The Ballard Group, Inc.
Mechanical Consulting Engineers

Colorado Springs Charter Academy

Mechanical Systems Assessment

June 26, 2024

General:

The Colorado Spring Charter Academy has two educational buildings and a Sports Center on campus at 2577 North Chelton Road, Colorado Springs, Colorado. The K-8 building is approximately 55,000 square feet, two-story and was originally constructed in 1966. The Sports Center, on the south side of the street, is approximately 8600 square feet and was originally constructed in 1975. The Middle School building is approximately 13,400 square feet and was originally constructed in 1986 as a priory, and converted to classroom spaces around 2010.

Additionally, the school is planning a new two-story, middle school addition of approximately 25,000 sf connect to the existing Sports Center. The new addition will include entry with secured vestibule, four classrooms, science room, makers space, toilet group and administration spaces. See attached mechanical system narrative for more information regarding this new addition.

The following is a breakdown of the various mechanical systems observed with a condition assessment, our recommendations and replacement equipment narratives for each building.

Mechanical Narrative – K-8 Building

Air Distribution:

A. Existing Conditions: The facility is currently served by the following air distribution systems.

1. There are (6) indoor air handling units providing air distribution to the larger spaces such as Cafeteria, Auditorium, Computer Lab, Child Watch, Entry Lobby and classrooms 105,7&9. These units are constant speed, heating, and ventilation with ducted outside air. There is a heating coil with pneumatic controls.

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2. There are two multizone units. MZU-1 feeds underground ductwork to two zones, now classrooms 111 and 113. MZU-2 feeds underground ductwork to classrooms 101 and 103 with overhead ductwork to SPED and the Library for six zones of control.

3. Unit Ventilators provide air distribution for some of the classrooms along the south exposure on both levels but only on the second level for the north exposure. First level north classrooms are fed from the multizone units. There is a total of (16) units; five (5) on first floor and eleven (11) on second floor. They all have hot water heating coil with pneumatic controls, exterior wall louver for fresh air and appear to be original to the building. They have an original scheduled capacity of 750 cfm each.


4. There are eight (8) exhaust fans for restroom exhaust, kitchen exhaust and relief air for the classroom unit ventilators. Fans appear to be original to the building.


5. There are four (4) room units (heating only fan coils) in the administration spaces.
6. Remaining spaces, such as hallways, small offices and storage room not served by overhead air systems, are heated by the hot water systems using cabinet unit heaters, convectors, fined tube and unit heaters.
7. The kitchen cook line hood appears original to the building and now oversized for the cooking equipment currently beneath the hood. The grease duct makes a long run above the ceiling to the kitchen exhaust fan, on the west end of the building. Years of grease build up is concern given the long horizontal duct run. Hoods fire protection system is at end of life.



B. Condition:

1. The overall condition of the facility air distribution equipment is at end of useful life as most appear original to the building. Recommend all equipment should be replaced due to age and pending increasing maintenance costs.
2. The original mechanical plans do not indicate any airflow values for mechanical ventilation. From the heating coil schedule list an entering air temperature of 50°F, for this location that translates to 25% outside airflow relative to supply airflow. But no where do the original plans indicate to set the minimum outside air for the air handlers and unit ventilators. No balance report is available, and if so, would still be nearly 60 years old. The ventilation rate for this era was 5 cfm/person, today we are closer to 15 cfm/person. Minimum outside airflow is typically around 30-35% of supply airflow for schools. This is why we are recommending upsizing the unit ventilators from 750 cfm to 1000 cfm so outside air ventilation rates can be increased as needed to meet code minimum requirements. The new air handling units will be designed with larger heating coils to handle the increased outside airflow rates required.
3. Existing sheet metal ductwork observed was in fair to good condition. With professional cleaning and new sealant applied, the duct systems can be reused assuming the existing sizing is adequate for the cooling loads.
4. All the exhaust fans observed were in fair to poor condition and nearing the end of expected life.
5. Per ASHRAE Equipment Life Expectancy the useful life of fans and dampers is between 20 and 25 years depending on fan type. Many of these fan systems are approaching 60 years of age and recommend that all air handling and fan systems be replaced. See appendix for ASHRAE Equipment Life Expectancy chart with highlights of associated equipment for the K-8 building.

