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Continuous Optimization for Commercial Buildings Program

Recommissioning Report

Version	Updated on	Phase
1	May 10, 2022	Investigation. Draft for client feedback.

Prepared for:

School District 69

Oceanside Elementary School

980 Wright Rd

Qualicum Beach, BC

Project: BCH-07834

Prism Project: 2021300

Prepared by:

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Burnaby, BC

saving you energy™

TABLE OF CONTENTS

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 Oceanside 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.

Twelve recommended retrofits were identified as a part of this investigation. The proposed measures will be reviewed in a meeting with School District #69 and Prism Engineering representatives to determine which measures will be implemented.

Recommended retrofits for implementation include:

- Measure 1: AC-1 operates continuously
- Measure 2: HV-2 operates continuously
- Measure 3: HV-3 operates continuously
- Measure 4: Air handler schedules
- Measure 5: HV-3 excess ventilation
- Measure 6: Boiler supply setpoint higher when unoccupied
- Measure 7: Night setbacks for reheats and fan coils
- Measure 8: HV-3 occupancy schedule out-of-date
- Measure 9: HV-2 coil issue
- Measure 10: Fan sensor issues
- Measure 11: DHW circulation pump manually on

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 7.

Retrofits include:

- Measure 12: Add reversible heat pump to boiler loop

2.0 Project Overview

Project Information

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RCx Project File #	**BCH-07834**
Date of Workbook Update	10-May-2022
Organization	School Distict 69
Building Name	Oceanside Elementary
Building Type	Large School
Location (City)	Qualicum Beach, BC
Owner Contact	Ron Amos
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)	61,695		
Annual elec consumption (kWh)	233,861	3.8	kWh/ft^2
Annual elec costs ($)	$ 23,071	$ 0.10	Avg. $/kWh
Fuel type	Natural Gas		
Annual fuel consumption (GJ)	1,588	7.2	ekWh/ft^2
Annual fuel cost ($)	$ 19,255	$ 12.1	Avg. $/GJ
Total GHG emissions (tCO2e/yr)	82		
Total Energy Cost	$ 42,326	$ 0.69	$/ft^2
Energy Use Intensity (ekWh/ft2)	10.9		
Year for energy data above	2020		

3.0 Savings Summary

Savings Summary	Previous, still working	New + Previous, rectify + Previous, documented					
		Identified		Selected		Implemented	
# of measures	0	12		11		11	
	Re-claim Savings	Total Savings	% Savings	Total Savings	% Savings	Total Savings	% Savings
Electrical savings (kWh/yr)	-	85,865	36.7%	150,182	64.2%	150,182	64.2%
Fuel savings (GJ/yr)	-	1,558	98.1%	803	50.5%	803	50.5%
Cost savings ($)	$ -	$ 27,359	64.6%	$ 24,548	58.0%	$ 24,548	58.0%
GHG reduction (tCO2e/yr)	-	78.6	96.2%	41.6	51.0%	41.6	51.0%
# 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 Oceanside Elementary Schools was built 1993 and has a floor area of 61,695 sqft. The building contains classrooms, admin offices, gym, library, music/drama, and technical teaching spaces.

Table 1: Schedules

	Area	Days	From	To
Occupancy	Classrooms	All schooldays	8:45am	2:36pm
	Office hours	All school days	8:00am	3:30pm
Building Equipment	Air Handling Units	Monday-Wednesday	4:00/7:00am*	4:00pm
		Thursday-Friday	7:00am	4:00pm
	Boilers	Monday-Friday	6:30am	6:00pm

* HV-1, HV-2, HV-3 start at 4am, while other units start at 7am.

Outside occupied hours, air handlers run when required to maintain room temperatures. During occupied hours, boilers are enabled when OAT is below 14°C. Outside these hours they operate when OAT is below 10°C.

Other (zone) equipment, such as reheats and fan coils, do not appear to have any schedules.

Schedules are changed during summer, when the school is mostly unoccupied, and air handlers are only scheduled to flush the school each morning hours.

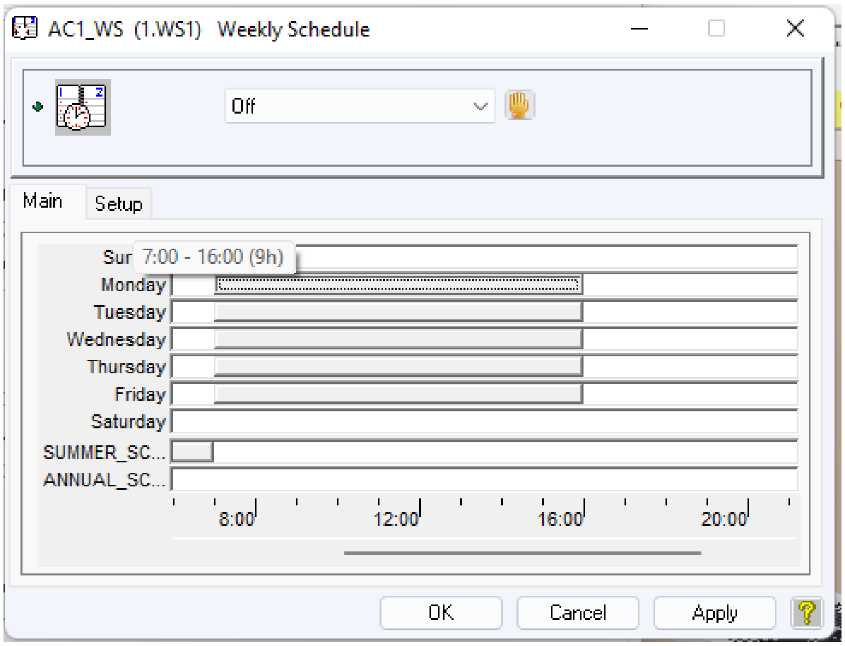


Figure 1: Typical air handler schedule (AC-1)

4.2 *Heating System*

Heating is provided by five 399 MBH (input) IBC condensing gas boilers. Each boiler has its own circulating pump. The primary boiler loop is connected to the secondary loop via a low loss heater. The supply water setpoint for the primary loop has been manually set to 50°C.

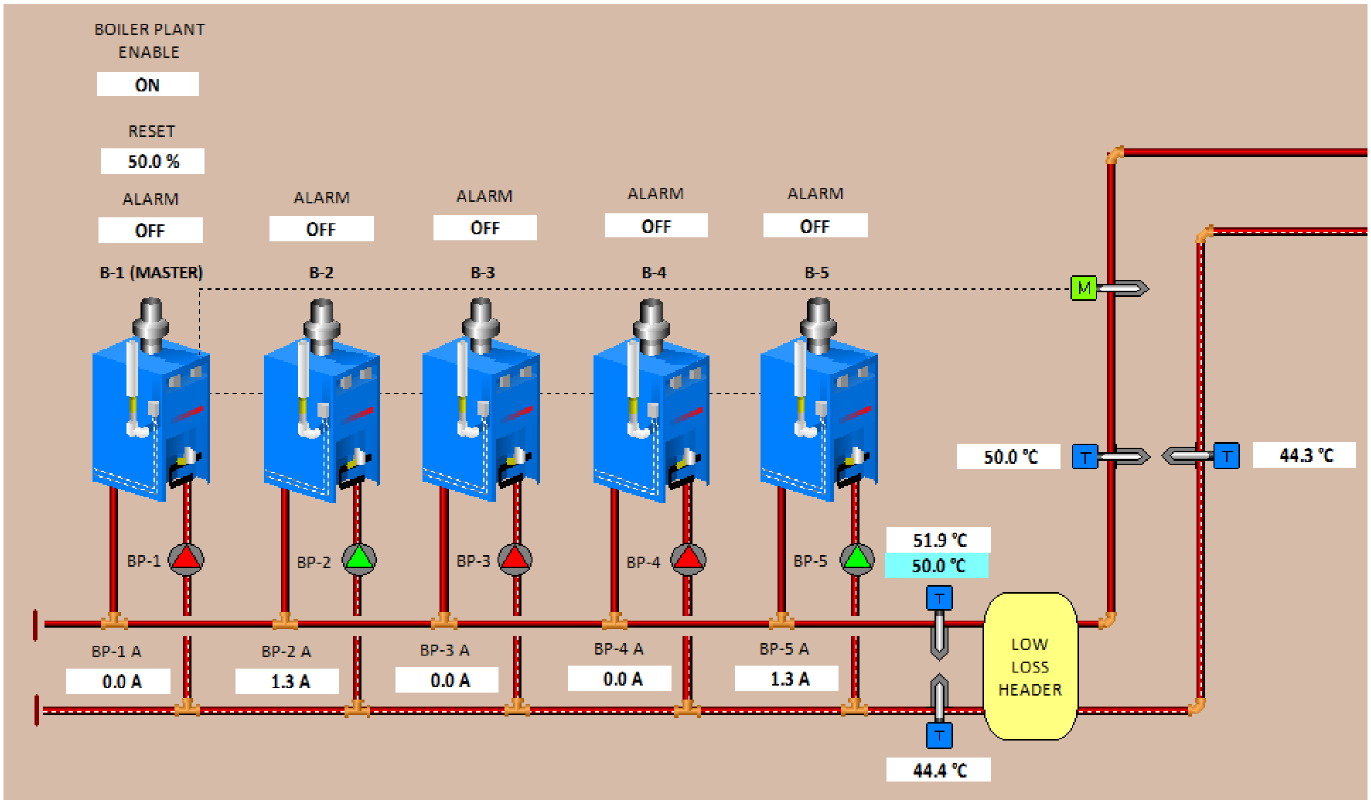


Figure 2: Boilers in the DDC

Heating water is distributed through a secondary loop to heating coils in AHU-2, AHU-3, and AHU-4, as well as duct reheat coils, fan coil units, unit heaters, and convectors.

Table 2: Pumps

Tag	Serves	Size	VSD	Flow	Head (Ft)
BP-1 to BP-5	Boiler pumps	Unknown	No	Unknown	Unknown
P-2	Zone heating coils	3 HP	VSD	10.6 l/s	131.9 Pa
P-3	HV-2	1100 W @ 3.25 A 208 V 3ph	No	0.63 l/s	78.3 Pa
P-4	HV-3	1/3 HP 235 W @ 0.72 A	No	0.95 l/s	68.7 Pa
P-5	DHW circulation	77 W	No	Unknown	Unknown
P-7	Chilled water	3 HP	No	4.48 l/s	186.8 Pa

4.3 Cooling System

An air-source chiller serves one hydronic cooling coil in air handling unit AC-1.

Details of the existing chiller have not been made available, but based on AC-1 cooling coil specification, we estimate the chiller capacity is around 25 Tons.

