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Continuous Optimization for Commercial Buildings Program

Recommissioning Report

Version	Updated on	Phase
1	July 12, 2021	Investigation

Prepared for:

School District 69

Springwood Elementary School

450 Despard Ave W

Parksville, BC

Project: BCH-07833

Prism Project: 2021300

Prepared by:

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saving you energy™

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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 School District 69. 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.

Recommended retrofits for implementation include:

- Measure 1: AHUs running overnight
- Measure 2: AHU Schedules
- Measure 3: Summer schedules
- Measure 4: Boiler temperature override
- Measure 5: AC-2 valve and damper control
- Measure 6: Ineffective Reheat Coils
- Measure 7: Broken HV-5 SAT sensor
- Measure 8: HV-2 return fan not running when SF is at 40%
- Measure 9: AC-1 mixed air temperature

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 chiller with reversible heat pump

2.0 Project Overview

Project Information

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RCx Project File #	**BCH-07833**
Date of Workbook Update	12-Jul-2022
Organization	School District 69
Building Name	Springwood Elementary School
Building Type	Large School
Location (City)	Parksville, 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)	56,694		
Annual elec consumption (kWh)	309,465	5.5	kWh/ft^2
Annual elec costs ($)	$ 30,487	$ 0.10	Avg. $/kWh
Fuel type	Natural Gas		
Annual fuel consumption (GJ)	1,199	5.9	ekWh/ft^2
Annual fuel cost ($)	$ 14,535	$ 12.1	Avg. $/GJ
Total GHG emissions (tCO2e/yr)	63		
Total Energy Cost	$ 45,023	$ 0.79	$/ft^2
Energy Use Intensity (ekWh/ft2)	11.3		
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	10		9		9	
	Re-claim Savings	Total Savings	% Savings	Total Savings	% Savings	Total Savings	% Savings
Electrical savings (kWh/yr)	-	102,019	33.0%	170,450	55.1%	170,450	55.1%
Fuel savings (GJ/yr)	-	983	82.0%	171	14.3%	171	14.3%
Cost savings ($)	$ -	$ 21,971	48.8%	$ 18,867	41.9%	$ 18,867	41.9%
GHG reduction (tCO2e/yr)	-	50.1	79.4%	10.4	16.4%	10.4	16.4%
# 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 Springwood Elementary School was built in 1996 and has a floor area of 56,694 sqft. The building contains classrooms, admin offices, gym, library, music room, and technical teaching spaces.

Table 1: Occupancy Schedule

Area	Days	From	To
Classrooms	All schooldays	8:55am	2:45pm
Office hours	All schooldays	8:00am	3:30pm

Table 2: Operating Schedules

<table>
<tr><th>Area</th><th>Days</th><th>From</th><th>To</th></tr>
<tr><td rowspan="2">Main equipment schedule</td><td>Mon/Tue/Thu/Fri</td><td>6:30am</td><td>3:30pm</td></tr>
<tr><td>Thursday</td><td>6:30am</td><td>9:30pm</td></tr>
<tr><td>DHW</td><td>Monday-Friday</td><td>6am</td><td>9pm</td></tr>
<tr><td>AC-1</td><td>Monday-Friday</td><td>6am</td><td>3:30pm
(9pm Thu)</td></tr>
<tr><td rowspan="3">HV-1, HV-5</td><td>Monday-Wednesday</td><td>4am</td><td>4:30pm</td></tr>
<tr><td>Thursday-Friday</td><td>7am</td><td>4:30pm</td></tr>
<tr><td>Monday and Friday</td><td>6pm</td><td>7pm</td></tr>
<tr><td rowspan="3">HV-2, HV-3, HV-4, AC-2</td><td>Monday-Wednesday</td><td>4am</td><td>4pm (9pm Tue)</td></tr>
<tr><td>Thursday-Friday</td><td>7am</td><td>4pm</td></tr>
<tr><td>Mon/Fri (HV-3 only)</td><td>6pm</td><td>7pm</td></tr>
</table>

Outside occupied hours, air handlers run when required to maintain room temperatures. During occupied hours, boilers are enabled when outdoor air temperature is below 15°C. Outside occupied hours, the boilers operate when outdoor air is below 12°C.

4.2 Heating System

Heat is provided by five 399 MBH (input) IBC condensing gas boilers. Boilers B-2 to B-5 heat a secondary loop through a low loss header. Boiler B-1 can either heat domestic hot water through a heat exchanger or supplement building heating, per the current requirements of the building.

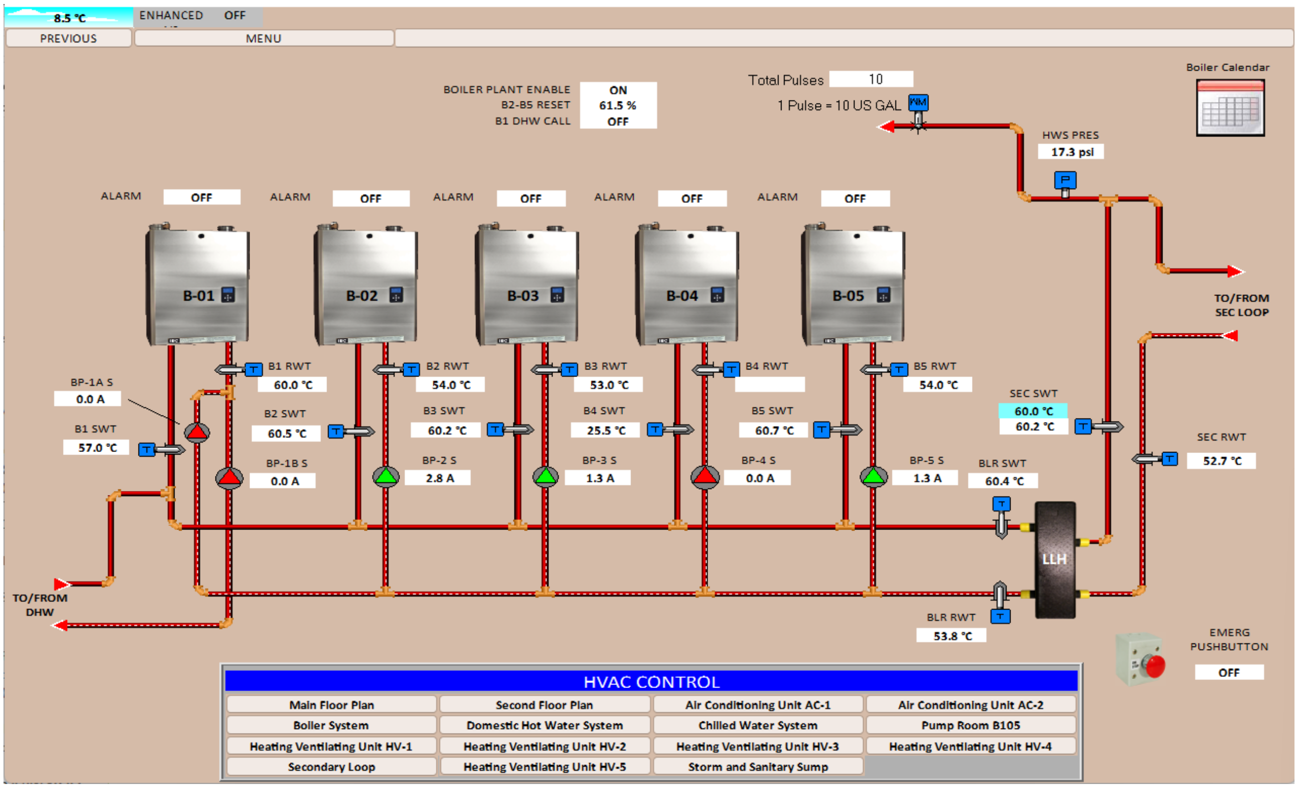


Figure 1: Boiler plant in the DDC

Figure 2: B-1 supplies both DHW and space heating via two boiler pumps

The heating water supply temperature setpoint was manually set to 60°C when observed during Prism's study.

Heating water is distributed to several air handlers, room terminal reheat coils, fan coil units, and radiators.