C. Long Term Recommendations:

1. Existing air distribution systems equipment, heating plant, and temperature controls systems all have surpassed the expected life and should be replaced including all the hydronic heating piping. New systems air handling equipment shall include chilled water coils for mechanical cooling.
2. Replace the indoor air handling units with new built-up air handling units and connect to existing ductwork. These new central station air handler units to be provided with a heating coil, chilled water coil, 30% filters, spring isolators, economizer controls and a supply fan with VFD will distribute a variable volume of conditioned air throughout the facility. The AHU will be single zone VAV. The existing multizone units will have cut-in VAV dampers with reheat coils added for temperature control.

AREA SERVED	TAG	CFM	TYPE
East CR's-1st	MZU-1	1,900	2 zones
West CR's-1st	MZU-2	4,650	6 zone
COMPUTER LAB	AHU-1	6,000	SAV
CR 105,107,109	AHU-2	3,000	SAV
ENTRY LOBBY	AHU-3	6,000	SAV
CHILD WATCH	AHU-4	2,000	SAV
CAFETERIA	AHU-5	5,500	SAV
AUDITORIUM	AHU-6	12,000	SAV

3. Replace the horizontal unit ventilators, like for like, with new units with hot water heating and chilled water coils. Provide with all new digital controls and valves. Existing wall louvers to be replaced to maximize airflow for economizer cycle, free cooling. Airflows have been increased for additional mechanical cooling be added to the system. This project to be considered a "direct" unit vent replacement with cooling added so the existing relief air path through the corridors and open stairwells can be maintained. This needs to be confirmed with local AHJ.
    i. First Level: (5) 1000 cfm
    ii. Second Level: (11) 1000 cfm
4. Replace the (4) existing fan coil units, like for like, with new units with hot water heating and chilled water coils. Provide with all new digital controls and valves.
5. Replace all Cabinet Unit Heaters (CUH), Unit Heaters (UH), convectors and fined tube radiation in the existing hallways, stairwells, toilet rooms, entries and at the building perimeter as shown on the existing 1965 mechanical plans.
6. Replace existing restroom exhaust fans and building relief fans with new. Existing exhaust ductwork shall be cleaned and sealed for reuse.
    i. (E) EF-1, ceiling, 180 cfm @ 0.25" wc
    ii. (E) EF-2, indoor utility set, 2450 cfm @ 0.38" wc
    iii. (E) EF-3, indoor utility set, 2300 cfm @ 0.38" wc
    iv. (E) EF-4, roof mounted, 400 cfm @ 0.50" wc
    v. (E) EF-5, roof mounted, 2100 cfm @ 0.50" wc
    vi. (E) EF-6, indoor utility set, grease fan, 5250 cfm @ 1.50" wc
    vii. (E) EF-7, inline fan, 850 cfm @ 0.50" wc
    viii. (E) EF-8, inline fan, 2080 cfm @ 0.50" wc

Heating:

A. Existing Conditions:

1. The building is heated from a pair of Clever Brooks power vented fire tube, gas-fired boilers which are original to the building, installed in 1966. The heating plant is installed in the original boiler room, as shown on the existing drawings. After expensive repairs, both boilers are still operational. Each boiler is listed at 4,184 MBH input. Per school facilities, only one boiler is needed to maintain the school's temperature in the winter.

2. The hydronic piping has steel mains and soft copper tubing, all heating mains appear original to the building and installed in the accessible crawlspace.


3. The boiler flues are sealed, pressure rated flues wrapped with insulation and terminates in the existing brick chimney.

4. The heating water circulation is by three base mounted pumps. Primary/standby for the central/east loop and a lone pump for the “west end” building. There are no dedicated boiler pumps so only a primary pumping system. These pumps appear to be original with various motors changed out over time.