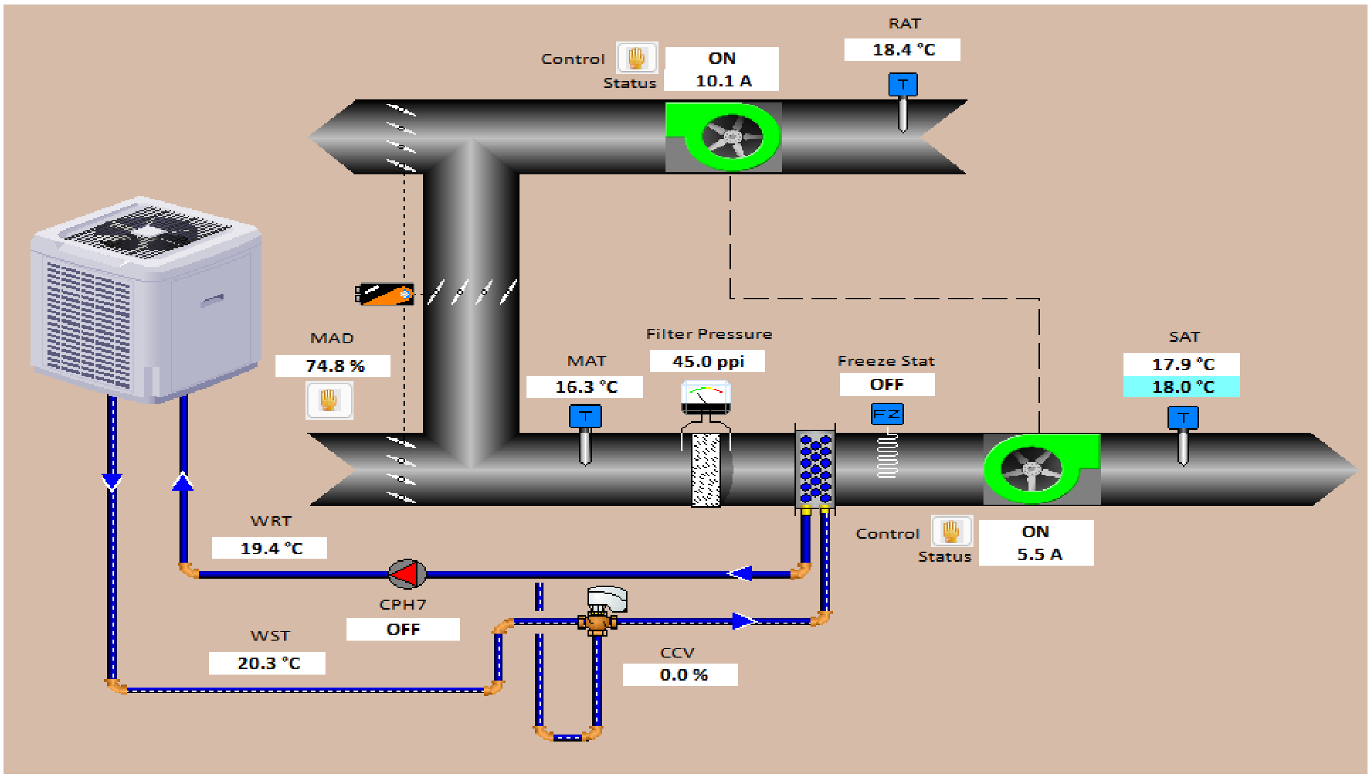


Figure 3: AC-1 and chiller

4.4 Ventilation System

Ventilation is provided by the air handlers shown in Table 3. Note that air handlers HV-1 to HV-5 are sometimes referred to as AHU-1 to AHU-5 in the DDC and other documentation.

Table 3: Air handlers

Tag	Service	Airflow	Supply Fan	Return Fan	Coils	Outdoor Air
AC-1	Computer, Tech Lab, Office, Library	5024 l/s	10 HP Constant speed	5 HP	Heating Cooling	Mix

HV-1	Block B. Part of Block C.	7237 l/s	10 HP Constant speed	5 HP	None	Mix
HV-2	Gym	7888 l/s	10 HP VSD	5 HP*	Heating	Mix
HV-3	Block A Classrooms (Main/Upper)	10888 l/s	20 HP Constant speed	7.5 HP Constant	Heating	Mix
HV-4	Construction	944 l/s	1.5 HP Constant speed	N/A	Heating	Mix
HV-5	Boiler room	590 l/s	0.75 HP Constant speed	N/A	None	Mix

* This fan is listed in the building HVAC documentation, but not shown in the DDC graphics.

Exhaust fans are listed in Table 4.

Table 4: Exhaust fans

Tag	Service	Airflow (l/s)	Fan	DDC
EF-A01	Washrooms	1062	½ HP	Not connected
EF-A02	Science	1416	1 HP	Not connected
EF-A03	A104	236	¼ HP	Not connected
EF-A04 EF-A05	Fume Hood Exhaust	330	1 HP	Not connected
EF-A06	A111 Range	94	100 W	Not connected
EF-A07	A130 Range	36	50 W	Not connected
EF-A08	A131 Range	94	100 W	Not connected
EF-B01	B107 Range	94	100 W	Not connected
EF-C01	Gym Dressing	813	½ HP	

EF-C02	B119, B120	376	¼ HP	Controlled
EF-C03	C106	708	½ HP	Controlled
EF C04	C107	708	¾ HP	Controlled
EF-C05	C107 Kiln	472	½ HP	Controlled
EF-C06	C107 Cer	472	½ HP	Controlled
EF-C07	C112	472	½ HP	Not connected

4.5 Domestic Hot Water System

Domestic hot water is provided by an electric tank heater with 15 kW heating capacity from three elements and 405 litres storage capacity. The domestic hot water recirculation pump (P-5) is controlled by the DDC.

4.6 Controls System

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

Boilers, boiler pumps, and P-2 are on BACnet protocol. Other systems use the older "V2" protocol.

Zone heating (coils and radiators) are not shown in the DDC graphics.

4.7 Other Equipment

The school has a 50 kW_p roof-mounted solar PV system, connected to the electrical system through two string inverters.

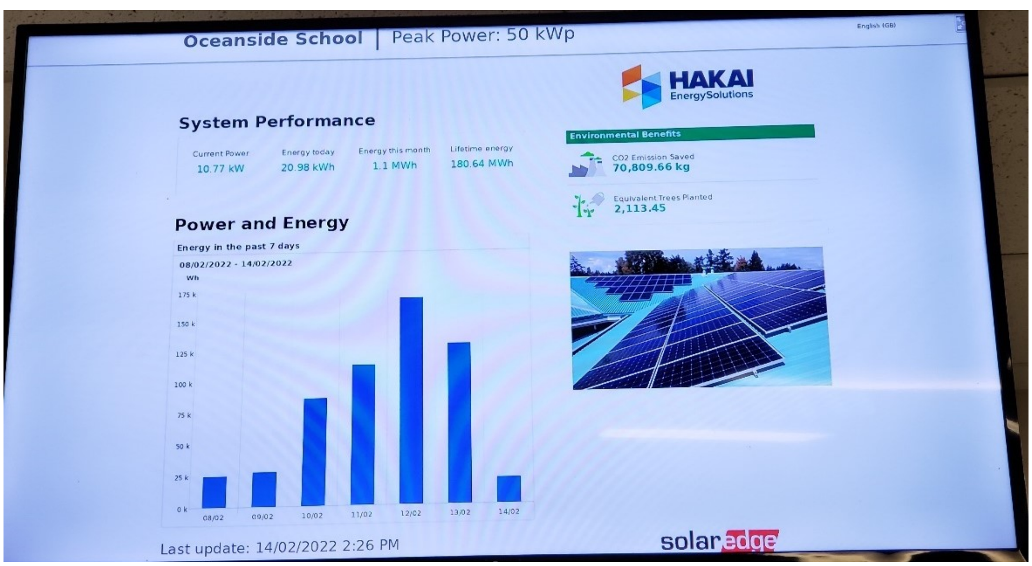


Figure 4: Solar PV Dashboard

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

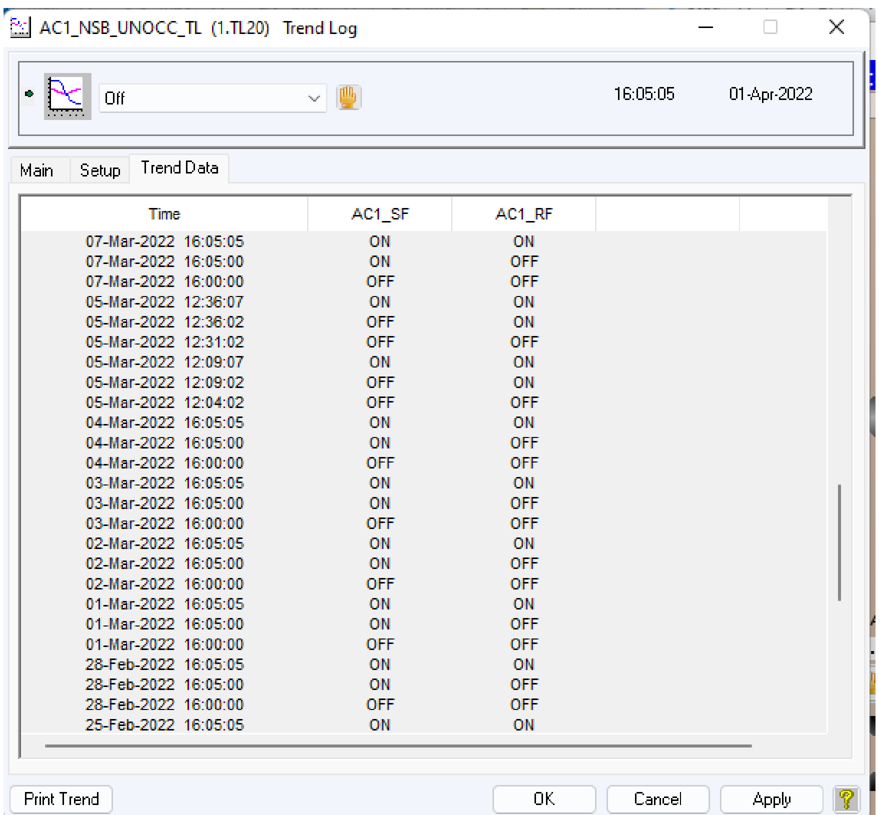
This section provides an overview of each measure, recommendations for implementation, and an update after implementation.

5.1 New Measures

5.1.1 Measure 1: AC-1 operates during unoccupied hours

Description of Finding

Outside occupied hours, AC-1 operates to maintain unoccupied setback temperatures based on the temperature of coldest room it serves (the DDC analog value AC1_LOW_RT). This variable is always 0 due to an apparent error in the programming (Figure 6 and Figure 7), so AC-1 operates continuously.



Time	AC1_SF	AC1_RF
07-Mar-2022 16:05:05	ON	ON
07-Mar-2022 16:05:00	ON	OFF
07-Mar-2022 16:00:00	OFF	OFF
05-Mar-2022 12:36:07	ON	ON
05-Mar-2022 12:36:02	OFF	ON
05-Mar-2022 12:31:02	OFF	OFF
05-Mar-2022 12:09:07	ON	ON
05-Mar-2022 12:09:02	OFF	ON
05-Mar-2022 12:04:02	OFF	OFF
04-Mar-2022 16:05:05	ON	ON
04-Mar-2022 16:05:00	ON	OFF
04-Mar-2022 16:00:00	OFF	OFF
03-Mar-2022 16:05:05	ON	ON
03-Mar-2022 16:05:00	ON	OFF
03-Mar-2022 16:00:00	OFF	OFF
02-Mar-2022 16:05:05	ON	ON
02-Mar-2022 16:05:00	ON	OFF
02-Mar-2022 16:00:00	OFF	OFF
01-Mar-2022 16:05:05	ON	ON
01-Mar-2022 16:05:00	ON	OFF
01-Mar-2022 16:00:00	OFF	OFF
28-Feb-2022 16:05:05	ON	ON
28-Feb-2022 16:05:00	ON	OFF
28-Feb-2022 16:00:00	OFF	OFF
25-Feb-2022 16:05:05	ON	ON

Figure 5: Both AC-1 supply and return fans operate continuously, except for brief shutdowns between occupancy modes