Table 3: Heating Water Pumps

Tag	Serves	Size	VSD	Flow	Head
BP1A	Boiler Pump from B-1 to DHW heat exchanger	Unknown	No	Unknown	Unknown
BP1B to BP5	Boiler Pumps for space heating	Unknown	No	Unknown	Unknown
P-1	Secondary loop to building	3 HP	Yes	12.62 l/s	108 kPa
P-HCHV2	HV-2 heating coil	335 W	No	0.63 l/s	79.2 kPa
P-HCHV3	HV-3 heating coil	335 W	No	0.60 l/s	79.3 kPa
P-HX1	DHW heat exchanger to storage tank	Unknown	Unknown	Unknown	Unknown
P-DHWR	DHW building circulation	265 W	No	Unknown	Unknown

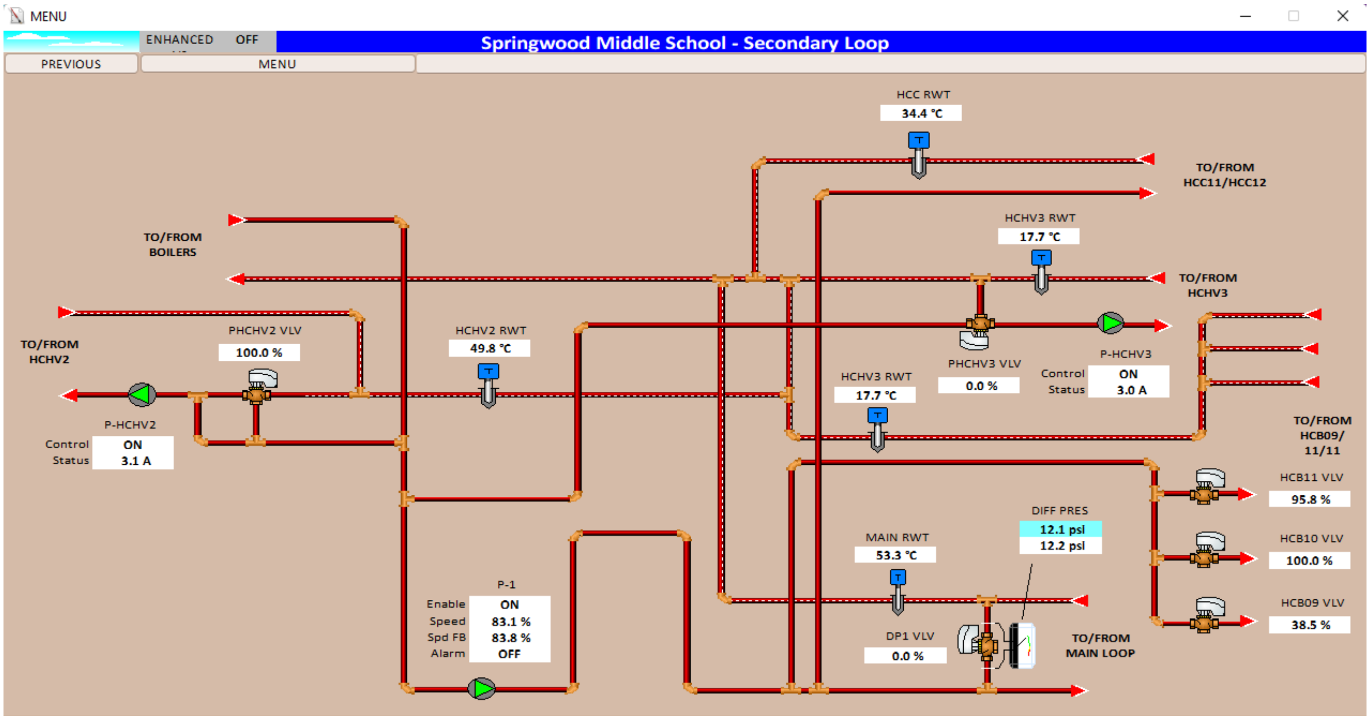


Figure 3: Secondary loops

4.3 Cooling System

Cooling is provided by a chiller which serves cooling coils in air handlers AC-1 and AC-2.

The chiller was manually disabled during the investigation phase. The DDC is programmed to enable the chiller when the outdoor temperature exceeds 15°C and AC-1 or AC-2 request cooling.

4.4 Ventilation System

Ventilation is provided by the air handlers show in in Table 4.

Table 4: Air handlers

Tag	Service	Airflow	Supply Fan	Return Fan	Coils	Outdoor Air
AC-1	Administration	3698 l/s	10 HP Constant speed	5 HP	Cooling	Mixed Min 30% OA
AC-2	Tech C110	944 l/s	3HP Constant speed	-	Heating, Cooling	Mixed Min 30% OA
HV-1	Multi-purpose. Music.	6110 l/s	10 HP Constant speed	5 HP	None	Mixed Min 20% OA
HV-2	Gymnasium	7792 l/s	10 HP Variable speed	5 HP Variable speed	Heating	Mixed Min 30% OA

Tag	Service	Airflow	Supply Fan	Return Fan	Coils	Outdoor Air
HV-3	Block A Classrooms	9812 l/s	20 HP Constant speed	7.5 HP	Heating	Mixed Min 30% OA
HV-4	Construction	944 l/s	3 HP	-	Heating	Mixed Min 30% OA
HV-5	Boiler Room	590 l/s	¾ HP	-	None	Mixed

4.5 Domestic Hot Water System

Domestic hot water is heated by B-1 through heat exchanger HX-1 and stored in a 473 l tank. A pump recirculates domestic hot water through the building. The tank temperature setpoint is 60°C.

Two large decommissioned hot water tanks have been left in the boiler room.

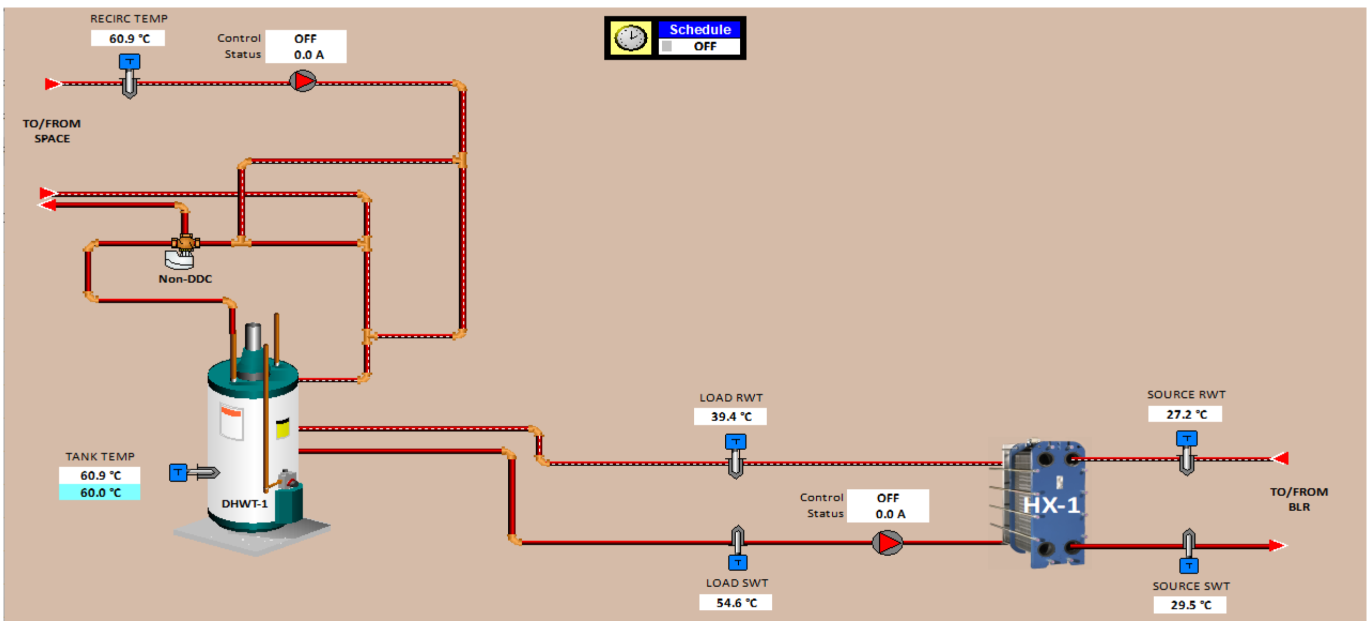


Figure 4: Domestic hot water system

4.6 Controls System

The HVAC system is controlled by a Delta Controls DDC, using ORCAView 3.40 software. Remote access to the system is available. Trends are not available from the DDC graphics screens.

An IBC boiler controller provides stages the boilers to meet the secondary loop heating water supply temperature setpoint and domestic hot water setpoint.

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: AHUs running overnight*

5.1.1 Description of Finding

Several air handlers run for long periods overnight, while attempting to maintain night setback temperatures.

