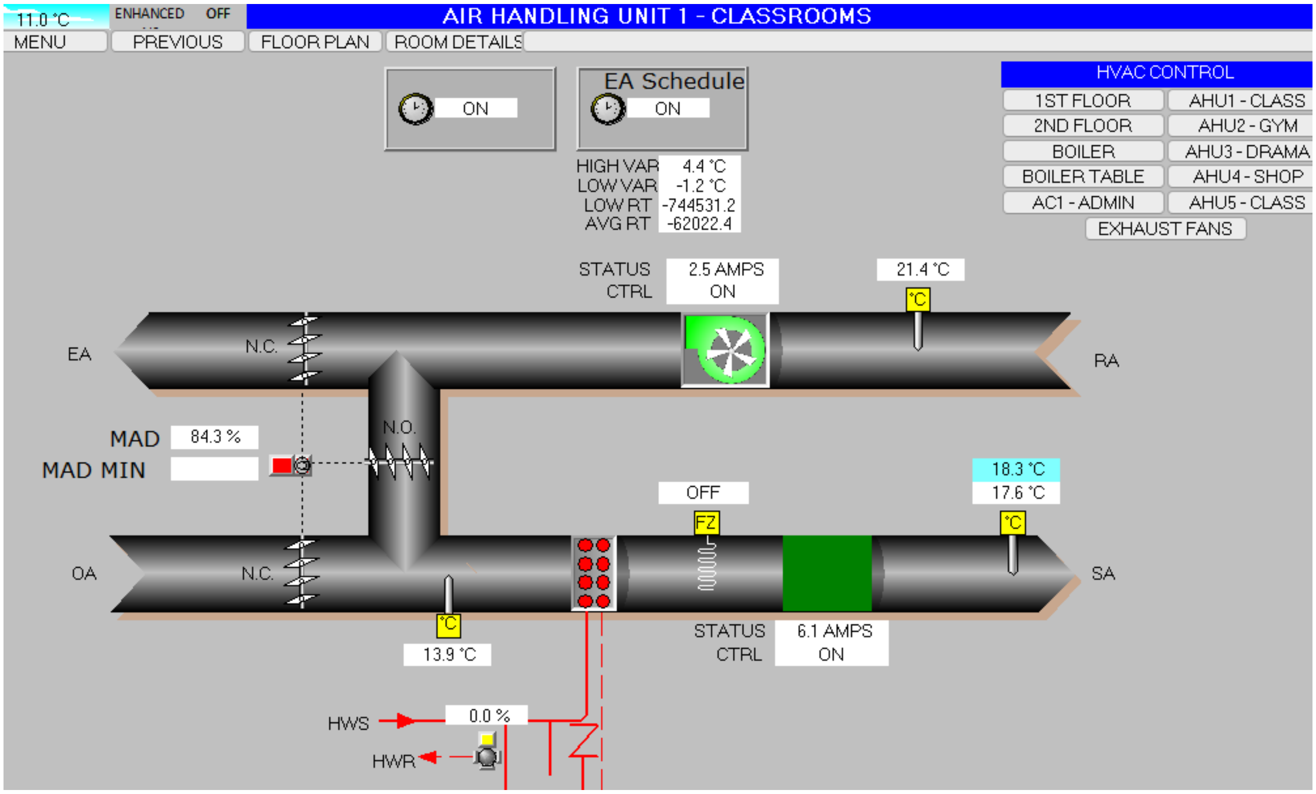

Figure 8: AHU-1 DDC Graphic

```
If AHU1_OCC On Then
   AHU1_RFC = On
   AHU1_NSB_GV = Off
Else
  AHU1_NSB_GV = Switch ( AHU1_NSB_GV, AHU1_LOW RT, NSB SP, NSB_SP + 1)
  AHU1_RFC = AHU1_NSB_GV
End If
```

20301.AV3 = -726819.1875 °C

Figure 9: The value of AHU1_LOW_RT is random (low negative number) which triggers night setback heating

5.2.2 Measure Description

Confirm whether the return fan responds correctly when commanded on and off. Confirm whether the feedback sensor correctly measures fan current. Replace the current sensor if necessary.

Replace any failed sensors used to calculate *AHU1_LOW_RT* and remove any sensors from its calculation that no longer exist.

5.2.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.3 Measure 3: AHU-4 random operation

5.3.1 Findings

AHU-4 sometimes runs outside occupied hours, with no clear pattern.