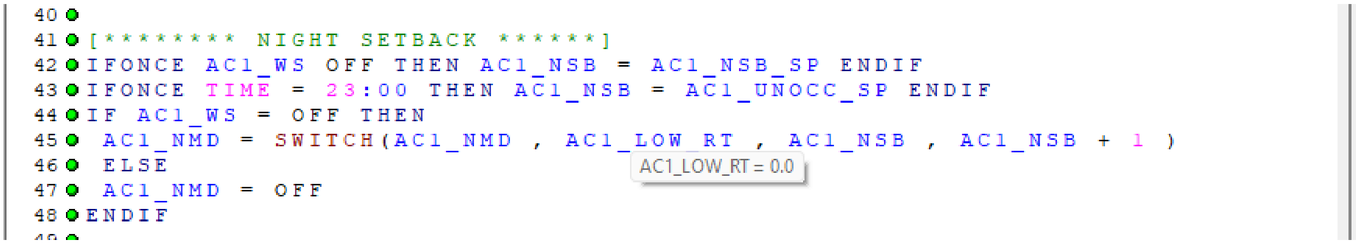


Figure 6: AC1_LOW_RT is always zero and does not reflect actual room temperatures

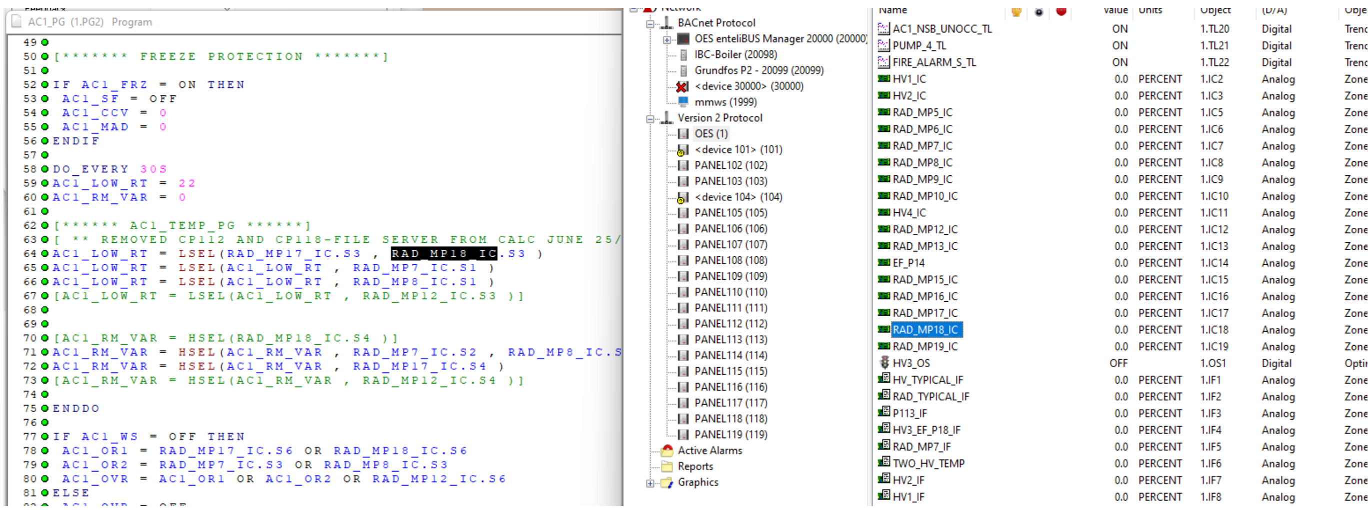


Figure 7: AC1_LOW_RT appears to be calculated from non-temperature values or variables with no defined value.

The outdoor air damper remains at least 30% open whenever the supply fan operates. It only closes if return air temperature drops below 16°C. This seldom occurs because the AC-1's zones are always maintained at occupied temperature setpoints, including during scheduled unoccupied hours.

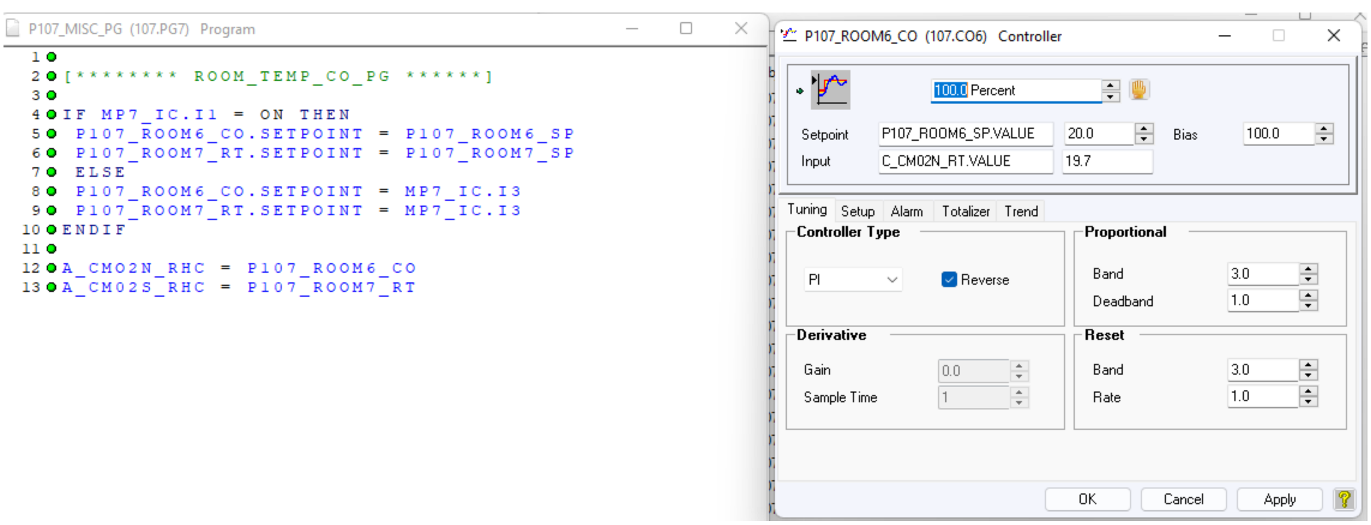


Figure 8: Typical reheat controller

Measure Description

Correctly calculate AC1_LOW_RT from room temperature readings in the spaces served by AC-1. This will enable the air handler to only run when required to maintain space setpoints.

Measure Implementation Update

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

5.1.2 Measure 2: Gymnasium HV-2 operates continuously

Description of Finding

During unoccupied periods, gymnasium air handler HV-2 operates if the temperature of the coldest space served by HV-2 (HV2_LO_RT) is lower than HV-2's night setback temperature setpoint (HV2_NSB, overridden to 19°C). The value of HV2_LO_RT remains constant at 18.1°C, which is not the gymnasium temperature. This causes HV-2 to operate continuously.

```
 HV2_DMP_RAMP = 0
ENDIF

[******* HV2_NIGHT MODE ********]

IF HV2_WS = OFF AND HV2_WS_EA = OFF THEN
 HV2_NMD = SWITCH(HV2_NMD , HV2_LO_RT , HV2_NSB , (HV2_NSB + 1) )
 ELSE
 HV2_NMD = OFF
ENDIF
```

HV2_LO_RT = 18.1

Figure 9: HV2_LO_RT value on 17 April 2022, 2:29PM

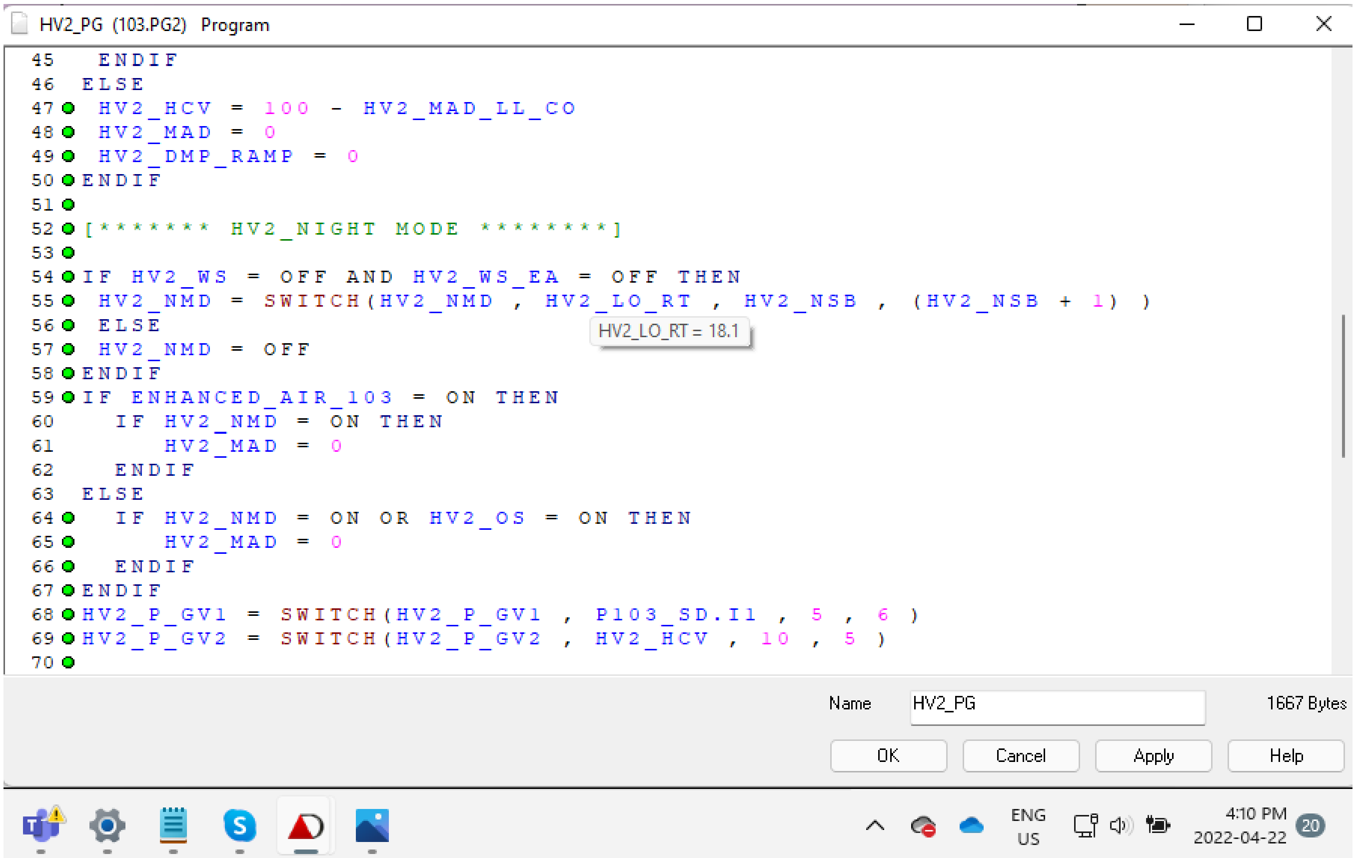


Figure 10: value of HV2_LO_RT on April 22, 4:10pm

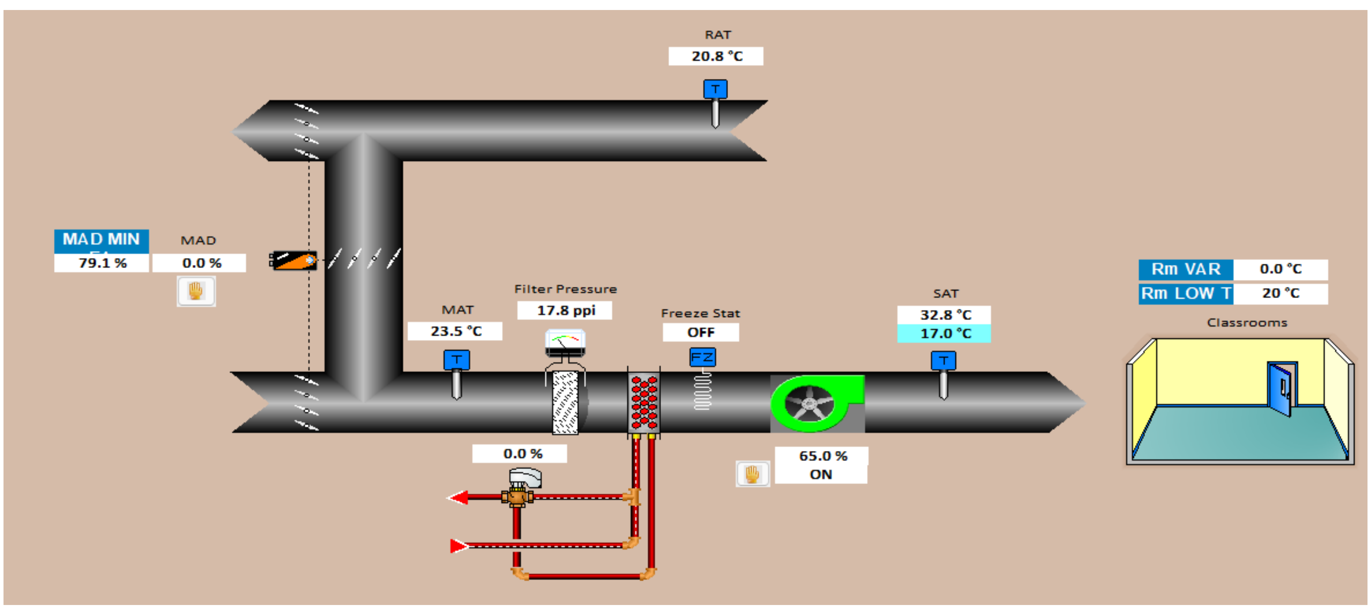


Figure 11: HV-2

Measure Description

Calculate the value of HV2_LO_RT correctly using the existing gymnasium zone temperature sensors. This will allow HV-2 to shut down during unoccupied hours when its unoccupied setback temperature is satisfied.