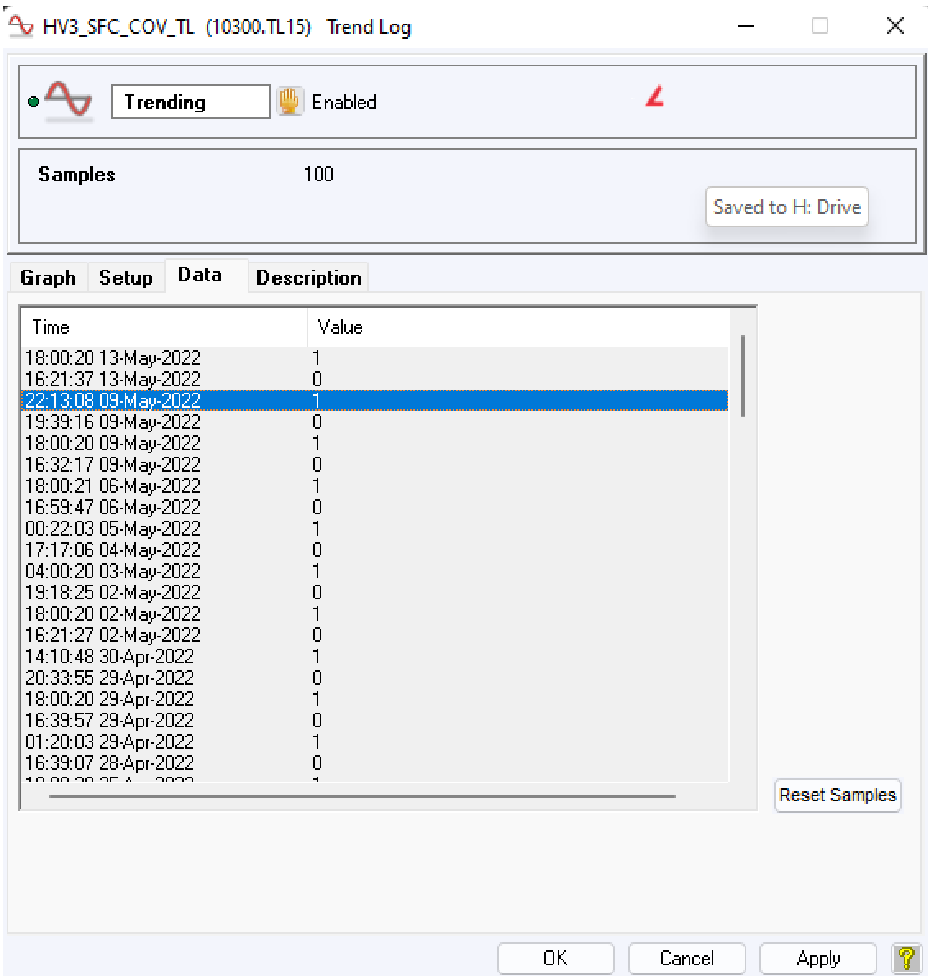


Figure 5: HV-3 supply fan operates almost continuously, running from 9 May to 13 May, then starting soon after.

```
HV3_MADCO = Min (HV3_MADCO, HV3_MAT_LL_CO)

//[***CONTROL SEQUENCE***]
If HV3_FZ Off Then
   If (HV3_MODE > 1) Or (Enhanced_Air_SCH_BV = On) Then
      HV3_SFC = On
   Else
      HV3_SFC = Switch ( HV3_SFC, HV3_LO_VAR, - 1, 0)
   End If                                 10300.AV5 = -1.94383 °C
   If HV3_SFS > 2 Then
//[***NORMAL OPERATION***]
      HV3_RFC = On
```

Figure 6: HV-3 switches on when any room it serves drops below the night setback temperature.

The boilers are disabled when the school is unoccupied, so the AHUs are unable to increase room temperatures, even with heating coil valves fully open.

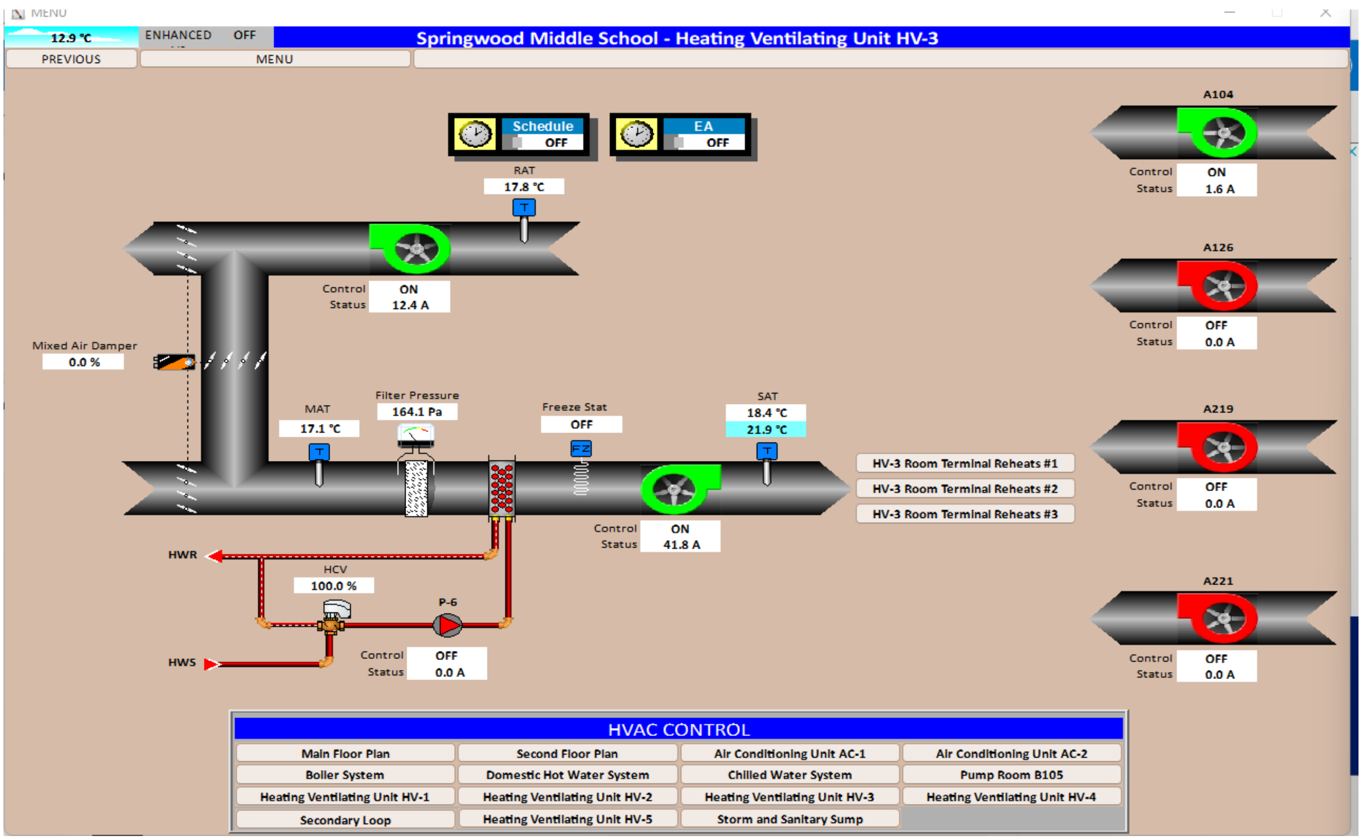


Figure 7: HV-3 night setback operation: heating coil 100% open but no heat available from boilers, so the supply air only increases slightly (due to heat from the fan).

The night setback setpoint has been manually overridden to 19C, which makes it more likely that the air handlers need to run.

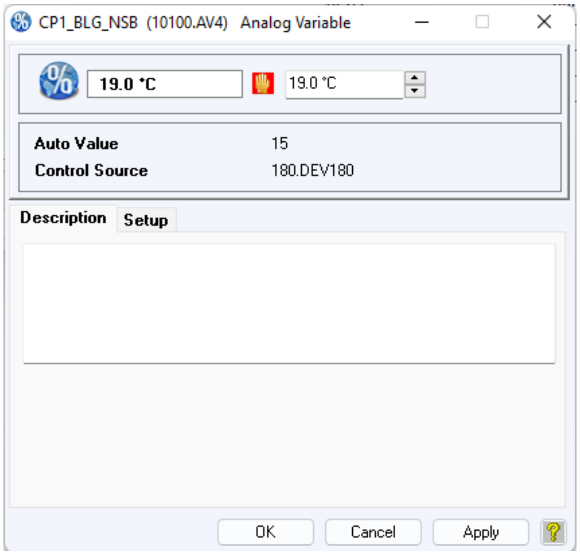


Figure 8: The main building night setback temp is 19°C. It is overridden from a default "Auto Value" of 15°C