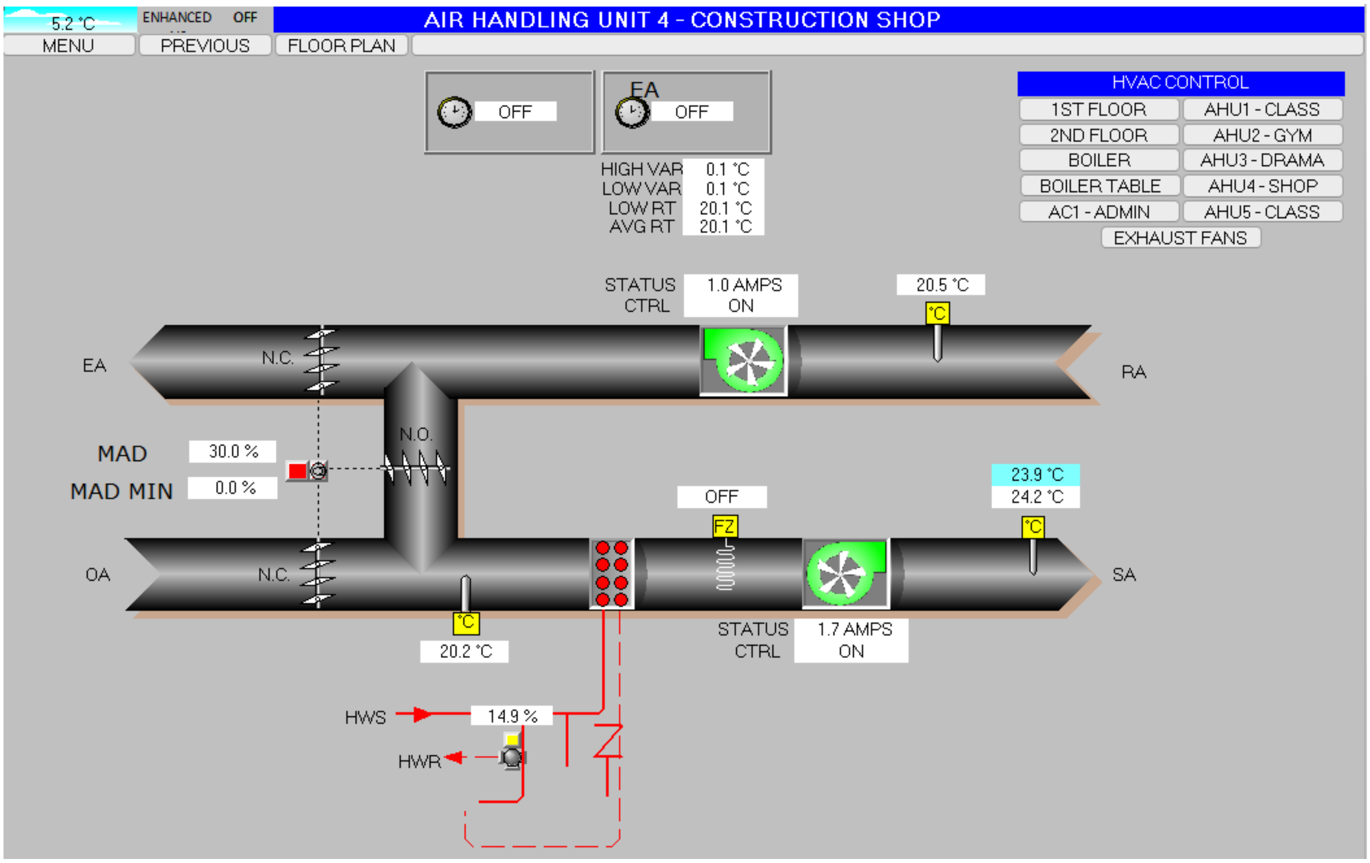

Figure 10: Operating schedule is OFF (Sunday) but AHU-4 is running.

Operation of AHU-4 is triggered by occupancy data from panel 20210 in room 169. However, this panel appears to be offline with undefined values, and the air handler operation does not match expected occupancy.

RM169_OCC contains changing values and the value of 20210.Alg.Mode is "Object Undefined"

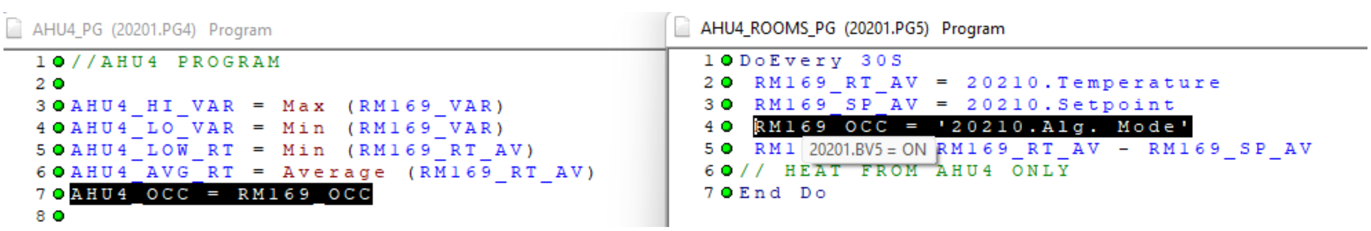

Figure 11: AHU-4 occupancy determined by panel 20210

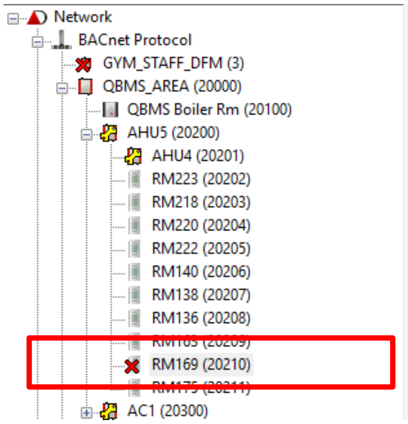

Figure 12: Panel 20210 is offline

5.3.2 Measure Description

Ensure Panel 20210 is correctly connected and that all control variables are available to other panels as required.

Savings assume AHU-4 should run during regular class hours, but currently runs randomly (50% of all hours).

5.3.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.4 Measure 4: Reheat valves blocked or passing

5.4.1 Description of Finding

The following reheat coil valves are suspected to be *passing* (discharge air temperature is higher than the supply air temperature from the air handler with the reheat coil valve commanded closed), or *blocked* (discharge air temperature close to the supply air temperature from the air handler with the reheat coil valve open).

Table 5: Reheat issues

Room / reheat	Air handler	Issue
RM123, RM127, RM129	AC-1	Blocked
RM107, RM108	AHU-3	Blocked
RM102, RM106	AHU-3	Passing