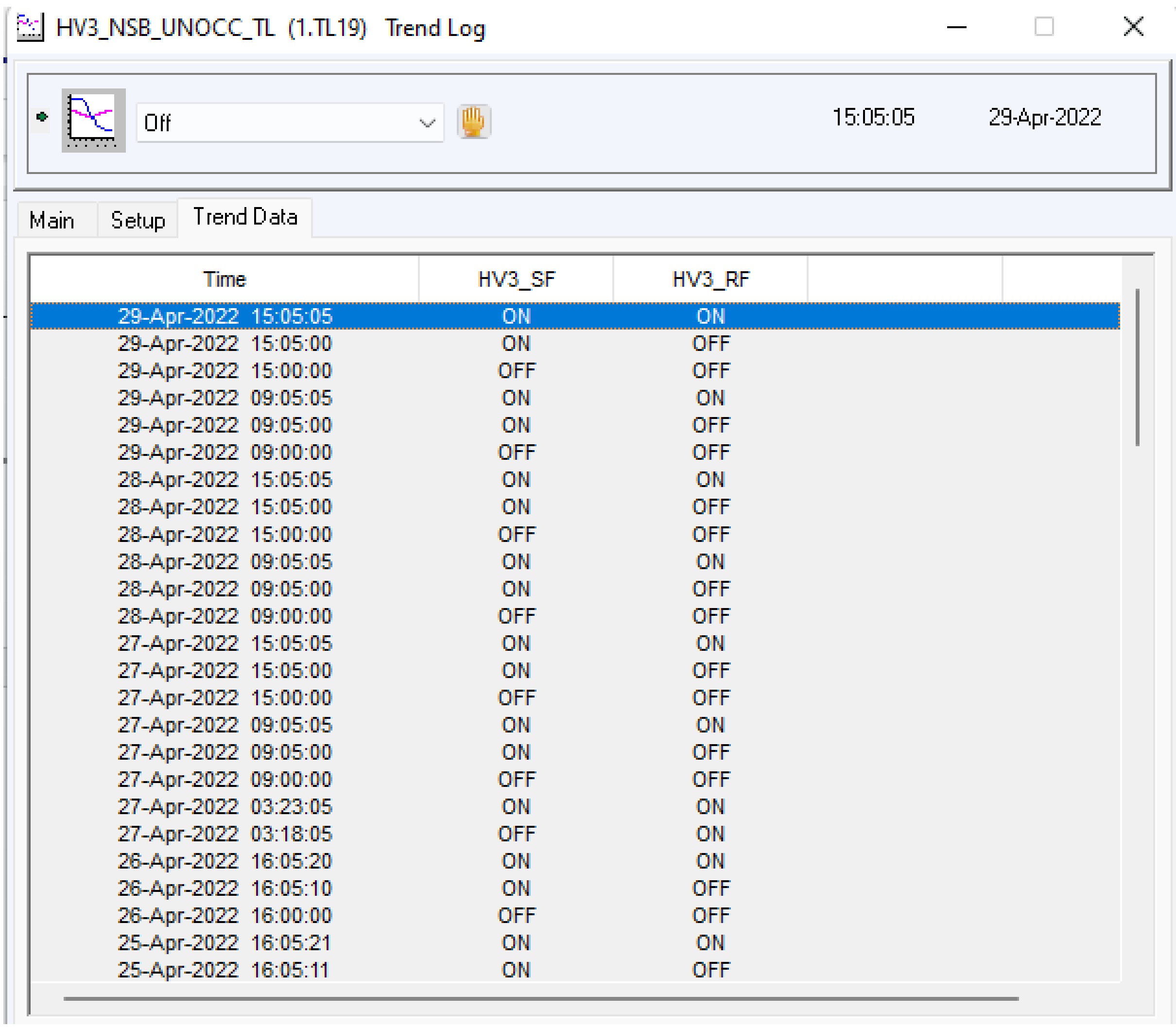
Measure Implementation Update

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

5.1.3 Measure 3: HV-3 operates continuously

Description of Finding

HV-3 operates continuously, including during its scheduled unoccupied hours. Outside of scheduled occupied hours, HV-3 is programmed to start if the temperature of the coldest zone it serves is below its night setback setpoint (19°C). However, this variable (HV3_LOW_RT) is always 0, apparently because it is calculated using sensors that have been removed.



Time	HV3_SF	HV3_RF
29-Apr-2022 15:05:05	ON	ON
29-Apr-2022 15:05:00	ON	OFF
29-Apr-2022 15:00:00	OFF	OFF
29-Apr-2022 09:05:05	ON	ON
29-Apr-2022 09:05:00	ON	OFF
29-Apr-2022 09:00:00	OFF	OFF
28-Apr-2022 15:05:05	ON	ON
28-Apr-2022 15:05:00	ON	OFF
28-Apr-2022 15:00:00	OFF	OFF
28-Apr-2022 09:05:05	ON	ON
28-Apr-2022 09:05:00	ON	OFF
28-Apr-2022 09:00:00	OFF	OFF
27-Apr-2022 15:05:05	ON	ON
27-Apr-2022 15:05:00	ON	OFF
27-Apr-2022 15:00:00	OFF	OFF
27-Apr-2022 09:05:05	ON	ON
27-Apr-2022 09:05:00	ON	OFF
27-Apr-2022 09:00:00	OFF	OFF
27-Apr-2022 03:23:05	ON	ON
27-Apr-2022 03:18:05	OFF	ON
26-Apr-2022 16:05:20	ON	ON
26-Apr-2022 16:05:10	ON	OFF
26-Apr-2022 16:00:00	OFF	OFF
25-Apr-2022 16:05:21	ON	ON
25-Apr-2022 16:05:11	ON	OFF

Figure 12: HV-3 fans run except for brief stops when occupancy mode changes

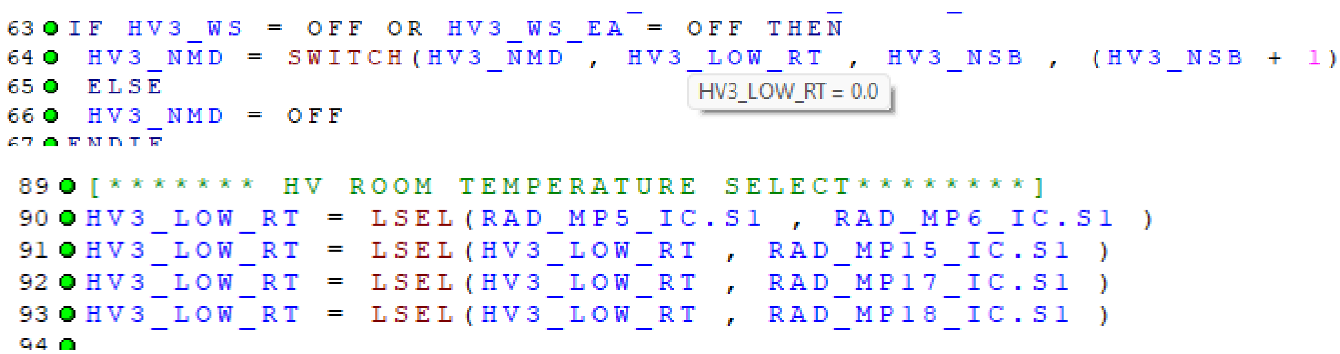


Figure 13: HV3_LOW_RT value does not reflect actual room temperatures

Measure Description

Calculate HV3_LOW_RT using HV-3's functioning zone temperature sensors only. This will enable HV-3 to shut down during unoccupied periods when night setbacks are satisfied.

Measure Implementation Update

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

5.1.4 Measure 4: Air handler schedules

Description of Finding

HV-1, HV-2, and HV-3's weekly scheduled occupied hours begin at 4am on Monday to Wednesday. On other days, they begin at 7am.

The 7am Thursday and Friday start time indicates that a 7am start time is sufficient to warm up the building in time for regular occupied hours (offices are occupied at 8am, classes at 8:45am) and that the earlier Monday to Wednesday start time is not required.

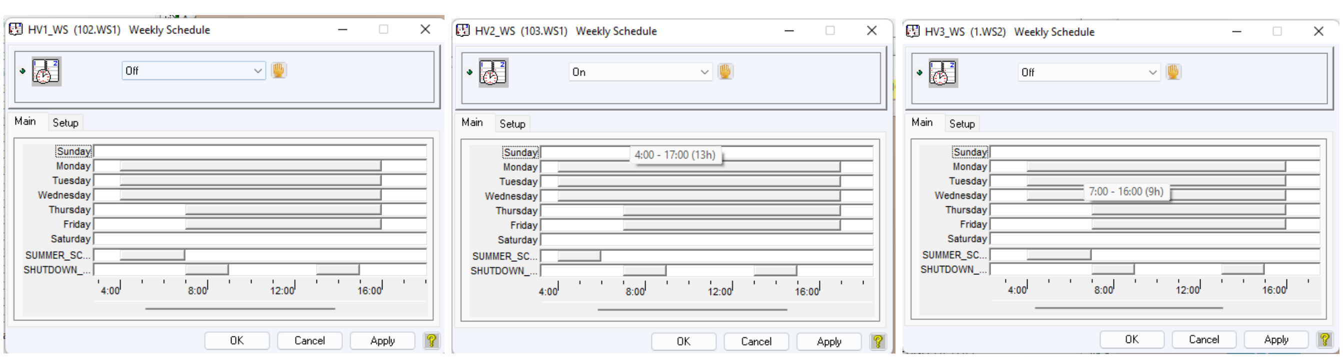


Figure 14: HV-1, HV-2, HV-3 schedules

Measure Description

Modify schedules for HV-1, HV-2, and HV-3 so the start time is 7am on all weekdays. Since the building may take longer to warm up after the weekend, the system may need to start slightly earlier on Monday morning for the room temperature to reach setpoint in time for occupancy.

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 (e.g. start AC-1 in time to bring office/admin spaces to temperature by 8am).

Measure Implementation Update

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

5.1.5 Measure 5: HV-3 excess ventilation

Description of Finding

Figure 1 shows HV-3 with its mixed air damper above minimum and its heating coil open at the same time. In this operating condition, HV-3 is drawing more cold outdoor air into the school than necessary for indoor air quality, only to immediately heat it as required for occupant comfort.