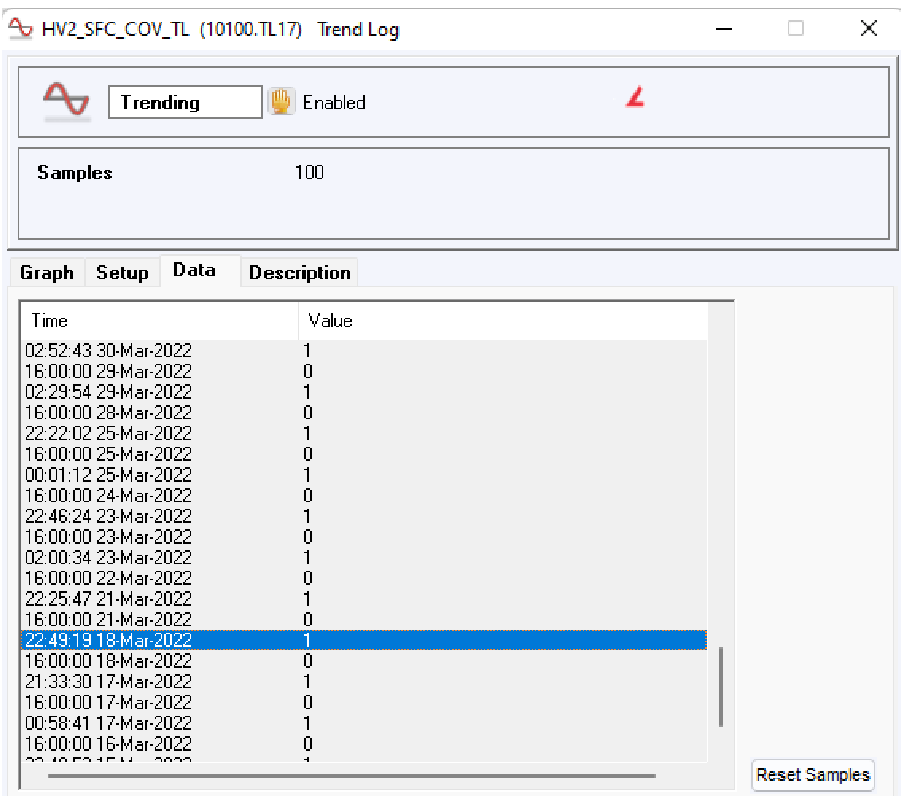


Figure 9: HV-2 supply fan stays on over weekends (18-21 and 25-28 March)

```
//[***CONTROL SEQUENCE***]

If HV2_FZ Off Then
    If (HV2_MODE > 1) Or (Enhanced_Air_SCH_BV = On) Then
        HV2_SFC = On
        HV2_SF_VSD = HV2_SPEED
    Else
        HV2_SFC = Switch ( HV2_SFC, HV2_LO_VAR, - 1, 0)
        HV2_SF_VSD = 40 * HV2_SFC
    End If
```

10100.AV12 = -1.88178 °C

Figure 10: Similar logic for HV-2

```
If HV1_FZ Off Then
    If (HV1_MODE > 1) Or (Enhanced_Air_SCH_BV = On) Then
        HV1_SFC = On
    Else
        // HV1_SFC = Switch ( HV1_SFC, HV1_LO_VAR, - 1, 0) //
        HV1_SFC = Switch ( HV1_SFC, 10101.B102_RT, 16, 17) //GERRY TEST JAN 2019//
    End If
```

Figure 11: Similar logic for HV-1, but using a lower night setback setpoint (16°C)

The boiler plant is disabled whenever the building is unoccupied, regardless of outdoor air temperature.

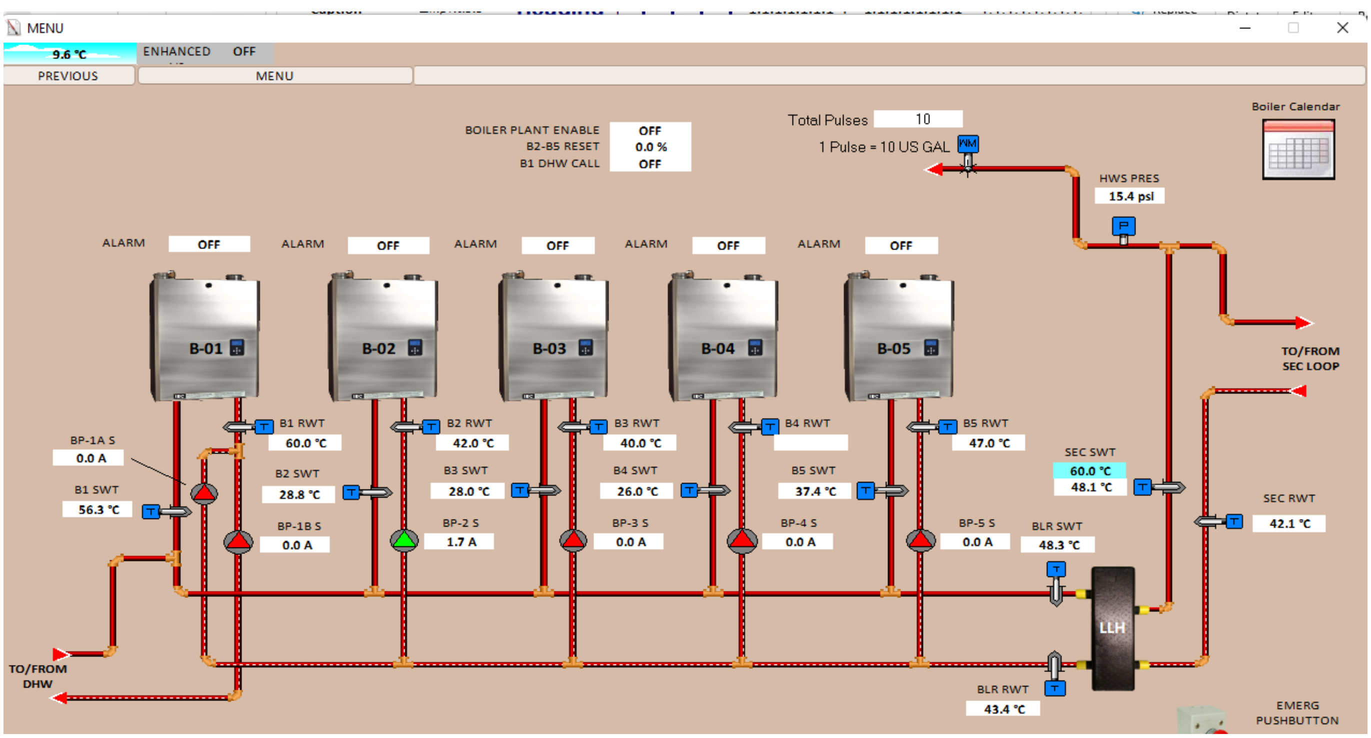


Figure 12: Boilers are disabled during unoccupied hours even when outdoor air is below the 12°C lockout

The boiler program sets the BLR_UNOCC_OAT_ENABLE_BV variable to "ON" when outdoor temperature is below 12°C, but this value is not used in the program.

```
    BLR_UNOCC_OAT_ENABLE_BV = Off
Else // - UNOCCUPIED
    BLR_UNOCC_OAT_ENABLE_BV = Switch ( BLR_UNOCC_OAT_ENABLE_BV, OAT_AV, 12, 14)
    BLR_OAT_EN 10000.BV4 = ON  Off
End If

```

Figure 13: Boilers are supposed to enable at 12°C when unoccupied.

```

//ENABLE/DISABLE BOILERS BASED ON DDC CALENDAR
BLR_CAL_DISABLE_BV = BOILER_SHUTDOWN
//GENERAL ENABLE BASED ON DDC CALENDAR AND OAT
BLR_ENABLE = BLR_OAT_ENABLE_BV * (BLR_CAL_DISABLE_BV = Off)
          10000.BV1 = OFF
```

Figure 14: The BLR_UNOCC_OAT_ENABLE_BV variable is not referenced in the logic that enables the boilers.

5.1.2 Measure Description

Reduce the unoccupied setpoint to 15°C. Enable boilers below 12°C outdoor temperatures (this can be reduced after observing how the HVAC system operates during cold periods).

5.1.3 Measure Implementation Update

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

5.2 Measure 2: AHU schedules

5.2.1 Description of Finding

Air handlers AC-2, HV-1, HV-2, HV-3, and HV-4 follow the BLDG_SCHED1 schedule and are scheduled to start three hours earlier on Mondays through Wednesdays than Thursdays and Fridays.