5. Combustion air is drawn into the boiler room by a 50x24 combustion air duct in the northwest corner of the boiler room with high and low openings into the room. There is a louver to the outdoors above grade on the north façade.
6. There are four expansion tanks mounted on a metal stand behind the boilers.

B. Condition:
   1. The boiler system is operational but long overdue for replacement due to the age of all the equipment and pending increasing maintenance costs.
   2. Per ASHRAE Equipment Life Expectancy the useful life of steel fire-tube boilers is 25 years, base-mounted pumps is 20 years as well as hot water coils is 20 years. This system is approaching 60 years of age and recommend the entire hydronic heating system be replaced.

C. Considerations/Recommendations:
   1. While the heating water plant is functional, it is well past its recommended useful life and provisions shall be made for the entire system replacement. A new high efficient boiler plant is recommended.
   2. The distribution piping is original, at nearly 60 years of age a complete piping replacement is recommended.
   3. Replacement boiler system narrative:
      i. Heating Source: Provide (2) condensing boilers provided for high efficiency heating (96.2% thermal efficiency) and additional redundancy. These boilers shall be provided with external primary circulation pumps installed by mechanical contractor. System shall be designed for 150°F EWT and 110°F LWT to provide condensing efficiency throughout the heating season. Boilers

shall utilize natural gas fuel, like the existing boilers. The flue and combustion air shall be direct vented to the outside, up through the first level in a new chase and terminate sidewall. System shall be provided with 30% propylene glycol for freeze protection. Glycol feeder, chemical pot feeder, expansion tank, and air/dirt separator shall be provided with the new boiler plant.

Equipment: B-1 & 2

Capacity: (2) 3,000 MBH boilers,

Acceptable manufacturers: Lochinvar Crest

Equipment: P-1 and P-2

Capacity: 150 GPM at 25' head

Acceptable manufacturers: Bell and Gossett (B&G) or Taco

ii. Distribution: Proposed system utilizes variable flow pumping with two (2) pumps sized for parallel (lead/lag) operation. Wall mounted variable frequency drives shall modulate the speed of the secondary pumps to meet the instantaneous heating load in the building. Pumps shall be vertical inline split-coupled construction. These two building pumps will feed the entire building, eliminating the need for the single "west end" pump.

Equipment: P-3 and P-4

Capacity: 425 GPM at 75' head

Acceptable manufacturers: Bell and Gossett (B&G) or Taco

iii. All new hydronic piping shall be Schedule 40 black steel with welded or threaded or Type "L" Copper with sweat at contractor's option. All piping shall be insulated per the requirements of the 2021 IECC. Piping shall be sized for maximum 3'/100' friction loss and a maximum velocity of 8 fps. New mains shall be installed in the crawlspace along side of the existing mains. Vertical risers shall follow the same pathways as the existing piping.

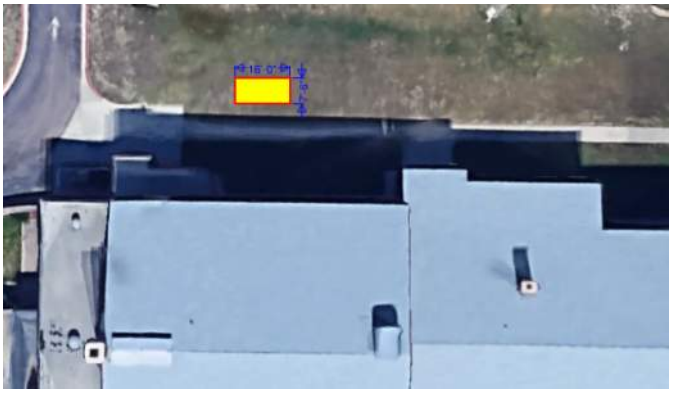
Cooling:

A. Existing Conditions:

1. The building has no mechanical cooling.
2. The original 1965 drawings indicated three alternates for a chilled water cooling system with indoor chillers and remote cooling tower, but no such equipment was found on site, so the alternate must not have been accepted.
3. Several portable cooling units were seen around the building.