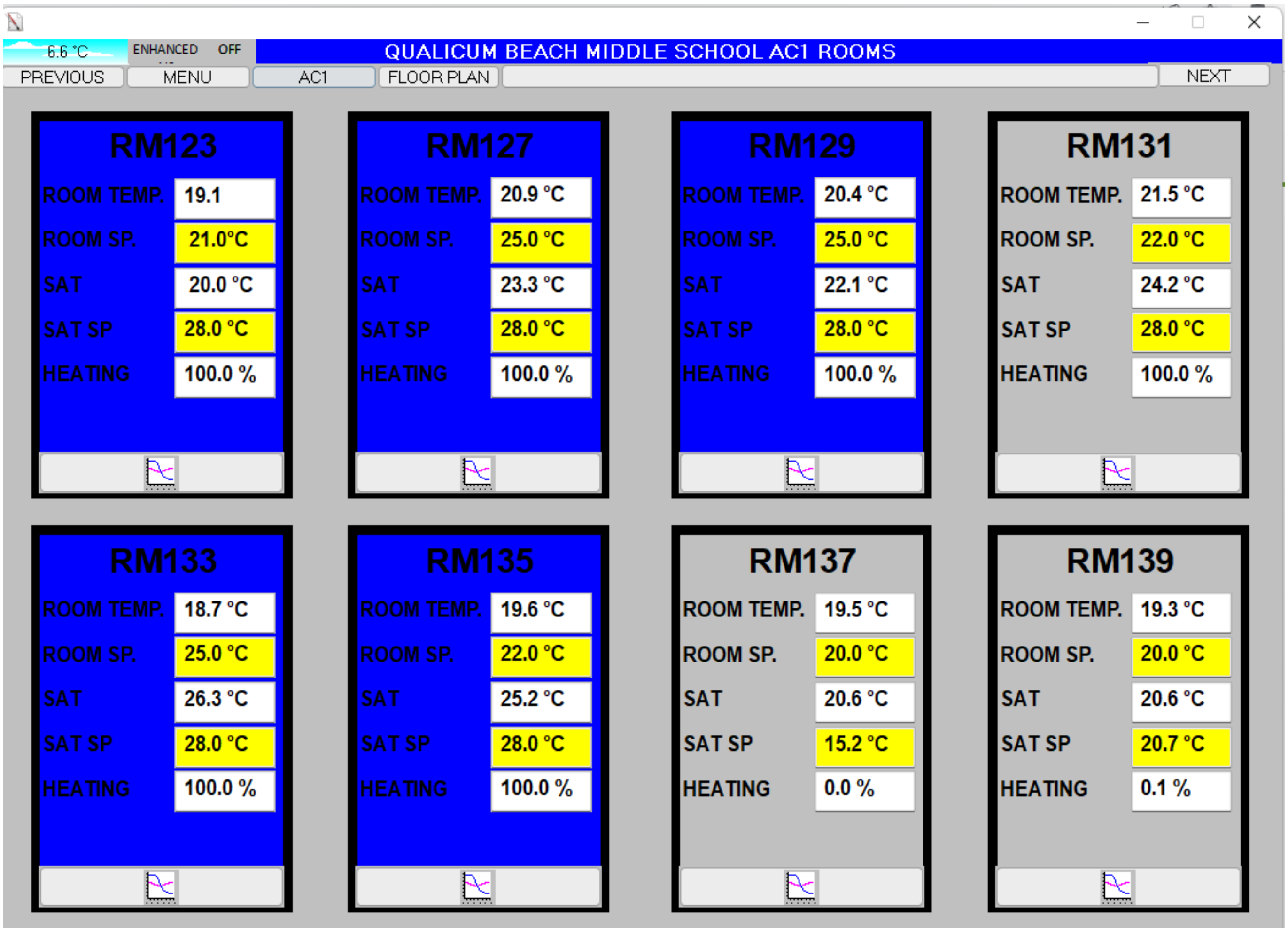

Figure 13: RM123 and RM129 reheat coils providing little or no heat. AC-1 supply air temperature was 21°C.