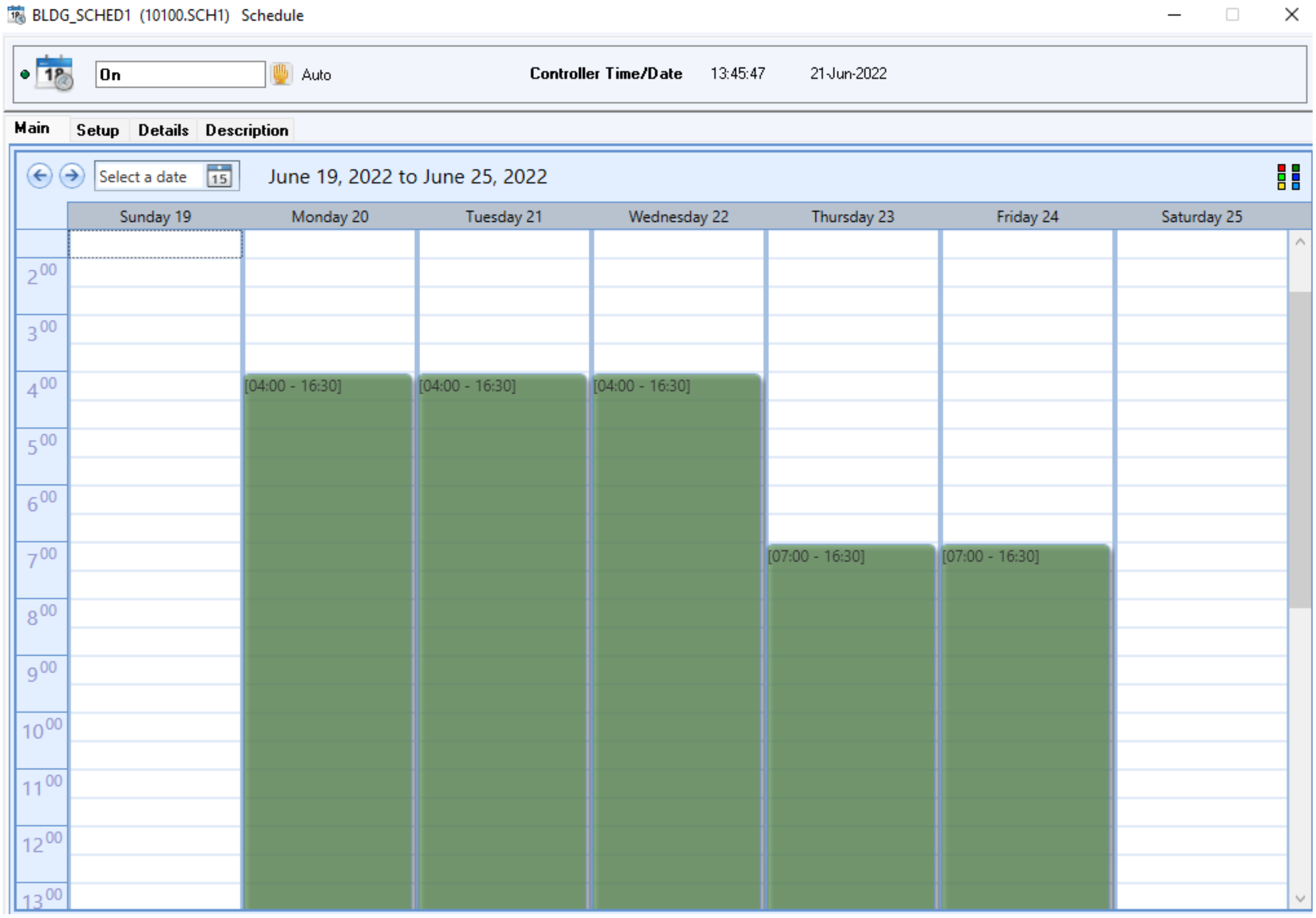


Figure 15: BLDG_SCHED1 schedule

5.2.2 Measure Description

Set morning startup time to 7am for air handlers AC-2, HV-1, HV-2, HV-3, and HV-4 on all school days.

A longer warmup period may be required on Monday mornings, since the building has had time to cool over the whole weekend. Monitor room temperatures on Monday morning, and adjust the start time as required.

5.2.3 Measure Implementation Update

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

5.3 *Measure 3: Summer schedules*

5.3.1 Measure Description

There are no summer break schedules set up for summer 2022 in the DDC. The last summer break events were set up were in 2020.

While equipment may be shut off manually during the break, it is more reliable to schedule this in the DDC.

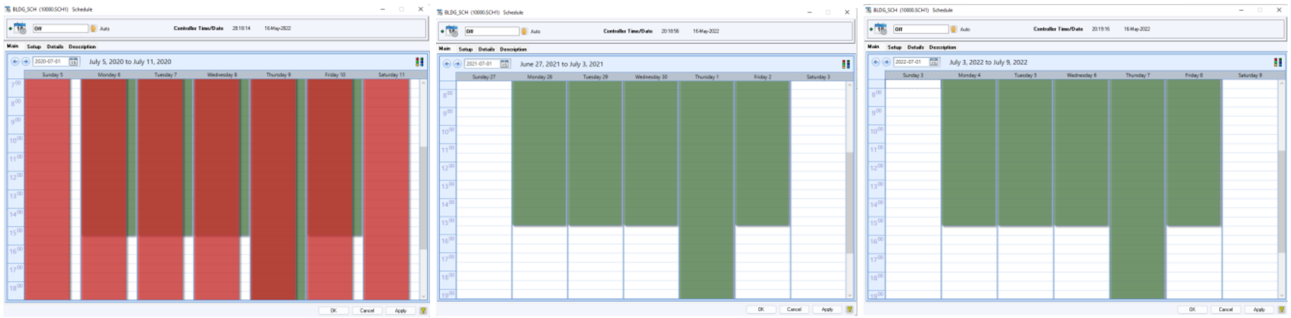


Figure 16: HVAC schedule BLDG_SCH for July 2020, 2021, and 2022

5.3.2 Measure Description

Define a summer break weekly schedule (for example a short morning flush). Add calendar exceptions for the summer break period (July and August). Savings calculations assume normal school week operation is replaced with a 2 hour flush on each weekday.

5.3.3 Measure Implementation Update

5.4 Measure 4: Boiler temperature overridden to 60°C

5.4.1 Description of Finding

The heating water supply temperature setpoint is overridden to 60°C. The DDC programming often calculates the optimal heating water supply temperature setpoint at 40°C. Lowering the heating water temperature reduces gas use through increased boiler condensing efficiency and lower distribution losses.

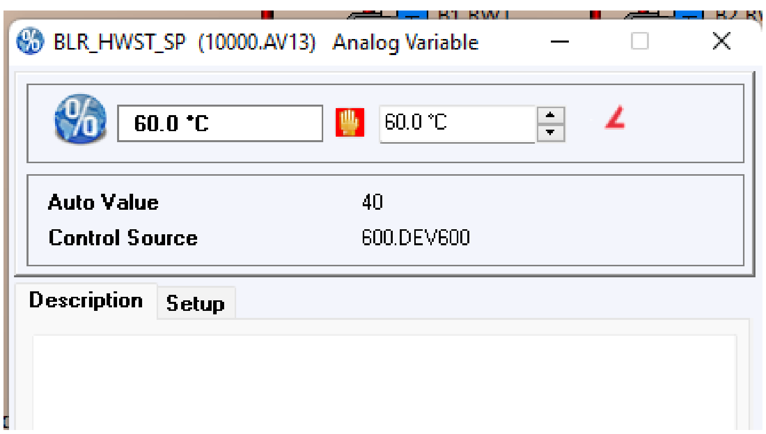


Figure 17: Heating water setpoint manually set to 60°C but the logic calculates setpoint to 40°C. The outdoor temperature was 14.4°C at this time.

5.4.2 Measure Description

The supply water temperature during the recent 2021/22 heating season should be confirmed. If the system heated the building successfully with 60°C supply water, this is recommended as the new maximum supply temperature (rather than the current 77C°).

The temperature setpoint should be allowed to drop lower when outdoor temperature and heating load permits it. This may require tuning the programming that optimizes the setpoint.

5.4.3 Measure Implementation Update

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

5.5 Measure 5: AC-2 valve and damper control

5.5.1 Description of Finding

Figure 18 shows AC-2 modulating its cooling coil valve prior to fully opening its outdoor air damper. At the outdoor air temperature of 15.9°C (as in Figure 18), air handlers should first maximize free cooling before using the chiller.