B. Considerations/Recommendations:

1. Install a new chilled water system to provide mechanical cooling for the entire building. Install one (1) new 120 ton air-cooled scroll compressor chiller on new concrete pad on grade north of the existing building, far west end. Provide new chiller enclosure to secure the equipment from children. Install 5" directed buried chilled water mains from the chiller into the existing boiler room.



2. Chiller basis of design is the Daikin AGZ-F-120E. The chiller is approximately 16' long, 7.5' wide and 8' tall, unit weight is approximately 6000 lbs. Chiller to have scroll compressors and include high efficiency variable speed fan technology with R-32 refrigerant. Chiller to have a minimum of 4 feet clearance around all sides. Provide with factory BacNet MS/TP card for integration into the new control system.

3. Provide new chilled water pumps with wall mounted VFD's and accessories within the existing boiler room.

   Equipment: CWP-1 & 2

   Capacity: 300 GPM at 75' head each

4. Install new 5" chilled water supply and return lines to all the new air handling units, fan coils and unit ventilators chilled water coils as outlined above.

   a. All new chilled water piping shall be Schedule 40 black steel with welded or threaded or Type "L" Copper with sweat at contractor's option. All piping shall be insulated per the requirements of the 2021 IECC. Piping shall be sized for maximum 3'/100' friction loss and a maximum velocity of 8 fps.

   b. New chilled water mains shall be installed in the accessible crawlspace along side of the new and existing heating mains. Vertical risers shall generally follow similar pathways as the existing heating water piping.

Temperature Controls:

A. Existing Conditions:

1. The original pneumatic control system installed when the building was originally built is still in operation today. The system has been maintained well enough through the years that it remains functional.

B. Condition:

1. The pneumatic controls system appears to still be operational, with some manual operations needed to maintain space temperatures. Heating valves fail open, so when they fail, the occupants feel the results as the space becomes very hot. Finding qualified service technicians to maintain a pneumatic system is getting harder and harder as this controls technology is seldom used much anymore.
2. Per ASHRAE Equipment Life Expectancy the useful life of a pneumatic control system and pneumatic valve actuators is 20 years. This system is approaching 60 years and needs to be replaced along with all the HVAC equipment.

C. Considerations/Recommendations:

1. Provide a new Direct Digital Control (DDC) system shall provide the basis of the temperature control system. The system will be computer based and will allow for the mechanical systems to be controlled and monitored from a remote location or from within the building itself. Provide a full graphics package. All new mechanical equipment listed above shall interface with and be controlled through the new Building Automation System (BAS) system with the following exceptions:
   a. Exhaust fans for individual/remote toilet rooms.
   b. Sewage Ejector/Sump Pumps.
2. Remove all the existing pneumatic controls, compressor, piping, hangers, stats, etc.

Plumbing Narrative – K-8 Building

Utilities and Piping:

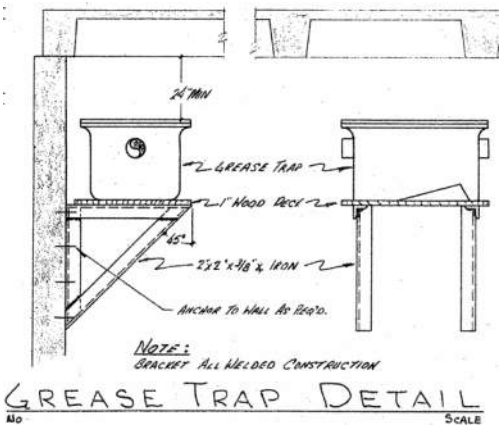
A. Existing Conditions:

1. The building is served by a 3" domestic service that enters the basement in the southwest corner of the building. The water entry backflow preventer and indoor water meter have been upgraded at some time and appear complainant with current codes. There was no pressure gauge on the water entry but water pressure at the middle school, up the hill, was over 100 psi. If pressure is over 80 psi, a pressure reducing station is required. All observed water piping in the facility appears to hard copper piping. Most all the distribution piping appears original to the build based on the pipe insulation.