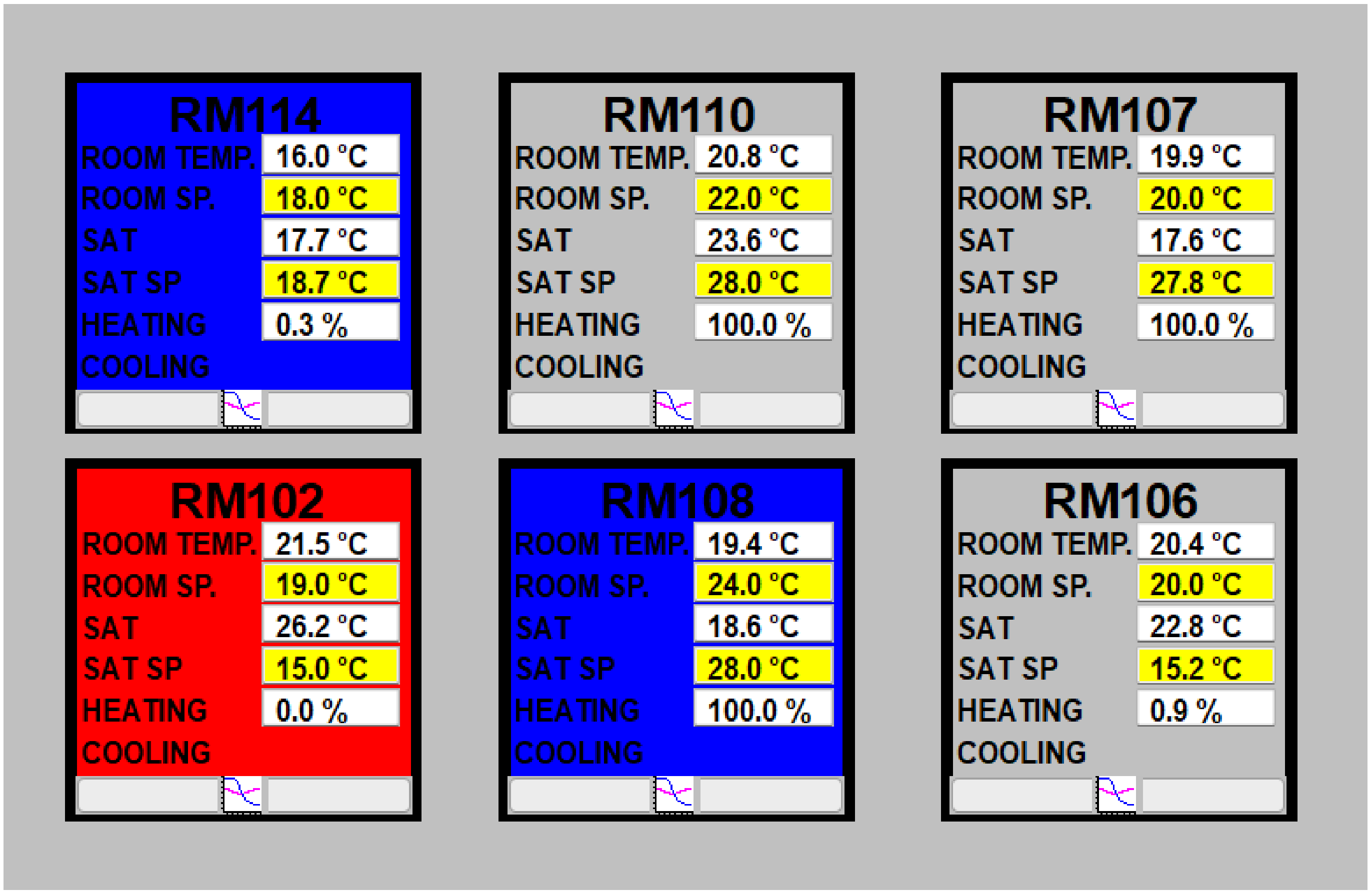

Figure 14: AHU-3 reheat coils. Little or no heat from RM107, RM108 reheats. RM102 and RM106 are heating even with valves at 0%. AHU-3 supply air temperature was 18.8°C.

The passing valve in room 102 is overheating the room. This causes AHU-3 to lower its supply air temperature setpoint and draw more outdoor air. This extra outdoor air needs to be reheated, increasing gas use.

5.4.2 Measure Description

Investigate the identified reheat coils:

- Confirm correct movement of the valve in positions from closed (0%) to fully open (100%).
- Confirm coils are clean and air flow matches design.

With boilers and air handler fans enabled:

- Close the valve fully, then confirm the vent discharge temperature matches the temperature of air supplied by the air handler, and that pipes leading to/from the cool quickly after the valve is closed.
- Open the valve fully, then confirm the pipes leading to/from the coil warm up, and that the air temperature rise over the coil matches specifications.

5.4.3 Measure Implementation Update

[Provide confirmation details **<u>AFTER</u>** the measure is implemented and verified]

5.5 *Measure 5: Daily HVAC operation schedule*

5.5.1 Description of Finding

The main HVAC schedule starts AC-1, AHU-1, AHU-3, and AHU-5 at 4am, Monday to Wednesday. On Thursday and Friday, the systems start at 7am, without any issues, which indicates that it should be possible to delay startup to 7am on the other days.

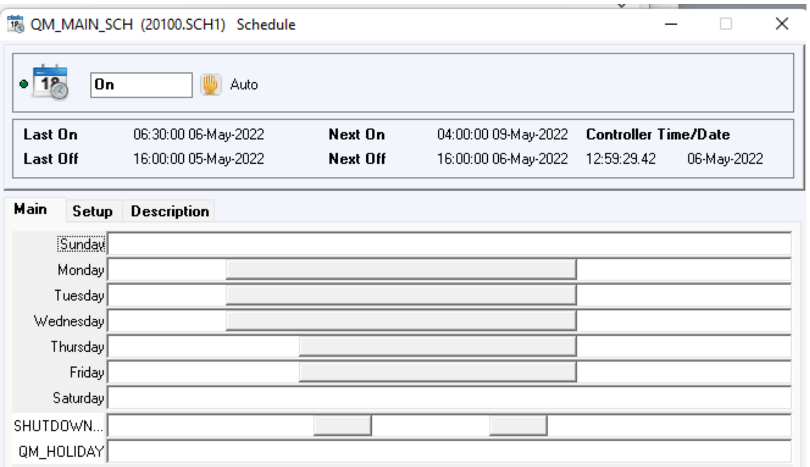

Figure 15: Main building operations schedule

5.5.2 Measure Description

Update the main building operations schedule (QM_MAIN_SCH) to start at 7am on all weekdays. Monitor room temperatures on Monday mornings, to determine if the Monday start time needs to be adjusted.

For further savings, the DDC can be programmed to adjust start times based on outdoor air temperature and room temperatures, since it takes more time to warm up the building on a cold morning than on a warmer day when the building has retained most of the heat from the previous day. This is commonly known as "optimal start". The start time should be calculated separately for each air handler since they have different occupancy times.

5.5.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.6 *Measure 6: Summer HVAC operation schedule*

5.6.1 Description of Finding

There is no evidence of a summer shutdown schedule for the HVAC system this year (2021) or in previous years.

Based on observation of the DDC system on 7 July 2022, the HVAC system maintains regular operation during the summer break. The occupancy of the school during this time is unknown, but it assumed that it is largely unoccupied.

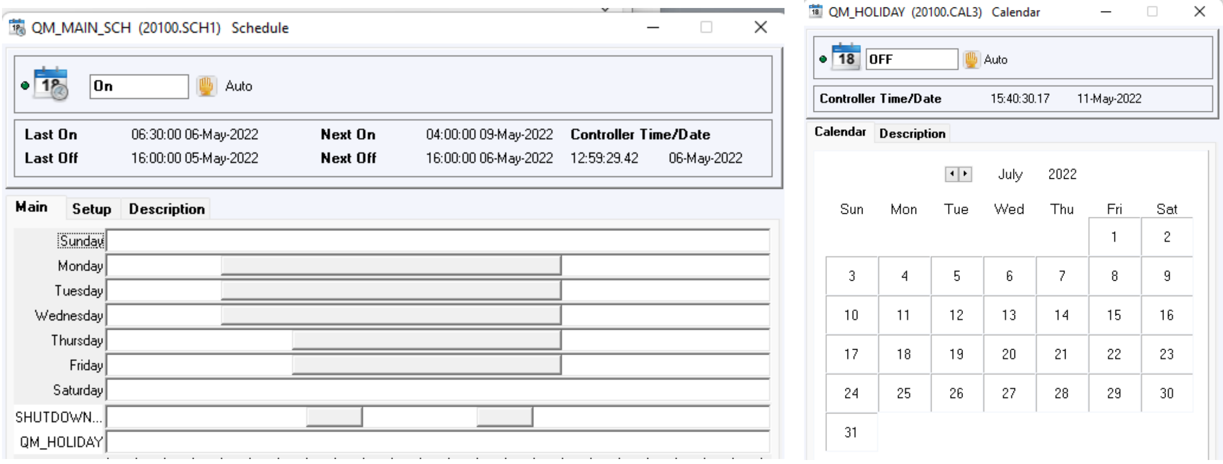

Figure 16: Main building operations schedule

5.6.2 Measure Description

Add summer shutdown days to the QM_HOLIDAY schedule.