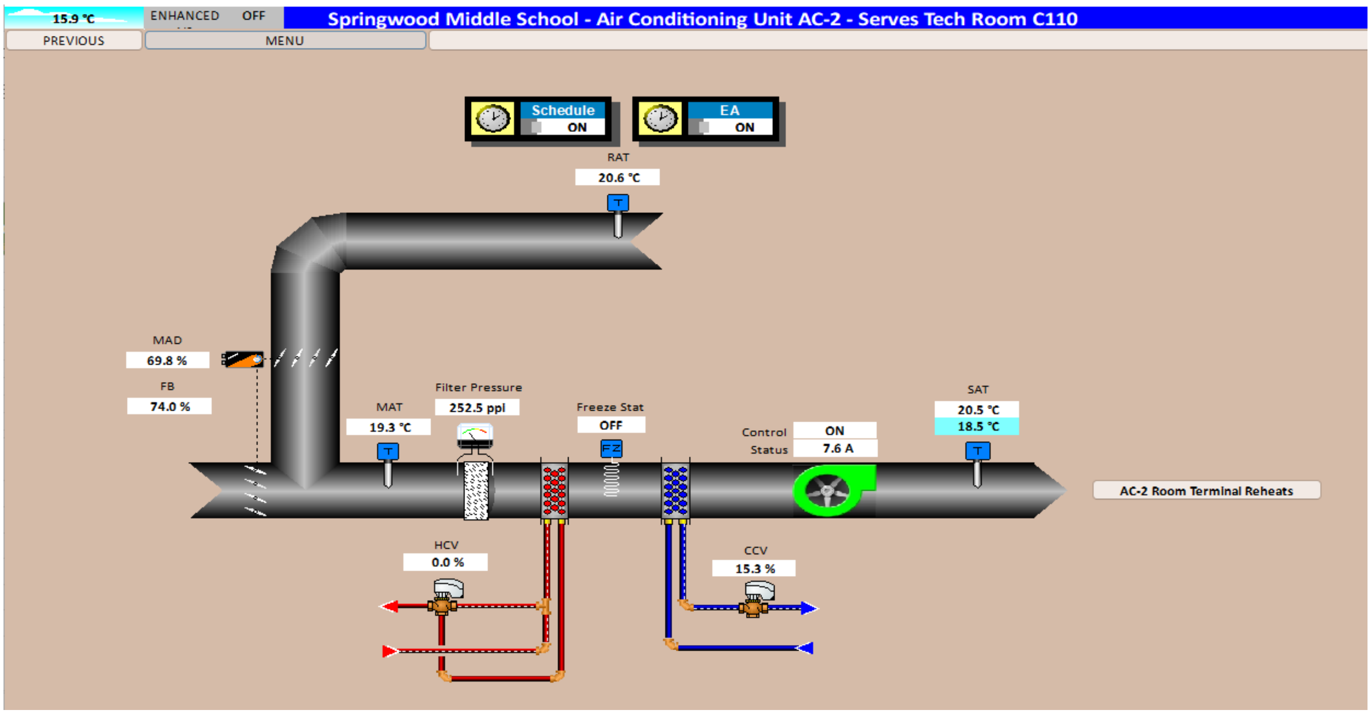


Figure 18: AC-2 using active cooling before the outdoor dampers are fully open

The damper, heating valve, and cooling valve are controlled by separate control loops, which leads to unintended overlap in their operation.

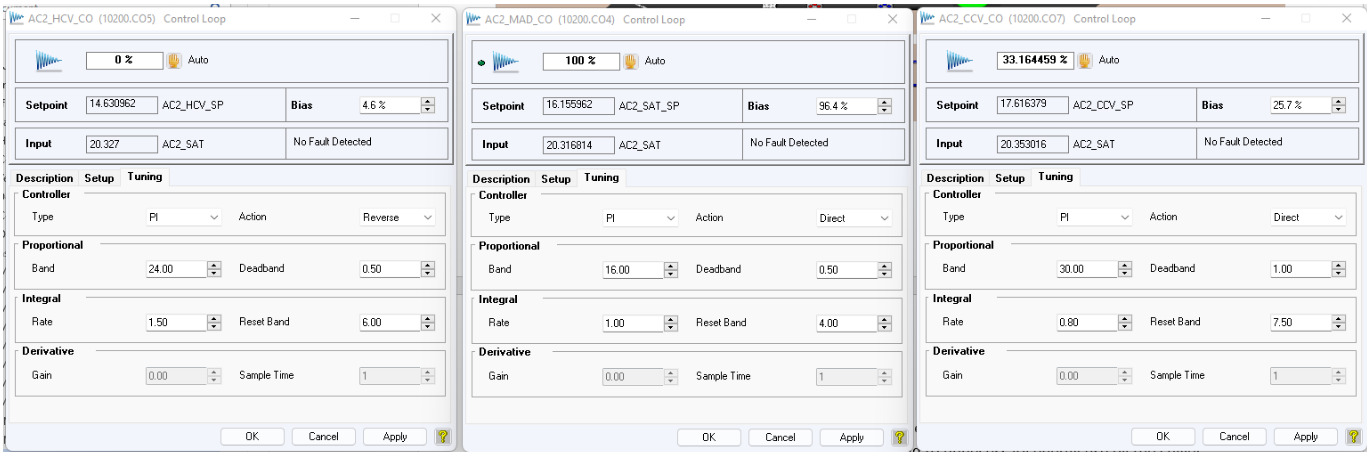


Figure 19: Dampers and valves controlled by three different control loops

5.5.2 Measure Description

We recommend that the heating coil, mixing dampers and cooling coil be controlled by a single supply air temperature control loop. The control loop output range would be split into three mutually exclusive full range outputs; one for each operator. This arrangement ensures that all operators are modulated to attain a single temperature setpoint and operator overlap cannot exist.

5.5.3 Measure Implementation Update

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

5.6 Measure 6: Ineffective Reheat Coils

5.6.1 Description of Finding

The reheat coils listed Table 5 provide negligible heating despite their 100% open reheat coil control valves. The room temperature setpoints for those reheats are typically not being met per Figure 20, Figure 21, and Figure 22, which confirms there is a lack of heating rather than a failed sensor. Failed reheat coils will leave some zones too cold. This may cause the DDC or operators to raise the heating water temperature to compensate, reducing heating efficiency and making it impossible to electrify the building with an air source heat pump.

Table 5: Ineffective reheat coils

Air handler	Ineffective Reheat Coils
AC-1	A131, A137
AC-2	A203
HV-1	B101, B102, B103, B104, B107, B114, CM06, CM03W
HV-3	A103, A105, A113, A117, CM02W, A208, A217

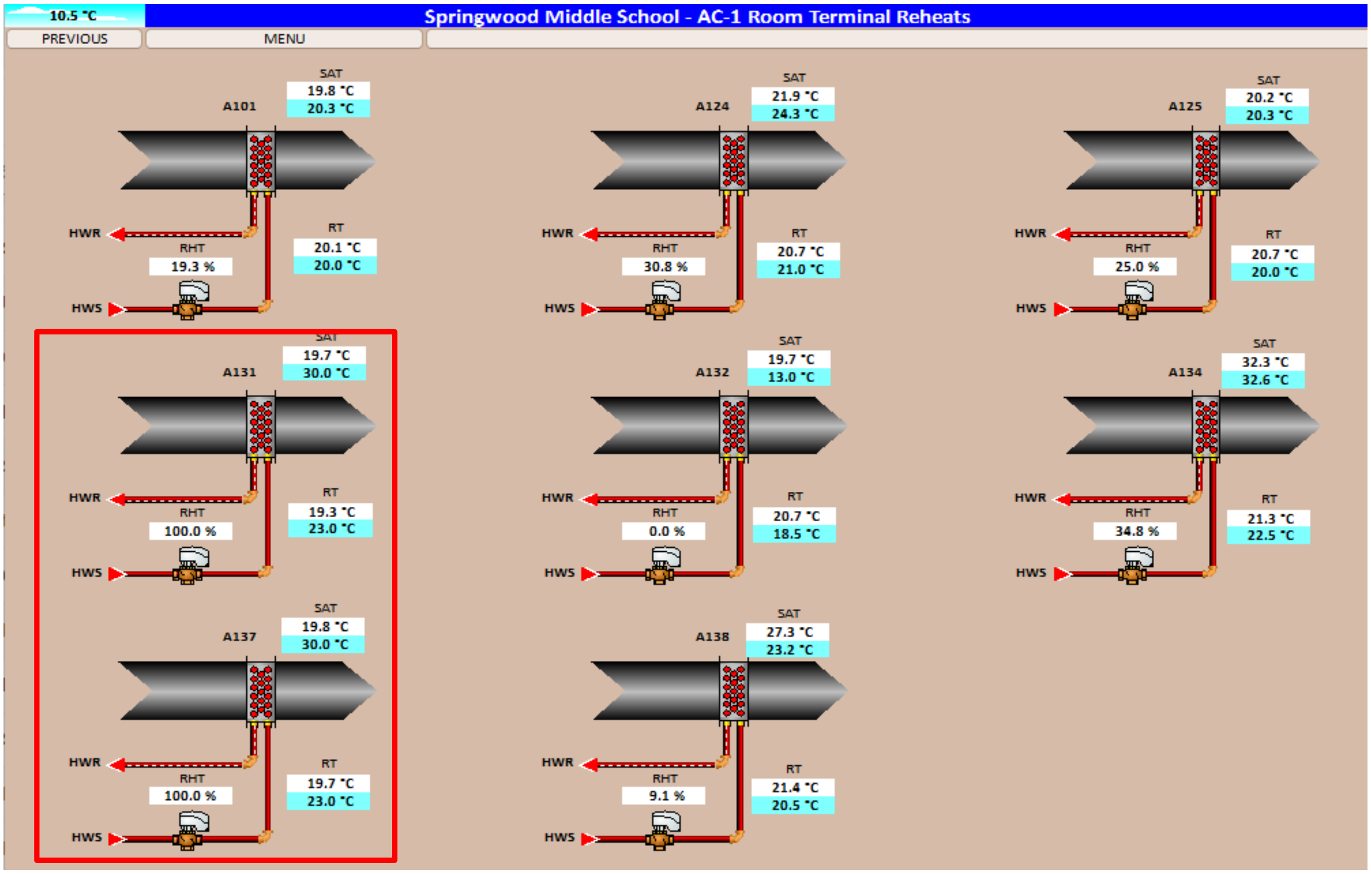


Figure 20: AC-1 failed reheat coils (in red box; low supply air temperature despite 100% open control valve)