2. The sanitary service is 6" in size and leaves on the south side of the building on far west end. Original piping consists of hub and spigot cast iron for above and assumed below grade. Repairs have been made with a number of different pipe materials such as PVC, CPVC, etc. The main sanitary sewer is run above grade in the accessible crawl space. Piping to the street is called out on original documents as viterous clay tile.



3. The existing grease interceptor (steel tank on shelf in mech room) has been abandoned per facility staff.



4. The VTR's on the roof are typically less than 3" in diameter per original documents.
5. Natural gas is fed from the utility gas meter on the west side of building, across the drive lane. This is a low pressure system given the 6" pipe size and no pressure regulators at each gas burning appliances.

B. Condition:

1. The original copper water piping is in fair condition. There are signs of leaks and repairs made around the building. The copper piping is past its useful life.
2. The waste and vent piping is in fair condition. There are signs of leaking joints and prior repairs made around the building. The waste and vent piping is past its useful life.
3. Natural gas piping is showing signs of age but appears to be in good working order.

C. Considerations/Recommendations:

1. Install a pressure reducing valve at the water entry into the building, set to 80 psi.
2. Replace all the original domestic water piping due to age.
3. Replace all the original waste and vent piping due to age. New vents through roof to be 3" minimum.
4. Install a properly sized grease interceptor for the kitchen.

Domestic water Heating Systems:

A. Existing Conditions:

1. The domestic hot water is provided from a natural draft, gas-fired water heater located in the boiler room. It is a Rheem/Ruud, 399 MBH at 100 gallons storage with three 100 gallon storage tanks. System appears to have been installed in 2019. There is hot water circulation system.

B. Condition:

1. The water heating system appears to be in good working order and has plenty of storage capacity.

C. Considerations/Recommendations:

1. Leave system as is.

Plumbing Fixtures:

A. Existing Conditions:

1. The toilet flushing fixtures are china type and utilize manual type flush valves with differing manufacturers through the building. Lavatories are china type, wall hung with manual type faucets of differing manufacturers and do not include point of use mixing valves. General purpose sinks are all manual style with some locations where the sink is built into the casework. Water coolers and drinking fountains are single use or high-low units, but none have water filling station. The water closets, lavatories and urinal flush valves appear to have been replaced in the 1999 mechanical upgrades.




B. Condition:

1. The fixtures seem to be operational and are in fair condition overall, but showing signs of age and wear.

C. Considerations/Recommendations:

1. Short Term:
    i. All fixtures should be tested and any damaged parts should be replaced and fixtures repaired to like new condition.
    ii. All lavatories and sinks should be provided with new stops and supplies.
    iii. All lavatories should have point of use thermostatic mixing valves installed.
2. Long Term:
    i. Remove and replace all fixtures to bring up to current code flowrates and design standards.

Mechanical Narrative – Sports Center

Air Distribution:

A. Existing Conditions: The facility is currently served by the following air distribution systems.

1. There are (2) indoor air handling units providing air distribution and gas-fired heating. One for the gym space and one for activity room and office. The gym duct distribution is by underground ductwork. The activity room has overhead ductwork with floor grilles for the upper level. The activity unit has DX cooling with a remote condensing unit.




B. Condition:

1. The air distribution equipment has been replaced with residential furnaces. The gym unit was originally scheduled at 3000 cfm, but the installed unit is not capable of that airflow. The Activity unit appears to have been replaced around 2005 and is near end of useful life.
2. Existing sheet metal ductwork observed was in good condition. With professional cleaning and new sealant applied, the duct systems can be reused.
3. All the exhaust fans observed were in fair to poor condition and nearing the end of expected life.

C. Long Term Recommendations:

1. Since equipment near end of life replacement of equipment is recommended. Replacement equipment shall be of commercial grade, not residential.
2. New equipment should have DX cooling. The air flow rate in the gym is short of capacity for a fully occupied load. Recommend that a second, new packaged rooftop unit (7.5 tons) be added on the new Middle School roof and back the existing gym with exposed round overhead ductwork to supplement the underground duct system.