Define appropriate daily/weekly schedule to main schedule. For the sake of saving calculations, a two-hour morning flush during unoccupied holidays is assumed.

5.6.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.7 Measure 7: DHW pumps run continuously

5.7.1 Description of Finding

The DHW recirculation pump control is overridden on in the DDC, causing it to operate continuously. Disabling the distribution pumps when the building is unoccupied would provide small electricity savings from reduced pump hours and gas savings from reduced distribution losses.

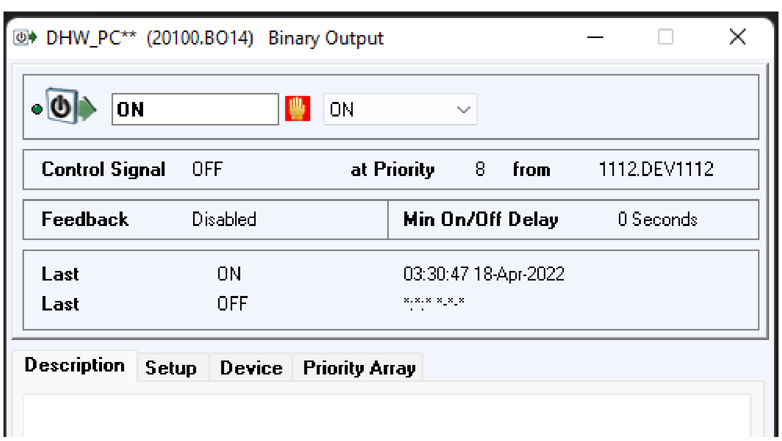

Figure 17: DHW recirculation pump override

5.7.1 Measure Description

Create a pump schedule to match occupancy, including custodial staff working outside regular occupancy hours. Remove manual override.

5.7.2 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.8 *Measure 8: Exhaust fan feedback*

5.8.1 Description of Finding

The feedback sensor values for several exhaust fans do not match the fans' commanded state.

While this is likely due to sensor defects or calibration errors, the function of the fans should be investigated. Failed fans can cause indoor air quality issues. Exhaust fans operating continuously will use unnecessary electricity to spin the fan and gas from heating the infiltrated makeup air.

Table 6: Mismatch between commanded state and feedback

Fan	Room	Command	Feedback
EF-2	Storage (104,112)	Off	Running (16.3 Amps)
EF-4	Storage (116)	Off	Running (16.9 Amps)
EF-9	Main washrooms	On	Not running (0 Amps)
EF-19	Rm 169	On	Not running (0 Amps)

EF no.	Serves:	CONTROL	STATUS
1	GYM CHANGE ROOMS	ON	2.1 AMPS
2	RM104 AND RM112	ON	23.7 AMPS
4	RM116	ON	18.1 AMPS
5	RM125	ON	14.0 AMPS
9	1ST AND 2ND FLOOR	ON	0.0 AMPS
10	RM209	OFF	0.0 AMPS
11	RM207, RM211, RM213	OFF	0.0 AMPS
12	RM215	OFF	0.0 AMPS
15	RM163	OFF	0.0 AMPS
18	RMS- 165,167,171,221	OFF	0.0 AMPS
19	RM169 - SHOP	ON	0.0 AMPS
20	TELECOM 217	ON	

EF no.	Serves:	CONTROL	STATUS
1	GYM CHANGE ROOMS	OFF	0.0 AMPS
2	RM104 AND RM112	OFF	16.3 AMPS
4	RM116	OFF	16.9 AMPS
5	RM125	OFF	0.0 AMPS
9	1ST AND 2ND FLOOR	ON	0.0 AMPS
10	RM209	OFF	0.0 AMPS
11	RM207, RM211, RM213	OFF	0.0 AMPS
12	RM215	OFF	0.0 AMPS
15	RM163	OFF	0.0 AMPS
18	RMS- 165,167,171,221	OFF	0.0 AMPS
19	RM169 - SHOP	OFF	0.0 AMPS
20	TELECOM 217	ON	

Figure 18: Exhaust fans at different times

5.8.2 Measure Description

Confirm in the field whether each exhaust fan operates when commanded and if the status aligns with its actual state.

5.8.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

5.9 Measure 9: AHU-4 damper issue

5.9.1 Description of Finding

AHU-4 mixed air temperature equals return air temperature in Figure 19 despite a 30% open mixed air damper. This suggests the dampers are not functioning, and the RM 169 Construction Shop served by AHU-4 is not getting any outdoor air. This reduces indoor air quality and cooling, reducing occupant comfort.

