WINDSOR ENGINEERS

Memo

To:	Brian Freeman
Cc:	Kirk Pawlowski, Geert Aerts, ESD 112
From:	Phillip Alexander, P.E.
Date:	06/03/2021
Subject:	Klickitat School District HVAC Assessment and Recommendations

1. Project Summary

The three main buildings of the Klickitat School District were investigated to assess the effectiveness of the existing Heating, Ventilation, and Air Conditioning systems. Existing construction record drawings and reports from ESD 112 personnel were reviewed in preparation for a site visit in April 2021. After visiting the site and discussion with school district personnel, the following goals for this report were set:

1. Assess the current ventilation strategy and its effectiveness against current state mechanical code standards and national covid mitigation recommendations. Use this assessment to make recommendations to address any deficiencies discovered.
2. Investigate and make a recommendation on how to most cost-effectively provide cooling to all regularly occupied spaces with an approach that can phased in across the campus.
3. Asses the current heating system and make a recommendation on its time-in-life and whether an upgrade to a less carbon-intense system is viable.

Findings:

Ventilation:

- The classrooms in the elementary and high school buildings are not sufficiently ventilated.
- This is primarily due to existing dedicated ventilation exhaust fans not operating.
- Any new ventilation system should not rely on exhaust fans to negatively pressurize the classrooms.

Cooling:

- The most cost-effective way to efficiently upgrade the current heating system into a heating and cooling system is to convert each building into a Variable Refrigerant Flow (VRF) system. This approach also addresses the third goal of upgrading the heating system into a low carbon system.

Heating:

- The current heating system is past the normal service life of 20 years and should be upgraded. Material degradation of the boilers, circulation pumps, and piping can be expected to start to impacting operation. At a minimum, the existing boilers and circulation pumps should be replaced, or the system approach should be changed.

Cost:

After initial estimated direct construction costs (those not including engineering fees, permits, project administration costs, bid advertisement, legal fees, and other indirect capital project costs) were communicated to the district, it was determined that correcting ventilation while upgrading heating and cooling was too expensive.

Corrective Actions:
Ventilation:

- Engage a reputable local mechanical contractor to investigate the condition, the operational functionality, potential solutions, test the acoustical performance, and estimated costs to improve the ventilation systems and improving indoor air quality in the High School and Elementary school classrooms, public areas, and offices.
- This contractor should meet the Basis of Design recommendations included with this report.

Heating and Cooling:

- Engage a reputable local mechanical contractor to design and install VRF systems at each of the buildings depending on the availability of funds.
- Installation to conform to Basis of Design recommendations included with this report.

2. Site Observations

The Klickitat School District campus consists of three main buildings. Each of these buildings has a dedicated boiler which provides heating hot water to fan coils and air handlers via a pump and piping system. Cooling was not part of the original design of any of these buildings but has been added to the elementary school classrooms.

Two of these buildings, the Elementary and the High School, have similar original approaches to ventilation and heating. Low wall fan coils draw air from the classroom and a dedicated outside louver then heat this combined air stream as directed by a classroom thermostat. Additional outside air was meant to be drawn into these spaces through these fan coils via exhaust fans mounted either on the wall (elementary school) or the roof (high school), but these fans no longer operate. Additional spaces in these buildings are heated via ceiling-mounted fan coils drawing from outdoor louvers and the buildings' interior spaces. Cooling has been added to the elementary school classrooms via two banks of four 2.5 ton AC units with coils integrated into the classroom fan coil units.

The majority of the gymnasium is served by a large air handing unit, with additional spaces heated and ventilated by ceiling-mounted fan coils. These systems appear to be operating as originally designed.

3. Ventilation Corrective Actions

Requirements
To be effective and compliant the ventilation approach of a K12 space must provide a greater rate of outside air flow than the minimum flow calculated after taking the room area and occupancy in account. This rate is sometimes referred to as an Air Change Rate, which represents how many times in an hour (ACH) the air volume of a space has been brought into and exhausted from a space.

Current covid recommendations require any recirculated air, air taken from inside the building, be filtered by a filter with at least a MERV13 rating.

Additional state noise restrictions limit the noise generated by ventilation equipment in classrooms be less than NC-35.

Fan Restoration
The non-operability of exhaust fans in the elementary and high school buildings is preventing classrooms from being properly ventilated. It is not clear how or why these fans were disabled. A mechanical contractor could be hired to investigate and restore these fans. It may not be possible to restore these fans and there is no guarantee that the original heating coils or cooling coils could maintain classroom temperature with them operational.

After restoration, the fans should be run whenever a classroom is occupied.