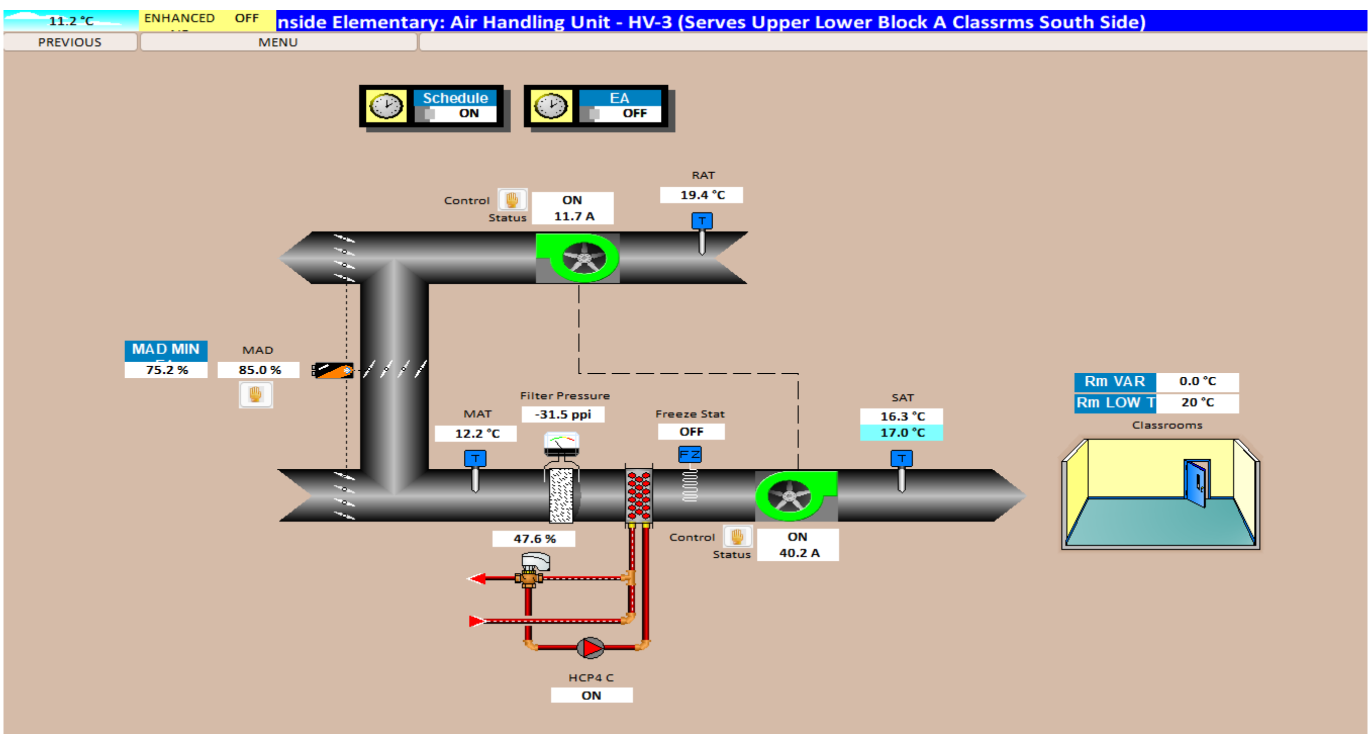


Figure 15: HV-3 has simultaneous high outdoor air and heating

Both the mixed air damper and the heating coil control valve modulate to maintain supply air temperature at its setpoint. This leads to situations where both the dampers and heating coil valve open more than required, resulting in simultaneous heating and cooling.

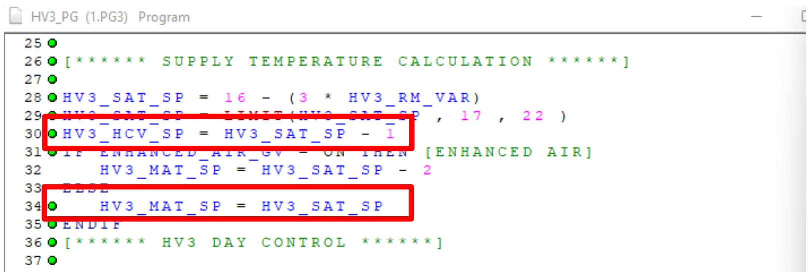


Figure 16: HCV targets SAT = SAT_SP – 1. MAD targets SAT = SAT_SP

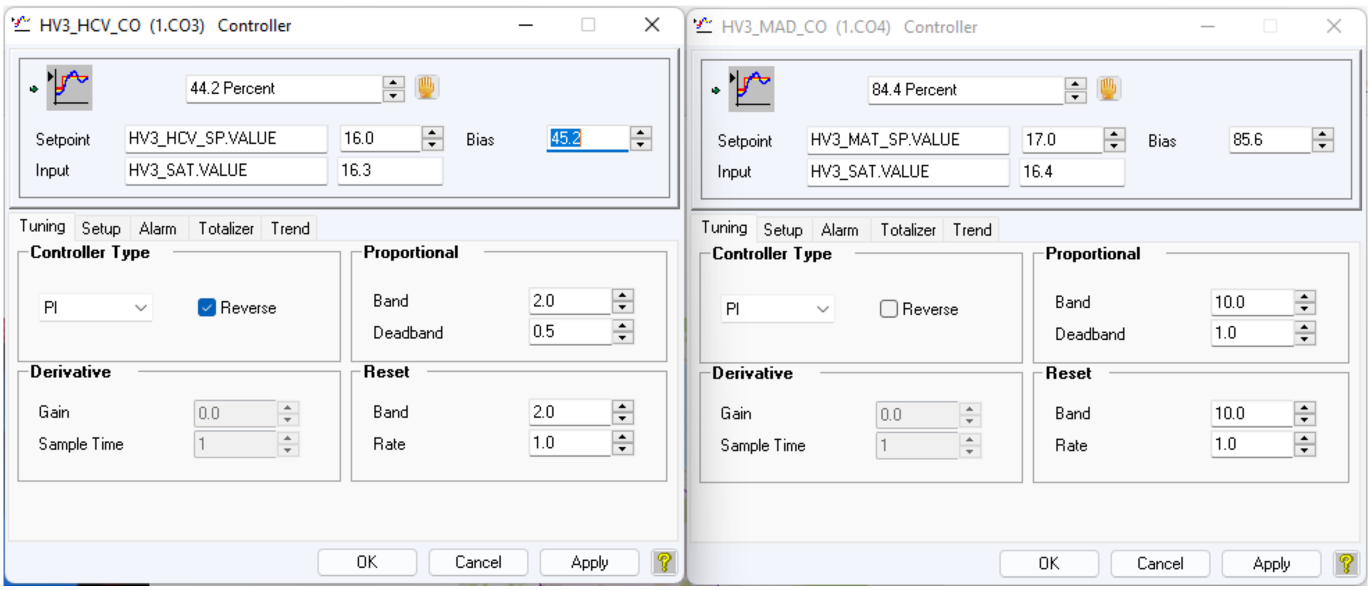


Figure 17: Overlapping bands on the HCV and MAD controllers enables heating and increased outdoor air at the same time

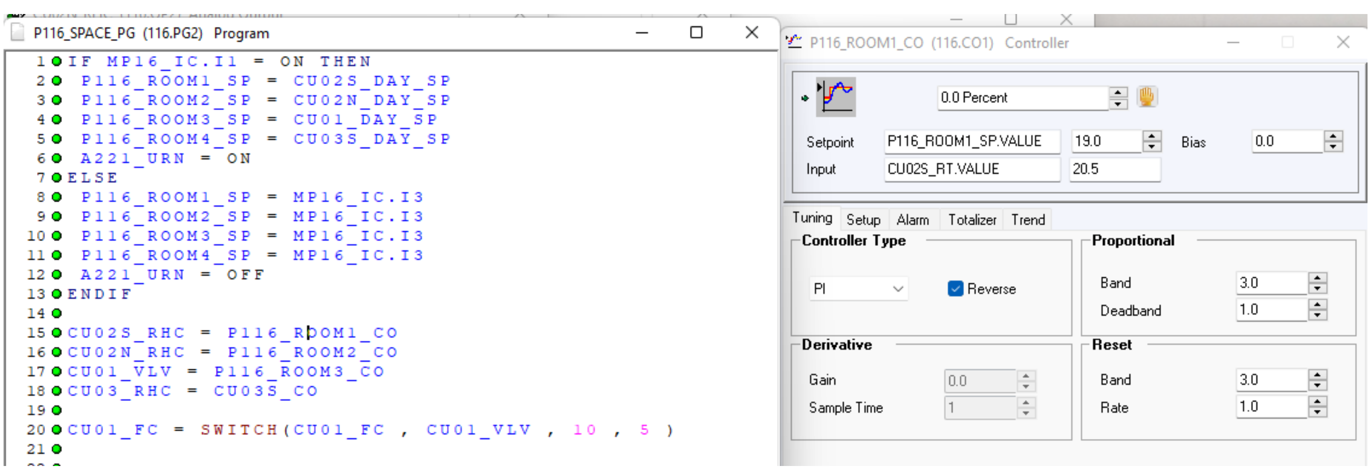


Figure 18: Typical reheat control to maintain 19°C RT

Measure Description

Implement a single split range control loop that controls both damper and heating valve.

Measure Implementation Update

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

5.1.6 Measure 6: Boiler supply setpoint higher when unoccupied

Description of Finding

During occupied hours, the boiler setpoint has been manually set to 50°C. Outside the boiler schedule (6:30am to 6pm Monday to Friday), the boiler setpoint changes to 60°C. This results in lower boiler efficiency, and higher heat losses from pipes.