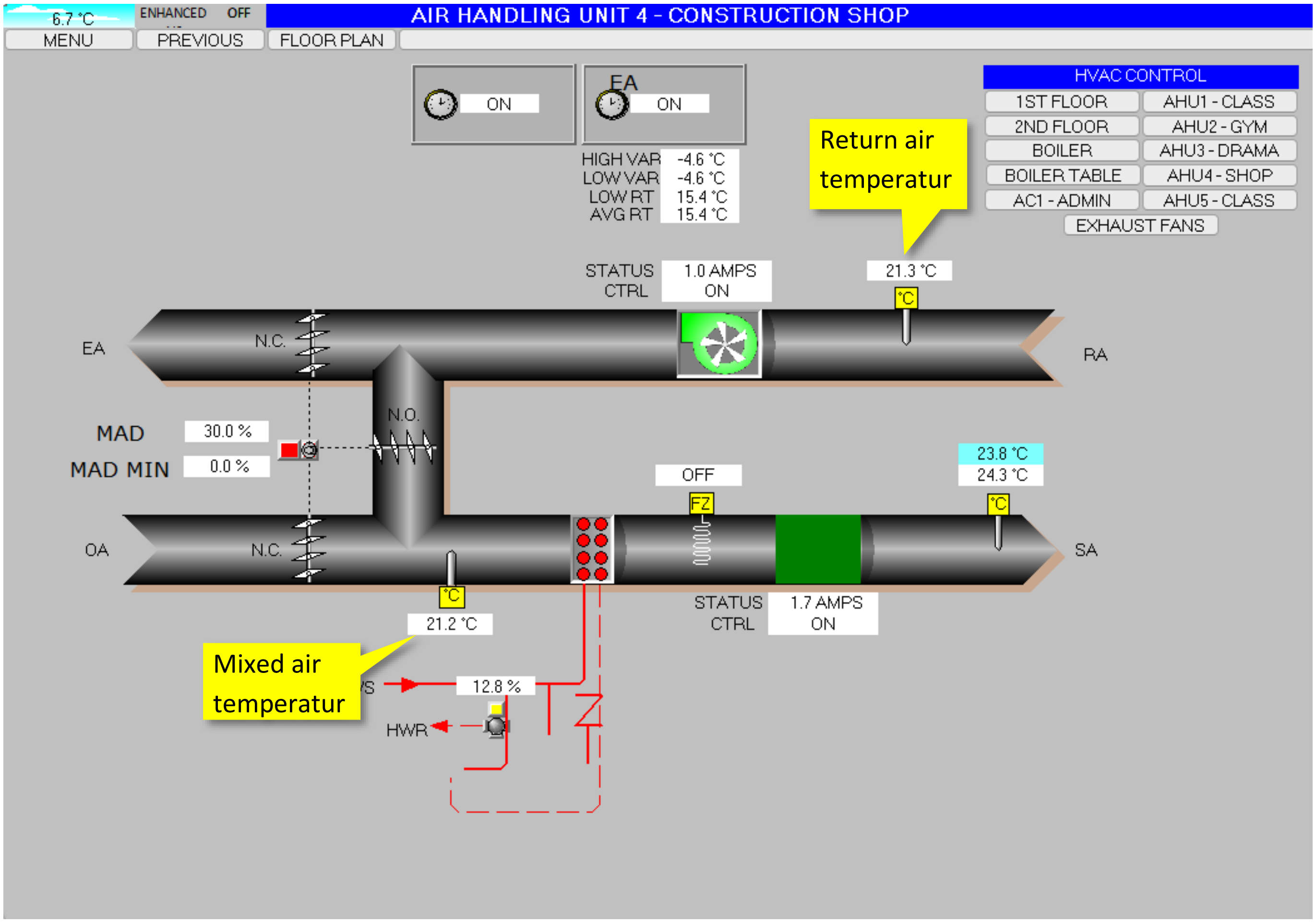

Figure 19: AHU-4 with RAT equal MAT

5.9.2 Measure Description

Visually confirm the AHU-4 dampers operate when commanded to various positions. Check for obstructions to the outdoor air supply.

Measure costs are for replacing one damper actuator.

There are no energy savings for this measure.

5.9.3 Measure Implementation Update

[Provide confirmation details **AFTER** the measure is implemented and verified]

6.0 Measures to be considered for Future Implementation

This section provides an overview of each measure (that was identified but **was not selected** as part of this C. Op. project, but maybe considered for future implementation), recommendations for implementation, and the most suitable method for providing evidence of implementation. See Appendix A - Investigation Phase Summary Table for more details.

6.1 Measure 10: Replace AC-1 condensing unit with air-to-water heat pump

AC-1's condensing unit is original to the building (2002) and at the end of its predicted service life. It could be replaced by a reversible air-to-water heat pump. The heat pump could be connected to the existing heating coils in AC-1 and the three other air handlers on the roof. During winter, the heat pump would operate in heating mode, and provide 1st stage heating to the four air handlers. When required, additional heat would be supplied from the existing boiler loop.

During summer, the heat pump and air handlers could be isolated from the rest of the boiler loop, and the heat pump would provide chilled water to AC-1, with either the existing coil, or a new larger coils serving as a switchover coils. Cooling could also be provided to the other nearby air handlers if desired[1], but this would require a larger heat pump at a higher project cost.

Estimated costs include all work required to replace the condensing unit with a heat pump. While a heat pump installation is likely to be more expensive than like-for-like replacement of the condensing unit, it is more cost effective than installing both a new condensing unit and a separate heat pump. If the heat pump is sized similarly to the existing condensing unit (20 Tons), it would be able to operate on the existing electrical circuit.

A feasibility study is recommended as the next step to assessing the viability of this project and alternatives. Heating water supply temperatures, and heating coil operation for the four impacted air handlers should be trended through the heating season to confirm savings potential. Mechanical and structural assessments are required to refine the cost and viability of the project.

[1] This help achieve any climate resilience goals that require managing extreme heat events.