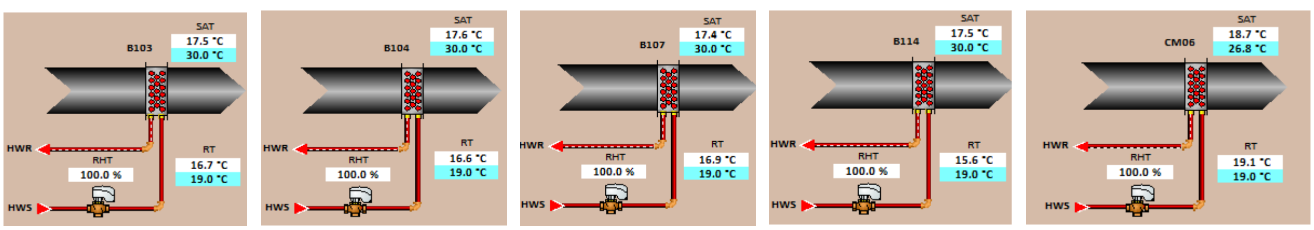


Figure 21: HV-1 failed reheat coils (low supply air temperature despite 100% open control valve)

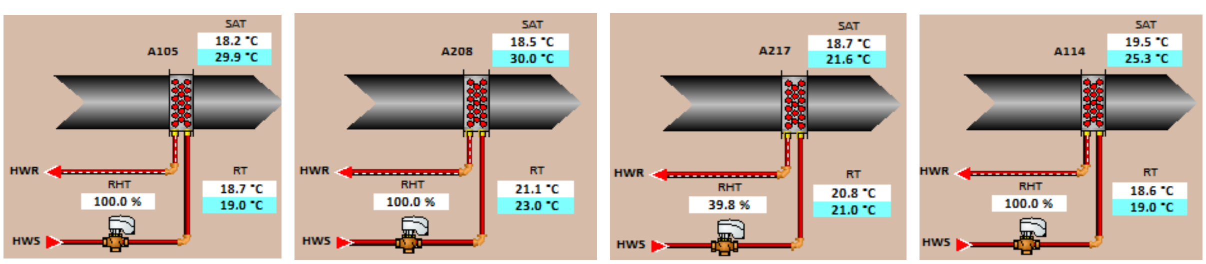


Figure 22: HV-3 failed reheat coils (low supply air temperature despite 100% open control valve)

5.6.2 Measure Description

We recommend inspecting each problematic reheat coil and its control valve. Possible causes include closed isolation valves, improper balancing valve positions, air locks, sticking control valve, and dirty coil. Measure costs assume half of the identified control valves needs to be replaced.

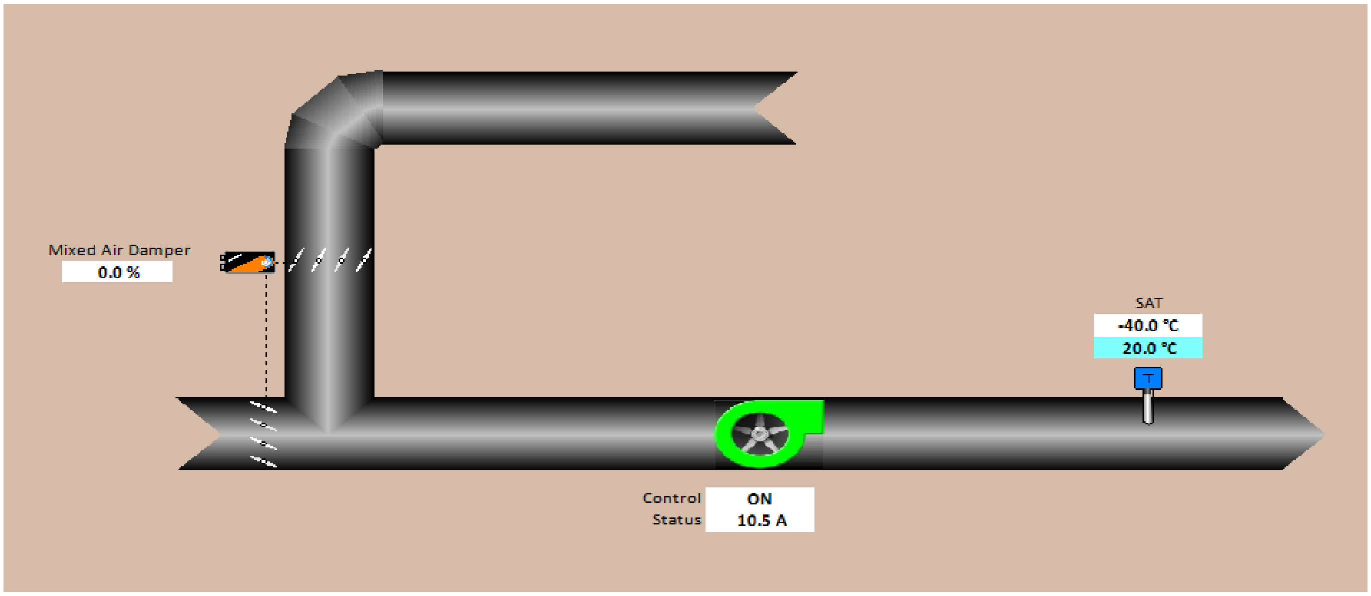
5.6.3 Measure Implementation Update

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

5.7 Measure 7: HV-5 Broken SAT sensor

5.7.1 Description of Finding

The HV-5 supply air temperature sensor (Figure) and the boiler room temperature sensor both report -40°C. They are likely either missing or disconnected. This is causing the HV-5 mixed air damper to remain fully closed at all times and for HV-5 to provide no outdoor air to its zones.



5.7.2 Measure Description

Reconnect or replace both sensors.

5.7.3 Measure Implementation Update

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

5.8 Measure 8: HV-2 RF not running when SF is at 40%

5.8.1 Description of Finding

HV-2 is programmed to only operate its return fan if the supply fan speed feedback exceeds 40% per Figure 23. When the supply fan speed is set to 40% (typical during unoccupied periods), the speed feedback is below 40% so the return fan is off. Note that the DDC graphic in Figure 24 is incorrect: the return fan shows the state of the supply fan, and vice versa.