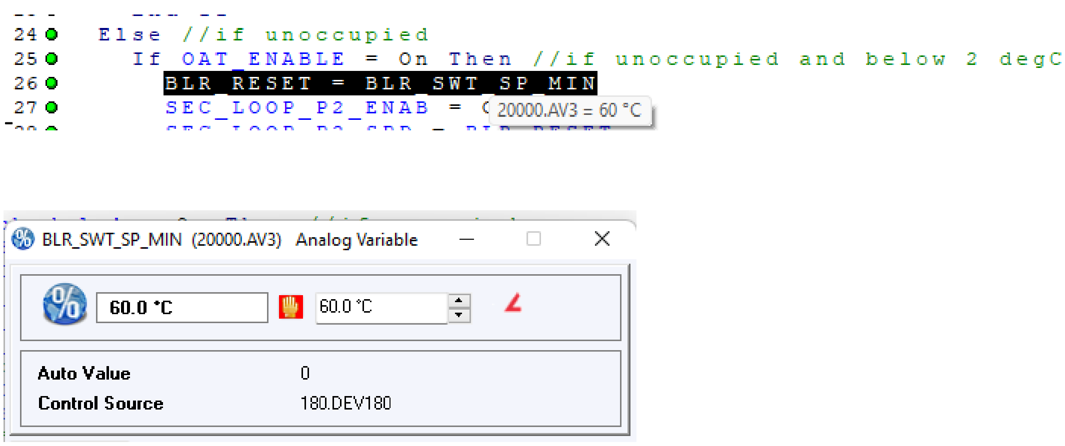


Figure 19: Boiler temperature is set to 60°C when unoccupied

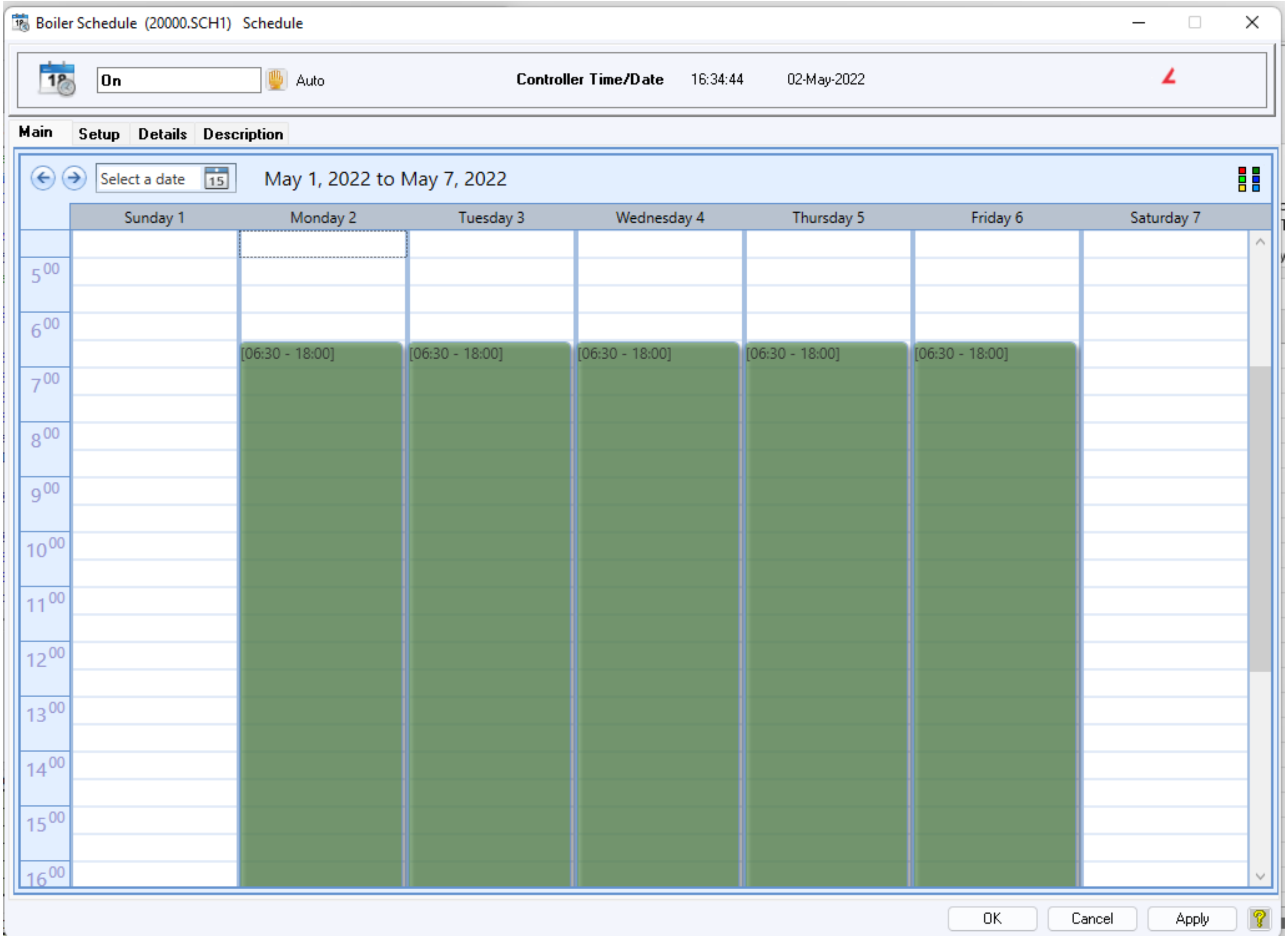


Figure 20: Boiler schedule

Measure Description

Reduce boiler supply minimum temperature variable (BLR_SWT_SP_MIN; the programmed unoccupied boiler supply water temperature setpoint per Figure 19) to 50°C.

Measure Implementation Update

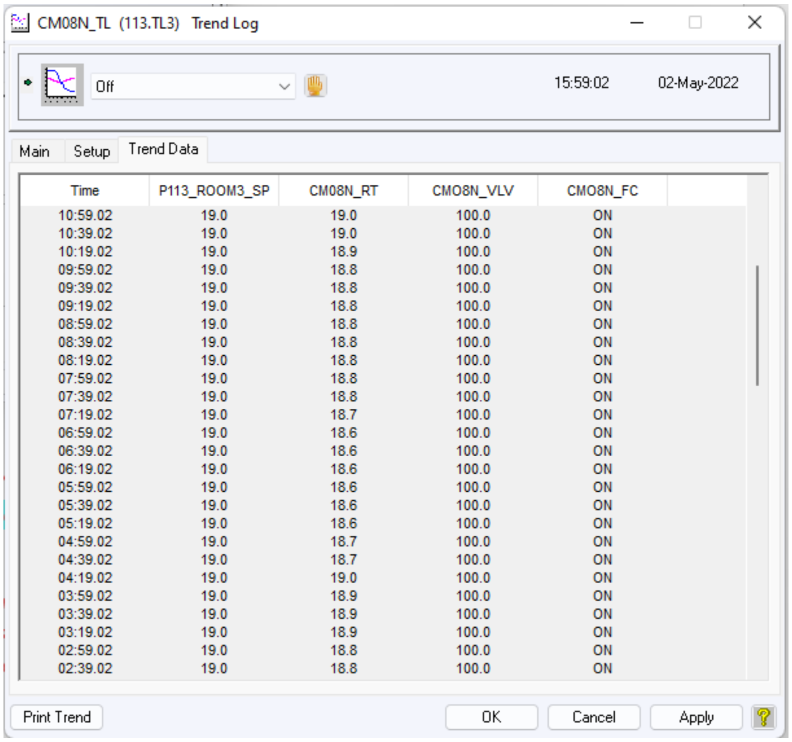
[Provide confirmation details **AFTER** the measure is implemented and verified]

5.1.7 Measure 7: Night setbacks for reheats and fan coils

Description of Finding

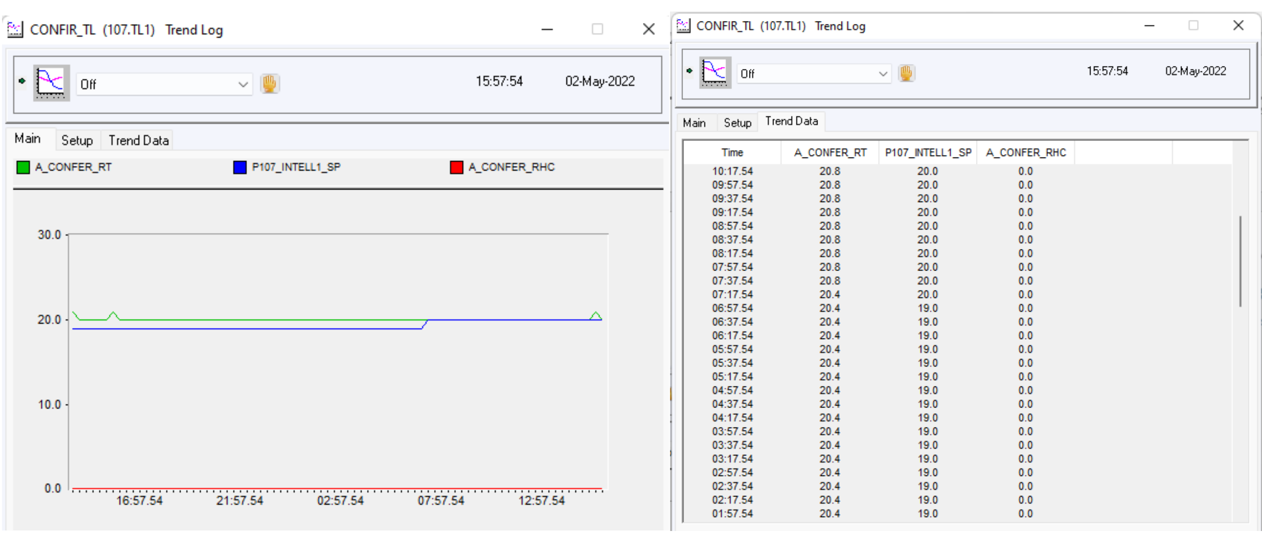
The controllers for the hydronic duct reheat coils and fan coil units do not have night setbacks configured and they will attempt to maintain rooms to their typical daytime setpoints, even during unoccupied hours.

In addition, the reheat coils are programmed to provide heat regardless of whether their air handling units are operating.



Time	P113_ROOM3_SP	CM08N_RT	CM08N_VLV	CM08N_FC
10:59.02	19.0	19.0	100.0	ON
10:39.02	19.0	19.0	100.0	ON
10:19.02	19.0	18.9	100.0	ON
09:59.02	19.0	18.8	100.0	ON
09:39.02	19.0	18.8	100.0	ON
09:19.02	19.0	18.8	100.0	ON
08:59.02	19.0	18.8	100.0	ON
08:39.02	19.0	18.8	100.0	ON
08:19.02	19.0	18.8	100.0	ON
07:59.02	19.0	18.8	100.0	ON
07:39.02	19.0	18.8	100.0	ON
07:19.02	19.0	18.7	100.0	ON
06:59.02	19.0	18.6	100.0	ON
06:39.02	19.0	18.6	100.0	ON
06:19.02	19.0	18.6	100.0	ON
05:59.02	19.0	18.6	100.0	ON
05:39.02	19.0	18.6	100.0	ON
05:19.02	19.0	18.6	100.0	ON
04:59.02	19.0	18.7	100.0	ON
04:39.02	19.0	18.7	100.0	ON
04:19.02	19.0	19.0	100.0	ON
03:59.02	19.0	18.9	100.0	ON
03:39.02	19.0	18.9	100.0	ON
03:19.02	19.0	18.9	100.0	ON
02:59.02	19.0	18.8	100.0	ON
02:39.02	19.0	18.8	100.0	ON

Figure 21: Fan coil CM08N. Room temperature remains at constant 19°C setpoint continuously



Time	A_CONFER_RT	P107_INTELL1_SP	A_CONFER_RHC
10:17.54	20.8	20.0	0.0
09:57.54	20.8	20.0	0.0
09:37.54	20.8	20.0	0.0
09:17.54	20.8	20.0	0.0
08:57.54	20.8	20.0	0.0
08:37.54	20.8	20.0	0.0
08:17.54	20.8	20.0	0.0
07:57.54	20.8	20.0	0.0
07:37.54	20.8	20.0	0.0
07:17.54	20.4	20.0	0.0
06:57.54	20.4	19.0	0.0
06:37.54	20.4	19.0	0.0
06:17.54	20.4	19.0	0.0
05:57.54	20.4	19.0	0.0
05:37.54	20.4	19.0	0.0
05:17.54	20.4	19.0	0.0
04:57.54	20.4	19.0	0.0
04:37.54	20.4	19.0	0.0
04:17.54	20.4	19.0	0.0
03:57.54	20.4	19.0	0.0
03:37.54	20.4	19.0	0.0
03:17.54	20.4	19.0	0.0
02:57.54	20.4	19.0	0.0
02:37.54	20.4	19.0	0.0
02:17.54	20.4	19.0	0.0
01:57.54	20.4	19.0	0.0

Figure 22: The typical zone night setback temperature setpoint is 19°C, which provides limited energy savings

Measure Description

Reducing the room temperatures while unoccupied will reduce heat loss through the envelope (walls, windows, etc.) and save energy. We recommend reducing room temperature setpoints for all equipment to 15°C during unoccupied periods.

Reprogram reheat coil control valves to close whenever the corresponding air handling units are disabled.

Show reheat coils in the DDC graphics for improved visibility and troubleshooting.