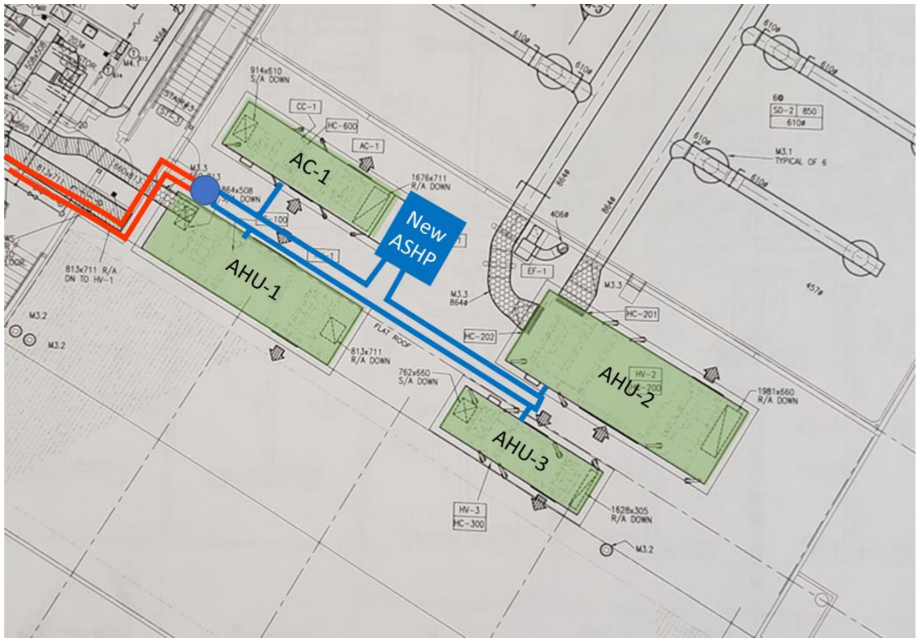

Figure 20: Possible location of ASHP on roof with new loop

6.2 *Measure 11: Air source heat pump connected to boiler plant*

The boiler supply temperature setpoint was observed to reset to low temperatures (50°C or below) at moderate outdoor temperatures (4°C and above), and the supply water temperature could likely be adjusted even lower. This makes the building a potential candidate for connecting an air source heat pump to the hydronic loop.

One possible location for an air-source heat pump would be in the gated storage/dust-collector area next to the construction classroom. Alternatively, any location near the school might suffice with fencing around the heat pump. It may also be possible to install the heat pump in the mechanical room, with outdoor air ducted through the heat pump.

During winter, the heat pump would operate in heating mode, and provide 1st stage heating to all heating coils in the building, with supplemental heating from the boiler plant. During colder periods, when the heating system requires higher water temperatures than what the heat pump can produce, the system would switch to full gas heating mode.

Estimated costs include all work required to install a new heat pump in the storage area. Alternative locations would involve higher costs. The need or cost for an electrical service upgrade has not been evaluated.

A feasibility study is recommended as the next step to assessing the viability of this project. Heating water supply temperatures, and heating coil performance should be trended through the heating season to confirm the heat pump could operate for most of the heating season. Mechanical and structural assessments are required to refine the cost and viability of the project.

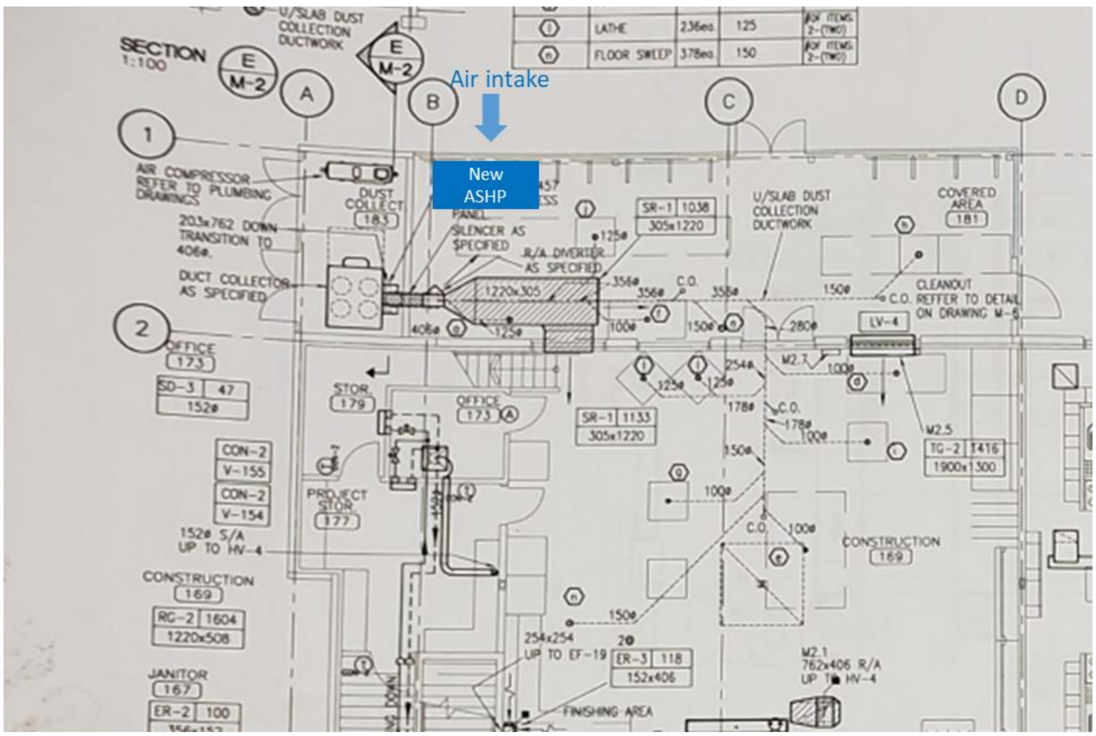

Figure 21: Possible location for ASHP in the covered storage/dust collector area

Figure 22: Possible alternative locations for an air-source heat pump connected to the heating loop

7.0 Next Steps – Implementation Phase and Completion Phase

7.1 Implementation Phase

To continue in the program, the owner is responsible for implementing the selected bundle of measures that pay back in two years or less. Using the *Recommissioning Report* for implementation allows flexibility in how the selected measures are implemented. Options include: utilize in-house building staff, hire the C.Op Provider to implement or provide technical assistance, contract with outside service contractors, or any combination of the above.

7.2 Completion Phase

C.Op Service provider will follow up after implementation of the selected measures and **update** this *Recommissioning report and Recommissioning Workbook*.

The updated report for the implemented measures includes but not limited to: date of completion of each measure, new or improved sequences of operation, the energy savings impact of the measures, the requirements for ongoing maintenance and monitoring of the measures, and contact information for the service provider, in house staff, and contractors responsible for the implementation. When feasible, verification data should include trends or functional test results, though other methods, such as copies of invoices, site visit reports, and before/after photos, may be acceptable.