It is possible that these fans were disabled due to noise complaints. After restoration, classroom noise levels should be evaluated by school staff. There are national standards regarding classroom noise that any **new** installation should conform to. Operating fan noise should be measured against this standard of

NC-35 for informational purposes only.

While restoring the ventilation exhaust fans will bring classrooms into ventilation compliance, this approach is over-reliant on the occupant selecting the proper fan speed. This approach also brings unconditioned air into the classroom and will create hot or cold conditions depending on outside air temperatures. Also, these fans are more than 30 years old and have passed their expected useful life span and should not be counted on to continue operating in the long term.

New System
The best way to address ventilation across the campus is to install new heat recovery ventilators in place of the exhaust fans. These ventilators would provide tempered outside air directly to each classroom or fan coil. This ventilation strategy provides clean air to each classroom without the possibility of contamination from other indoor spaces while maximizing energy efficiency.

The sizing, location, and installation of each heat recovery ventilator should be chosen to meet airflow and noise requirements previously listed.

Equipment located in classrooms may need to be placed in sound-lined enclosures to limit radiated noise.

4. Heating and Cooling

The most cost-effective way to install cooling into all three buildings while upgrading the heating system is via Variable Refrigerant Flow (VRF) systems.

Existing heating hot water boilers would be decommissioned and removed. Domestic hot water boilers for food preparation and showers would remain.

A VRF system uses 6-foot-tall exterior condensing towers to provide hot and cold refrigerant to fan coils providing heating and cooling throughout the building.

Requirements
As with the ventilation equipment, any VRF equipment installed in the building can not generate noise in the classrooms greater than NC35.

Equipment to be sized to maintain temperature in conditioned spaces.

Fan Coil Location

Due to classroom noise level restrictions, ductless VRF fan coils may not be appropriate to place in the classroom space. Ducted fan coil units may need to be placed in the hallways and ducted into the classrooms.

Gymnasium

The majority of the Gymnasium is currently served by a large vertical air handling unit with a heating coil served by a boiler system. This would be replaced by a new air handling unit with a heat-pump based heating and cooling coil. This unit would be served by either a dedicated refrigerant condenser unit or would be incorporated onto the VRF condensing unit tower serving the rest of the gymnasium fan coil units.

If cooling needs to be added to the kitchen space in the gymnasium building before the rest of the building is converted, a split system heat pump with a wall-mounted fan coil unit could be used.

5. HVAC Cost Estimates

Current conditions in the construction marked have made reliable cost estimates difficult. Our best guess at a rough order of magnitude for each portion of this project are:

Ventilation upgrade in classrooms, all buildings: $200,000

High School VRF: $300,000

Elementary School VRF: $250,000

Gymnasium VRF with Air Handler: $350,000

6. Electrical Impacts

The three buildings were assessed to determine the accuracy of the as-built drawings. The entire campus is supplied from pole mount transformers located on the northwest side of the property. There is a single electric utility meter located between the gym building and the high school building. This meter reads the power consumption for all three buildings (elementary, gym & high school). After reviewing the utility bills for the past 12 months, the peak demand for all three buildings was 60 kW which equates to about 167A at 208V, 3 phase. The gym building and the high school building are equipped with 1600A, 208V/3-phase services, therefore these two existing services have ample capacity for any additional loads added on the HVAC systems.

The elementary school building has a 400A, 208V/3-phase service fed from the gym building. Based on the utility bills, the service should have plenty of capacity for new loads. If the net increase in the electrical load is substantially more than anticipated, a 30-day power reading may be necessary to evaluate loading.

New VRF Condensing Towers will require new dedicated circuits supplied from the nearest panel. More specifically: the elementary building would require (2) 80A, 208V, 3-phase circuits; the gym building would require (2) 80A, 208V, 3-phase circuits; and the high school building would require (2) 100A, 208V, 3-phase circuits. The electrical loads for the indoor new fan coil units and the new energy recovery units are minimal. The intention would be to utilize existing circuitry or the nearest available circuitry as much as possible. Running new circuits may be required in some cases, but this will need to be evaluated on a case-by-case basis during design.

Cost impacts from the electrical work would be incidental to the main expense of the new HVAC systems. Keeping in mind current markets are highly volatile, especially for copper wire. Therefore these cost estimates should be verified and updated by a cost estimating consultant.

- New VRF circuits (6): $65,000
- Reconnect new fan coils: $12,000
- New fan coil circuits: $29,000
- New HRV connections: $25,000
- Selective demolition: $10,000
- **Total Electrical Estimate: $141,000**