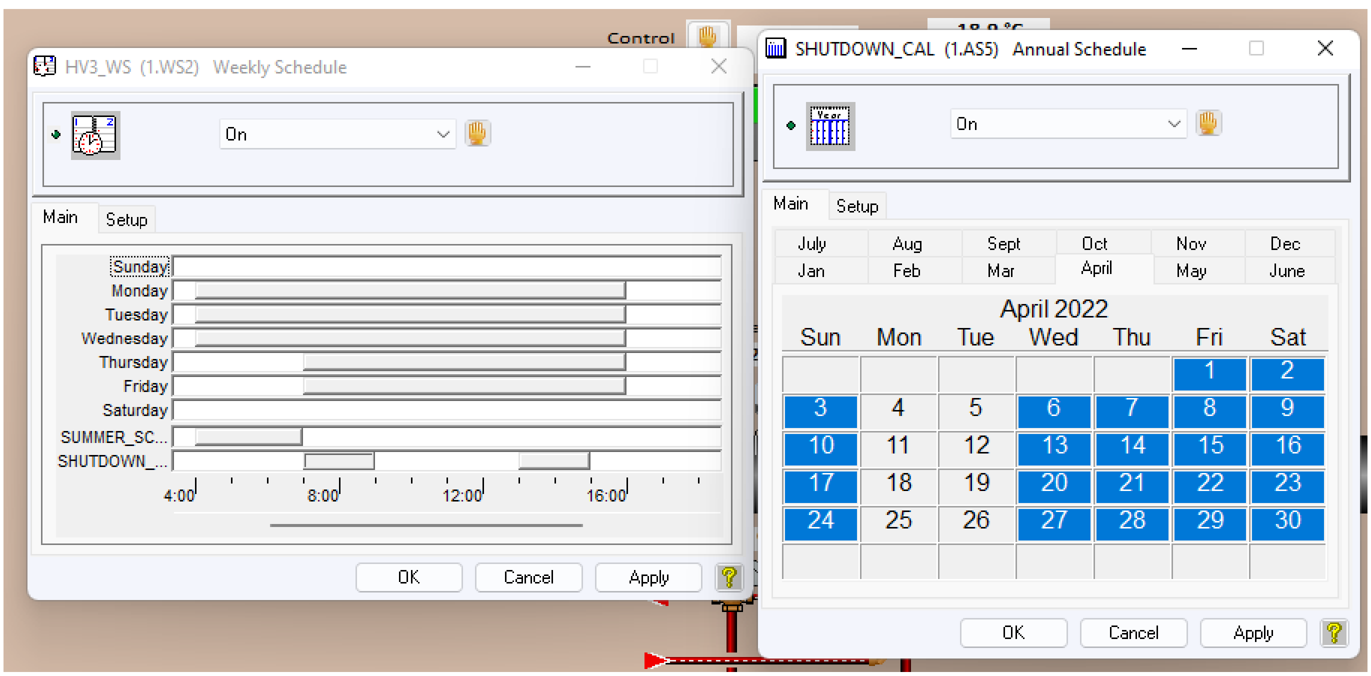
Measure Implementation Update

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

5.1.8 Measure 8: HV-3 occupancy schedule out-of-date

Description of Finding

The HV-3 occupancy schedule includes a secondary “shutdown” calendar which provides two 2-hour periods of operation, likely intended to maintain air quality during extended unoccupied period. The schedule appears to be from a previous year and causes the air handler to run on Saturdays and Sundays, over 6 weeks in March and April (a total of 12 days).



Measure Description

Review shutdown schedules and remove unnecessary entries.

Measure Implementation Update

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

5.1.9 Measure 9: HV-2 fan or coil issue

Description of Finding

Figure 23 shows HV-2 operating with its heating coil control valve closed but a supply air temperature of 31.8°C. This suggests the heating coil is passing, or there is an issue with the supply air temperature sensor.

This issue appeared in late April and was not present during earlier inspections of the DDC.

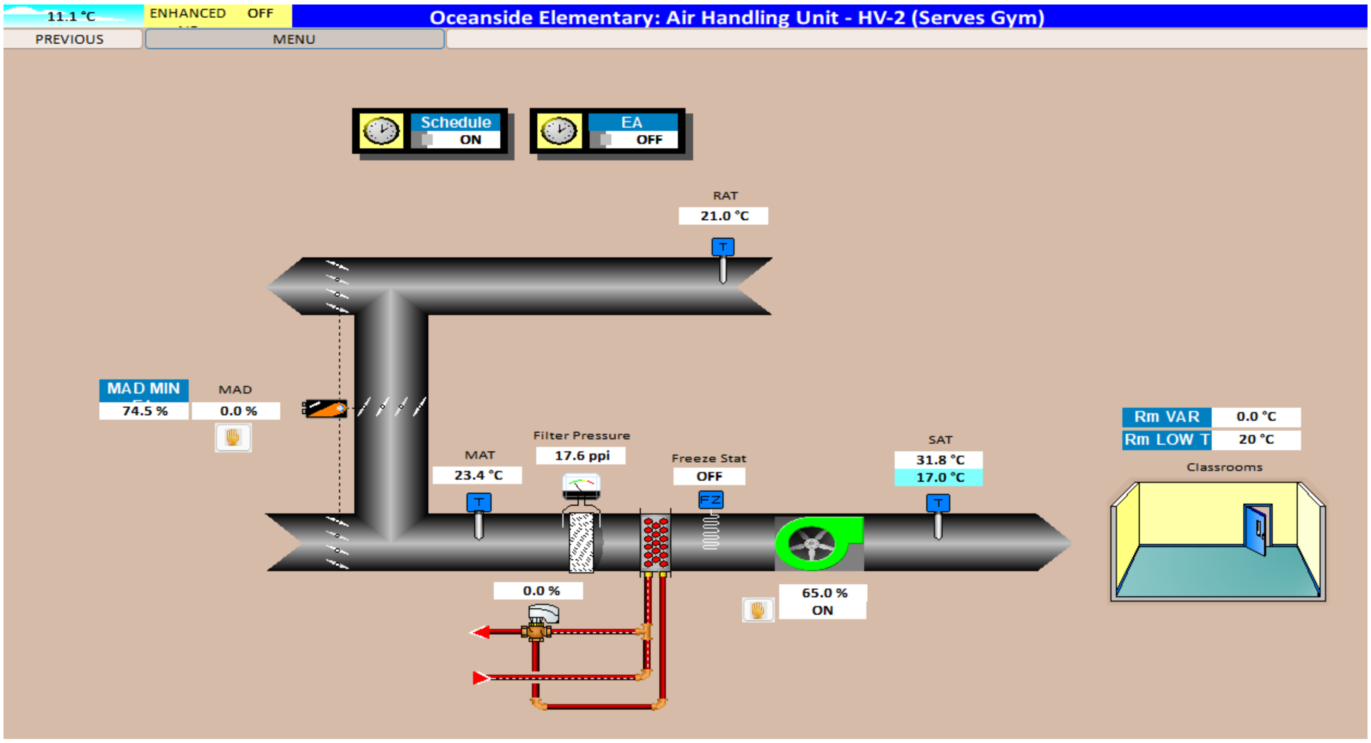


Figure 23: Significant increase in air temperature over the heating coil (and fan)

Measure Description

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

Operate HV-2 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 requires repair or replacement.

Measure Implementation Update

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

5.1.10 Measure 10: Fan sensor issues

Description of Finding

Several fans have inconsistent feedback values. There are no energy savings associated with this measure, but possible comfort or air quality issues.

EFC-02

The feedback from exhaust fan EFC-02 (Science Rooms, A220, served by HV-3) indicates it never runs, even when commanded on.

Figure 24: Exhaust fans in the DDC

AC-1 Supply Fan

The AC-1 supply fan feedback sensor shows a very different current (5 A) than what is specified for the fan motor (30 A), as seen in Figure 3.

This is likely a sensor issue. The air handler will function normally while the sensor reading remains higher than 3 A, but if may become an issue if the sensor degrades further.

HV-2 Supply Fan

The HV-2 supply fan feedback variable (HV2_SFVD_S) is 'Off' even when the fan is commanded to run. In this error state, the outdoor air dampers are always closed, and heating is minimized. This is leading to temperature and air quality issues in the gym.

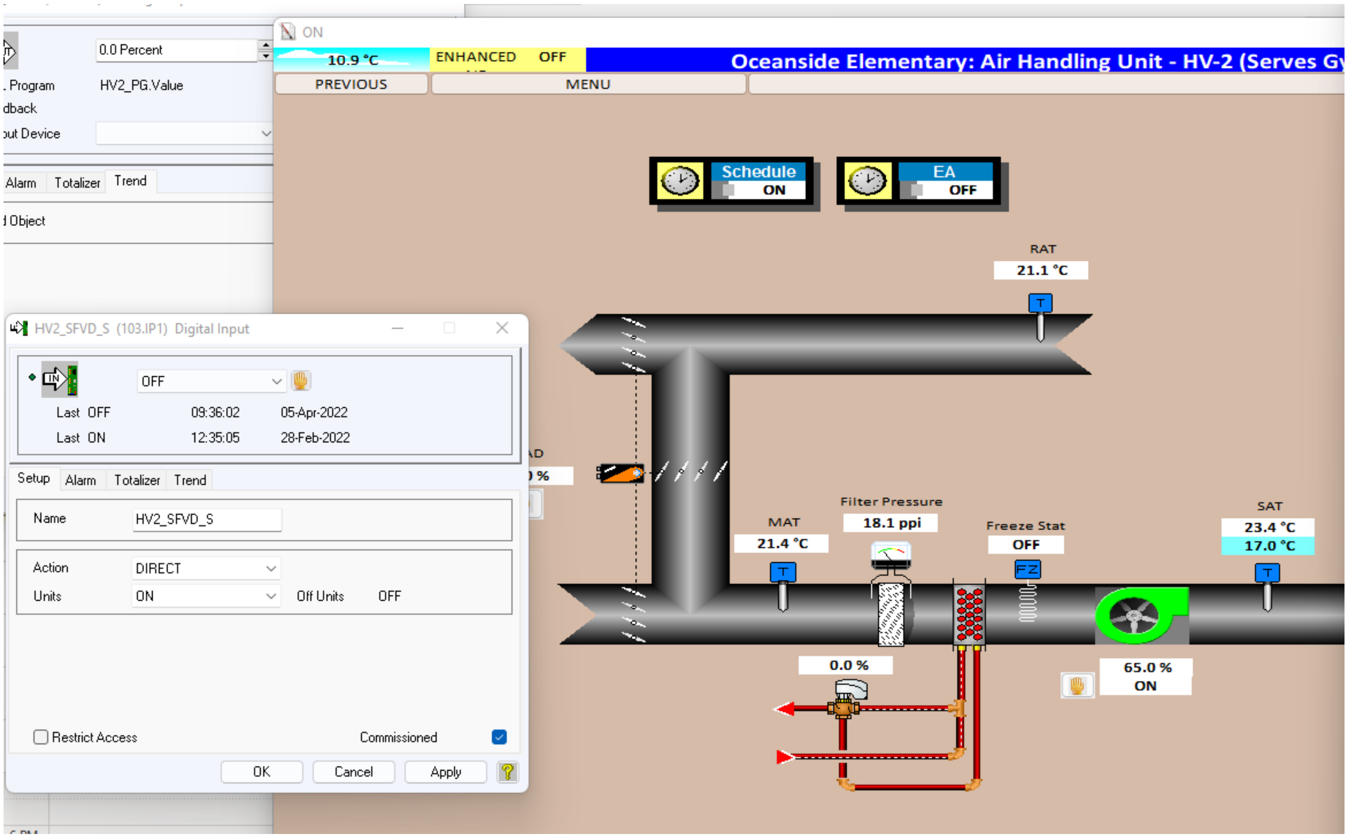


Figure 25: The value of HV2_SFVD_S is off even when the supply fan is commanded on.

```
IF HV2_SFVD_S = ON THEN
  HV2_HCV = HV2_HCV_CO
  HV2_DMP_RAMP = HV2_DMP_RAMP + 0.1
  HV2_DMP_RAMP = LIMIT(HV2_DMP_RAMP , 0 , 100 )
  IF ENHANCED_AIR_103 = ON THEN
    HV2_MAD = LIMIT(HV2_MAD_CO , MAD_MIN_POS103 , 100 )
    HV2_MAD = LSEL(HV2_MAD , HV2_MAD_LL_CO )
  ELSE
    HV2_MAD = LIMIT(HV2_MAD_CO , HV2_MAD_MIN , 100 )
    HV2_MAD = LSEL(HV2_MAD , HV2_MAD_LL_CO , HV2_DMP_RAMP )
  ENDIF
  IF HV2_RAT < 16 THEN
   HV2_DMP_RAMP = 0
  ENDIF
ELSE
  HV2_HCV = 100 - HV2_MAD_LL_CO
  HV2_MAD = 0
  HV2_DMP_RAMP = 0
ENDIF
```

Figure 26: HV-2 MAD is set to 0 if there is no fan feedback.