The C.Op Service Provider will conduct an in-house (teleconference) session for the Applicant and the appropriate building operations personnel covering the new documentation, measures that were implemented, and requirements for ongoing maintenance and monitoring. Document the attendance of the building operations staff.

The *updated Recommissioning Workbook* and *updated Recommissioning Report* will be submitted to the owner and the program for review. See Appendix B: Completion Phase Summary Table for more details on implemented measures.

Appendix A: Investigation Phase Summary Table

Investigation Phase Summary				Investigation Phase							
				Energy Savings			Cost Savings	Financial		Est. GHG Reduction	
ECM #	Measure Title	Measure History	Include cost	Demand (kW)	Electrical (kWh/yr)	Fuel (GJ)	Total ($/yr)	Estimated Measure Cost ($)	Simple Payback (yrs)	tonnes CO2e/yr	Enter "x" if DESELECT for implementation
ECM-1	AHU heating coil valve passing	New	1	-	-	467	$ 5,666	$ 9,500	1.7	23.3	
ECM-2	AHU-1 runs continuously	New	1	-	64,275	120	$ 7,793	$ 800	0.1	6.7	
ECM-3	AHU-4 random operation	New	1	-	26,282	22	$ 2,854	$ 700	0.2	1.4	
ECM-4	Reheat valves blocked or passing	New	1	-	-	58	$ 698	$ 4,800	6.9	2.9	
ECM-5	HVAC daily schedule	New	1	-	15,362	58	$ 2,218	$ 400	0.2	3.1	
ECM-6	HVAC summer schedule	New	1	-	13,452	-	$ 1,326	$ 600	0.5	0.1	
ECM-7	DHW pumps run continuously	New	1	-	627	23	$ 335	$ 600	1.8	1.1	
ECM-8	Exhaust fan feedback	New	1	-	-	-	$ -	$ 1,100	#DIV/0!	-	
ECM-9	AHU-4 damper issues	New	1	-	-	-	$ -	$ 1,000	#DIV/0!	-	
ECM-10	Replace AC-1 condensing unit with air-to-w	New	1	-	- 62,440	635	$ 1,543	$ 284,614	184.5	31.0	x
ECM-11	ASHP connected to boiler plant	New	1	-	- 73,756	809	$ 2,537	$ 307,151	121.1	39.6	x
			TOTAL (Previous, still working):	-	-	-	$ -	n/a	n/a	-	
			TOTAL (All potential measures for Implementation):	-	- 16,198	2,191	$ 24,969	$ 611,265	24.5	109.1	
			TOTAL (Selected measures only):	**-**	**119,998**	**748**	**$ 20,889**	**$ 19,500**	**0.9**	**38.6**	
							Implementation cap @$0.25/ft2	$ 13,280			

Appendix B: Completion Phase Summary Table

[Paste image of Completion Summary Table from the RCx Workbook **AFTER** Implementation]

Appendix C: Sample Training Outline

[Completion Report AFTER Implementation]

The Commissioning Provider (C.Op Provider) may customize the outline for the training and developing the training materials. Before preparing the training outline and materials, the C.Op Provider should assess the related level of knowledge of the building operators, to set up the training accordingly. For reference, the Program provides the following sample outline for the training:

- Background on the energy use of this particular building
    - Present Energy Utilization Index
    - Describe Operating Schedules and Owner's operating requirements
- RCx investigation process used in this building
    - Describe the methods used to identify problems and deficiencies
    - Review the RCx Workbook
- Implementation process in this building
    - Describe the measures that were implemented and by whom
    - Walk around the building to look at any physical changes or step through the new control sequences at the operator workstation
    - Provide as many details about implementation as necessary to describe what was done
    - Describe improved performance that these measures will create (show trends if available)
- O&M requirements
    - Describe the O&M requirements needed to keep these improvements working
    - Describe how the staff can be aware of energy efficiency opportunities and begin looking for additional savings potential

The C.Op Provider should follow the outline to prepare materials, as necessary, to hand out at the training session.

Appendix D: Training Completion Form

Project ID

Facility Information

Company Name	Building Name(s)	
Facility Address	City	Province

Training Details

Location	Date
Commissioning Provider/Trainer	

Materials Attached

☐ Agenda
☐ Materials used for training
☐ List of individuals who attended

COMMISSIONING PROVIDER SIGNATURE

By signing this Training Completion Form, I verify that this training took place with the listed attendees.	
Commissioning Provider (print name):	
Signature:	Date:

FACSIMILE/SCANNED SIGNATURES: Facsimile transmission of any signed original document, and the retransmission of any signed facsimile transmission, shall be the same as delivery of the original signed document. Scanned original documents transmitted to BC Hydro as an attachment via electronic mail shall be the same as delivery of the original signed document. At the request of BC Hydro, C.Op Provider shall confirm documents with a facsimile transmitted signature or a scanned signature by providing an original document.

Targeted Documentation

O & M Manual

O & M Manual updated ☐	Describe updates below and attach copies of new or amended portions
O & M Manual not updated ☐	Province reasons below
Building has no O & M Manual ☐	

Building Plans ("as-builts")

Building Plans updated ☐	Describe below
Wiring diagrams updated ☐	Describe below
No plans or diagrams updated ☐	Describe below

EMS Programming

New sequences of operation on file ☐	Specify location of file and attach copy
Printed screenshots on file ☐	Specify location of file and attach copy

Equipment Manuals

Manuals for new equipment are on file ☐	Describe below (attach copy if applicable)

Checklist of subjects discussed at training

Explain investigation process and how measures were identified	☐
Describe implemented measures, and how they are reducing energy usage	☐
Building walkthrough to show implemented measures	☐
Describe methods for monitoring and maintaining optimum system performance related to implemented measures	☐
Describe scenarios where system setting changes would be required, and how to maintain optimum energy efficiency, e.g., seasonal-based manual adjustments to setpoints.	☐

List of Individuals Who Attended

Name	Title	Building (address or name)	Contact information (e-mail and/or phone number)