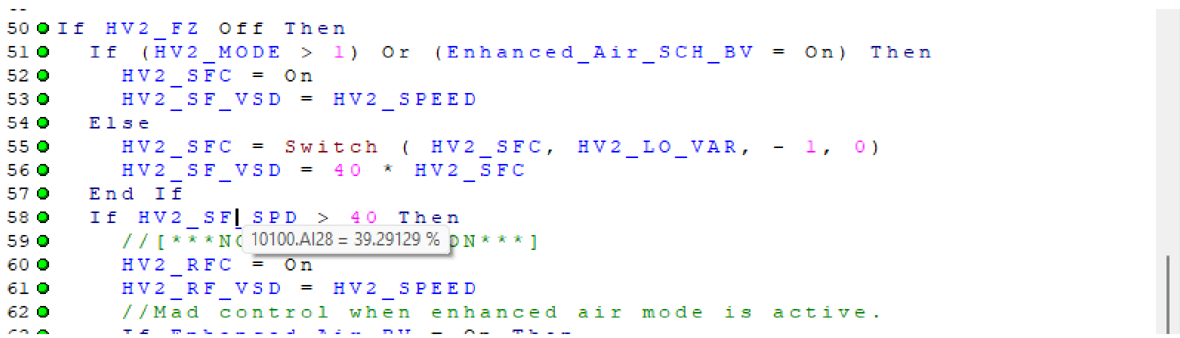


Figure 23: HV-2 fan logic

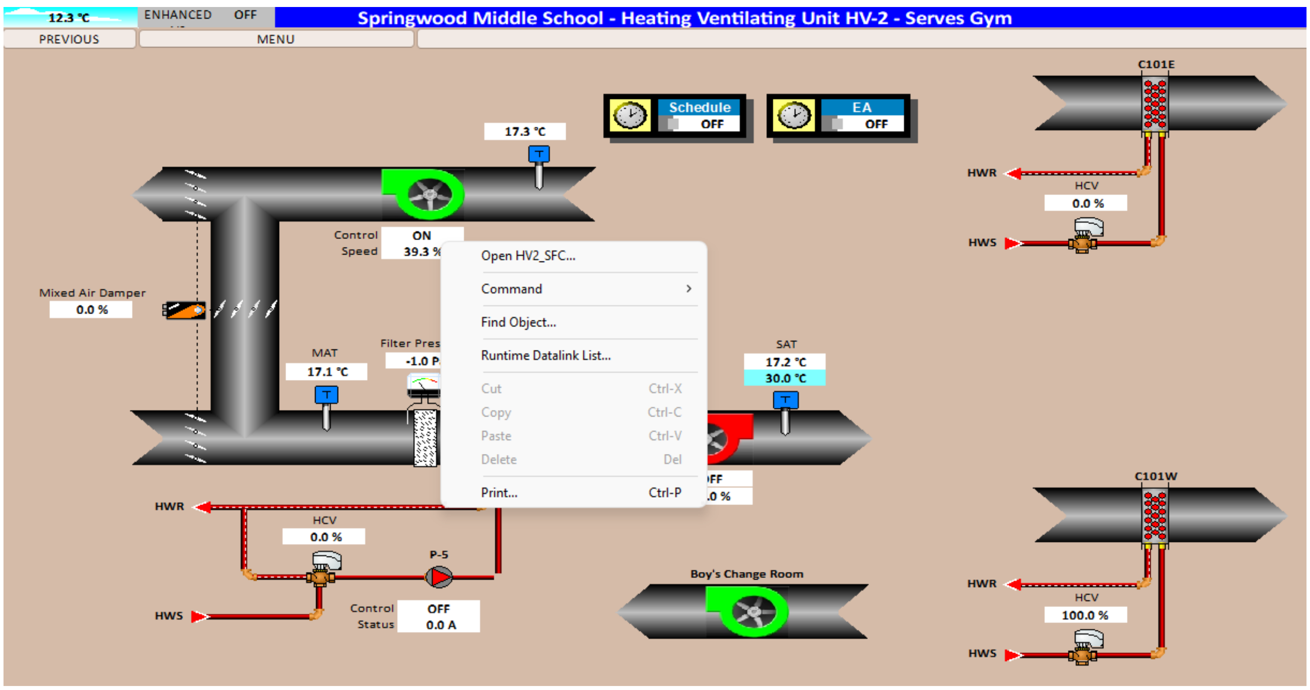


Figure 24: Supply fan and return fan values are swapped in the HV-2 DDC graphics

5.8.2 Measure Description

Revise HV-2 programming to account for possible error in the supply fan speed feedback.

5.8.3 Measure Implementation Update

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

5.9 Measure 9: AC-1 mixed air temperature is higher than expected

5.9.1 Description of Finding

Figure 25 shows AC-1 mixed air temperature only 1.2°C below the return air temperature despite the mixed air damper reporting 36.9% open and an outdoor air temperature of 9.7°C. This situation was common during the investigation phase. It suggests AC-1 is not obtaining the outdoor air it requires per design and will increase chiller electricity use in warmer weather.

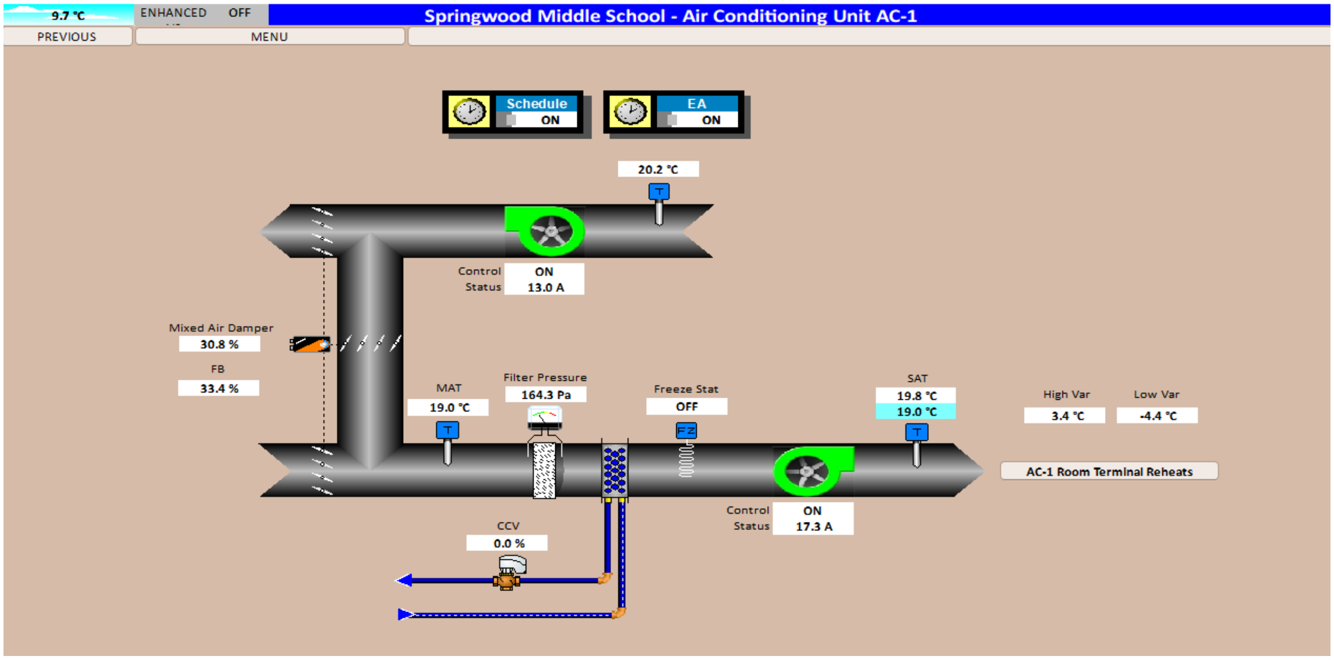


Figure 25: AC-1

5.9.2 Measure Description

Inspect the AC-1 dampers and damper actuators, and check if there are air flow obstructions along AC-1's outdoor air intake or exhaust ducts. Test sending various commands to the mixed air damper and visually confirm the damper blades move to the desired positions.

Measure costs assume mechanical cooling is currently required at 16°C outdoor temperature, and additional free cooling from properly operating damper can delay the need for active until outdoor temperatures reach 18°C.

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 chiller with reversible heat pump*

The boiler loop supply temperature is currently set manually to 60°C. The boiler program indicates that the setpoint would typically reset down to 40°C. Commercially available air and ground source heat pumps can efficiently heat water to 50°C. If SD69 is able to repair reheat coils and tune the reset to operate at such a heating water supply temperature setpoint, Springwood Elementary would be a candidate for low carbon electrification by supplementing the existing boilers plant with air or ground source heat pumps.

If the chiller is original to the building (1993), it would be nearing its end-of-service-life. If so, we propose replacing it with a two-pipe reversible air source heat pump. The heat pump would provide chilled water whenever AC-1 or AC-2 require cooling like the existing chiller but provide 1st-stage heating at other times. The boilers plant would remain to supplement building heating.

A feasibility study is recommended as the next step to assessing the viability of this project. The boiler plant's heating water supply temperature should be trended through winter to confirm the fraction of the year a heat pump could supplement the heating system. Mechanical and structural assessments are required to refine the cost and viability of the project. Measure costs assume the air source heat pump matches the existing chiller's electrical requirements (avoiding an electrical upgrade), but options for installing a larger unit should be assessed in the study.

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.

We're working together to help B.C. save energy.

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	AHUs running overnight	New	1	-	136,444	-	$ 13,442	$ 700	0.1	1.5	
ECM-2	AHU Schedules	New	1	-	20,214	129	$ 3,552	$ 1,100	0.3	6.6	
ECM-3	Summer schedules	New	1	-	13,487	-	$ 1,329	$ 900	0.7	0.1	
ECM-4	Boiler temperature override	New	1	-	-	42	$ 514	$ 400	0.8	2.1	
ECM-5	AC-2 valve and damper control	New	1	-	102	-	$ 10	$ 900	89.6	0.0	
ECM-6	Ineffective Reheat Coils	New	1	-	-	-	$ -	$ 10,600	#DIV/0!	-	
ECM-7	Broken HV-5 SAT sensor	New	1	-	-	-	$ -	$ 300	#DIV/0!	-	
ECM-8	HV-2 return fan not running when SF is at 4(	New	1	-	-	-	$ -	$ 400	#DIV/0!	-	
ECM-9	AC-1 mixed air temperature	New	1	-	203	-	$ 20	$ 900	44.9	0.0	
ECM-10	Replace chiller with reversible heat pump	New	1	-	- 68,431	812	$ 3,104	$ 264,900	85.3	39.8	x
			TOTAL (Previous, still working):	-	-	-	$ -	n/a	n/a	-	
			TOTAL (All potential measures for Implementation):	-	102,019	983	$ 21,971	$ 281,100	12.8	50.1	
			TOTAL (Selected measures only):	**-**	**170,450**	**171**	**$ 18,867**	**$ 16,200**	**0.9**	**10.4**	
							Implementation cap @$0.25/ft2	**$ 14,174**			

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)