Measure Description

EFC-02

Confirm whether EFC-02 runs when commanded on. If not, identify and correct issue with the fan or connections. If it runs, the fan feedback sensor or connections should be corrected.

AC-1 Supply Fan

Verify the AC-1 supply fan feedback sensor correctly reports that status of the fan by manually checking AC-1 supply fan's status in the field. If the sensor is faulty, it should be repaired or replaced. If the reading is correct, there may be an issue with the fan motor.

HV-2 Supply Fan

Verify the HV-2 supply fan feedback sensor by manually checking if the fan is running in the field and comparing it with the current feedback. If the sensor is faulty, it should be repaired or replaced. If the reading is correct, there may be an issue with the fan.

Update DDC graphics to reflect measured feedback, for example by showing the fan in red or green depending on the measured state.

Measure Implementation Update

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

5.1.11 Measure 11: DHW circulation pump manually on

Description of Finding

The DHW recirculation pump (P-5) has been overridden to operate continuously.

Running the pump outside of scheduled hours causes a (small) energy penalty and distribution losses.

The purpose of the pump is to ensure hot water immediately at taps and showers throughout the building, so it should run whenever custodial staff or other occupants are in the building.

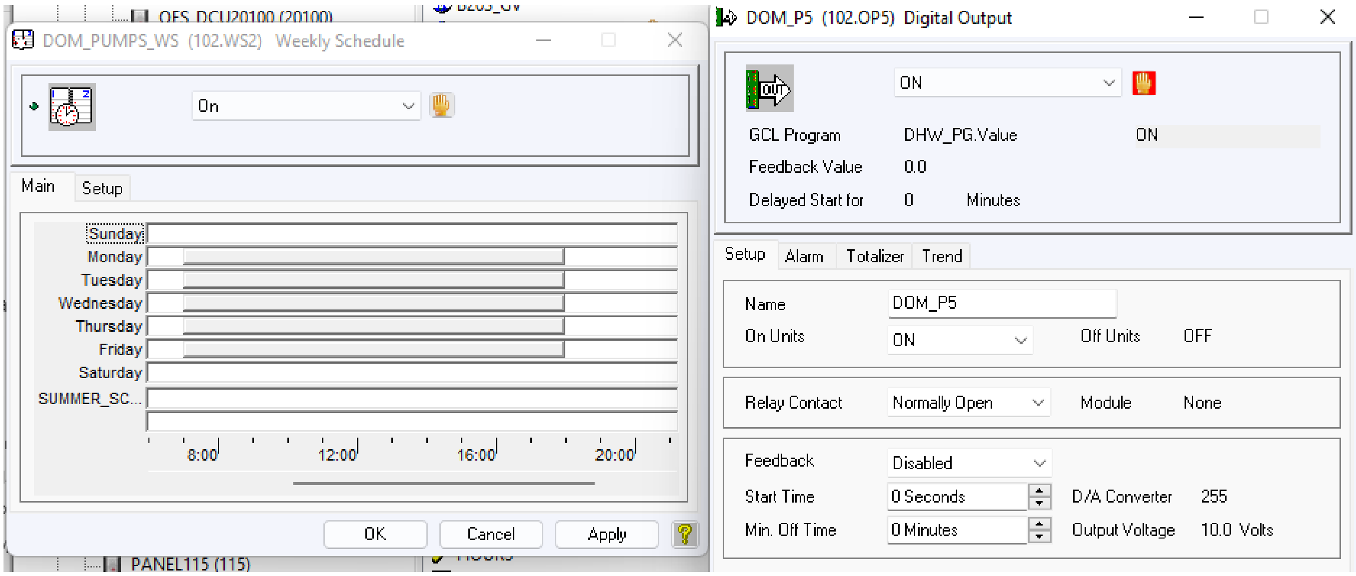


Figure 27: The P-5 schedule has been manually overridden

Measure Description

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

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 12: Add reversible heat pump to boiler loop

Measure Description

The boiler loop supply temperature is currently set manually to 50°C without any reported comfort issues. Commercially available air and ground source heat pumps can efficiently heat water to this temperature. This makes Oceanside Elementary an excellent candidate for low carbon electrification by supplementing the existing boilers plant with air or ground source heat pumps.

If the chiller connected to AC-1 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 able to heat or chill water depending on season. If a unit of similar cooling capacity to the existing chiller is selected (25 Tons, based on the AC-1 cooling coil specification), it will not require additional electrical capacity.

The current supply and return pipes from the chiller to AC-1 pass close by the boilers plant in the basement mechanical room. This makes it inexpensive to connect a heat pump installed in place of AC-

1's chiller with the heating water loop. During summer, the heat pump would provide cooling as it does now, serving AC-1[1]. In winter, the heat pump would provide 1st-stage heating to the heating water loop, supplemented by the existing boilers as required.

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 Oceanside's heating. Mechanical and structural assessments are required to refine the cost and viability of the project.

Estimated measure costs include all work required to replace the existing chiller with a heat pump. If the existing AC-1 chiller is nearing end-of-life, the base case cost (replacing the chiller like-for-like) may be similar.

Figure 28: Basement mechanical room. Chiller water pipe marked in blue. The boilers are on the right.

[1] If the school district is considering cooling in other parts of the school, for example as a climate resilience measure to manage extreme heat events, the chilled water piping could be extended supply other zones. This would require a larger heat pump, installation of additional cooling equipment, and higher project costs.

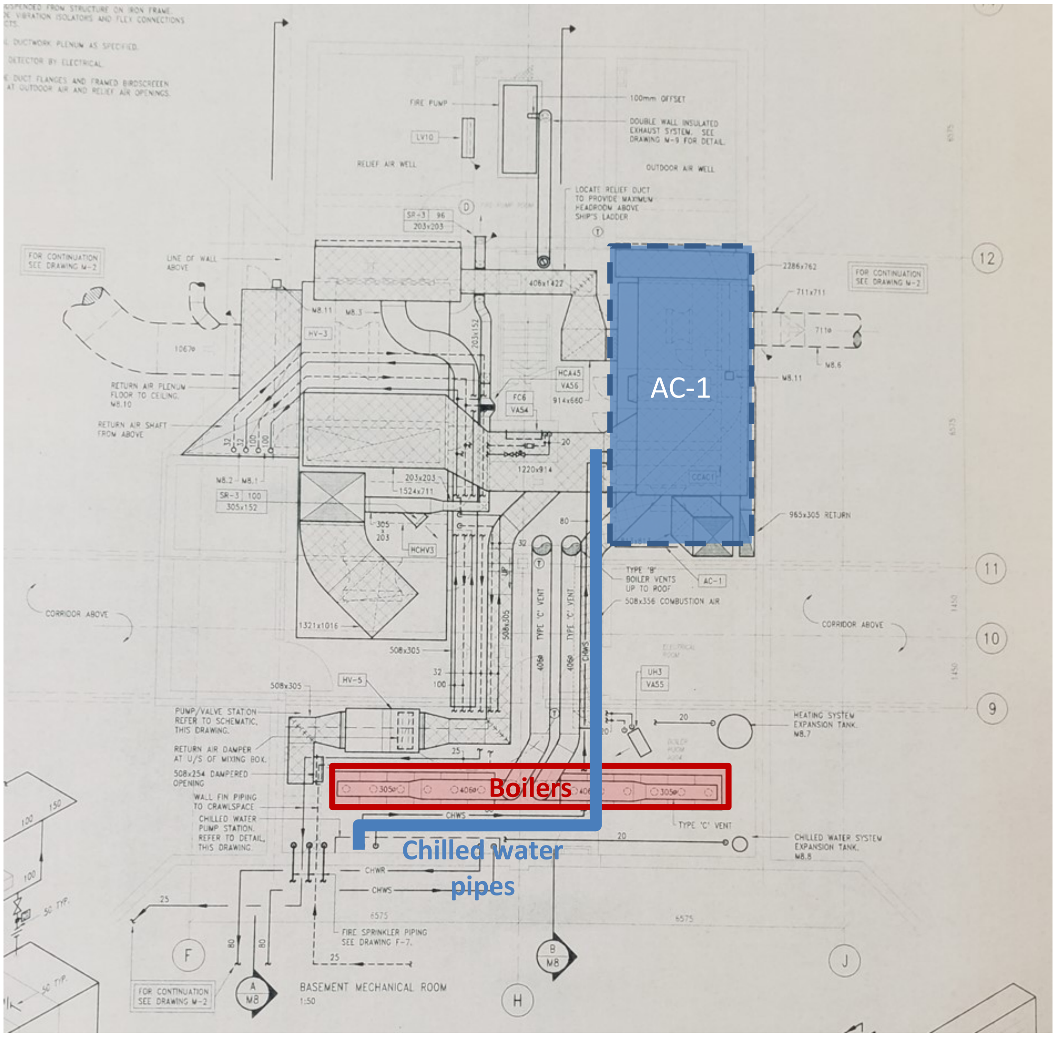


Figure 29: Basement mechanical room. Supply and return pipes from the existing chiller pass close to the boiler plant and heating loop.

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	AC-1 operates continuously	New	1	-	56,057	195	$ 7,892	$ 600	0.1	10.3	
ECM-2	HV-2 operates continuously	New	1	-	24,135	-	$ 2,381	$ 600	0.3	0.3	
ECM-3	HV-3 operates continuously	New	1	-	68,334	-	$ 6,741	$ 200	0.0	0.7	
ECM-4	Air handler schedules	New	1	-	1,419	61	$ 877	$ 400	0.5	3.0	
ECM-5	HV-3 excess ventilation	New	1	-	-	168	$ 2,043	$ 1,100	0.5	8.4	
ECM-6	Boiler supply setpoint higher when unoccu	New	1	-	-	28	$ 344	$ 200	0.6	1.4	
ECM-7	Night setbacs for reheats and fan coils	New	1	-	-	120	$ 1,457	$ 4,100	2.8	6.0	
ECM-8	HV-3 occupancy schedule out-of-date	New	1	-	-	2	$ 28	$ 200	7.0	0.1	
ECM-9	AHU-2 coil issue	New	1	-	-	228	$ 2,761	$ 4,800	1.7	11.4	
ECM-10	Fan sensor issues	New	1	-	-	-	$ -	$ 900	#DIV/0!	-	
ECM-11	DHW circulation pump manually on	New	1	-	236	-	$ 23	$ 200	8.6	0.0	
ECM-12	Reversible heat pump connected to hydron	New	1	-	- 64,316	755	$ 2,811	$ 236,929	84.3	37.0	x
			TOTAL (Previous, still working):	-	-	-	$ -	n/a	n/a	-	
			TOTAL (All potential measures for Implementation):	-	85,865	1,558	$ 27,359	$ 250,229	9.1	78.6	
			TOTAL (Selected measures only):	-	**150,182**	**803**	**$ 24,548**	**$ 13,300**	**0.5**	**41.6**	

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)**