Temperature Controls:

A. Existing Conditions: Each system is controlled by stand along programable thermostats.

D. Long Term Recommendations:

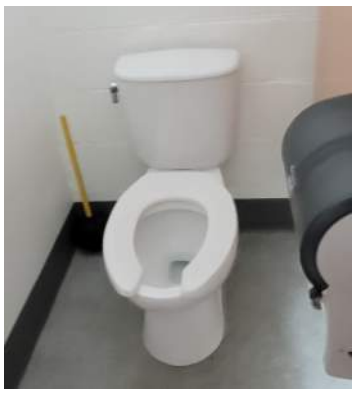
1. The new replacement equipment shall be tied into new Building Automation System on the new middle school.
2. Gas-fired heating equipment in schools are required to have CO detection. Add two CO detectors.

Plumbing System:

A. Existing Conditions:

1. The building is served by a 1" water and 4" waste line.
2. Water heater is a 40 MBH, 50 gallon Bradford White, 80% efficient, which has been installed recently.


3. Fixtures are white china with flush tank toilets.




B. Condition:

1. Piping system are original to the building, 1975.
2. Water heater is newer, but is slightly undersized for the four showers. Showers are probably not used much, so not a complaint by end users. Insulation is lacking on the water piping at the water heater.

C. Long Term Recommendations:

1. Remove the existing water service and back feed this building cold water supply from the new Middle School.
2. Given the age of the building, a complete piping replacement is recommended.

Mechanical Narrative – Middle School

Air Distribution & Heating:

A. Existing Conditions: The facility is currently served by the following air distribution systems.

1. There is one (1) heating and ventilating McQauy air handling unit in the north mechanical room. Its air distribution system is by underground ductwork to Classroom 1 & 2 and the Reception/Lobby space, west end of building. There is no mechanical cooling. Unit appears original to the 1986 build.

2. The reaming building (six classrooms and study spaces) are heated with only baseboard radiation heaters. Operable windows are used for natural ventilation.

3. There are two (2) gas-fired, 80% efficiency boilers that make the heating water for the entire building. One unit appears to be original to the 1986 build, the other replace in the late 1990's. Circulation pumps appear to be original.

4. Electric baseboard has been added to some rooms indicateding space comfort concerns from the prior design.

B. Condition:

1. The air handling unit is approaching 40 years old, and now beyond useful life.
2. Existing underground ductwork was not observed. Underground ductwork is a concern with IAQ with ground water penetration. More investigation needed.
3. All the exhaust fans observed were in fair condition and nearing the end of expected life.
4. Piping system lacks pipe insulation from prior renovations.

C. Long Term Recommendations:

1. All mechanical equipment is past useful life and should be replaced. The new mechanical system should include mechanical cooling and mechanical ventilation to all occupied spaces for better Indoor Air Quality and thermal comfort.
2. Building has been noted to have structural issues and may be demolished. If so, obviously, a mechanical replacement would not be needed.

Appendix

ASHRAE Equipment Life Expectancy chart

ASHRAE is the industry organization that sets the standards and guidelines for most all HVAC-R equipment. For additional info about ASHRAE the website is www.ashrae.org .

Equipment Item	Median Years
Air conditioners	
Window unit	10
Residential single or Split Package	15
Commercial through-the wall	15
Water-cooled package	15
Heat Pumps	
Residential air-to-air	15
Commercial air-to-air	15
Commercial water-to-air	19
Roof-top air conditioners	
Single-zone	15
Multi-zone	15
Boilers, hot water (steam)	
Steel water-tube	24 (30)
Steel fire-tube	25 (25)
Cast iron	35 (30)
Electric	15
Burners	21
Furnaces	
Gas- or oil-fired	18
Unit heaters	
Gas or electric	13
Hot water or steam	20
Radiant Heaters	
Electric	10
Hot water or steam	25

Equipment Item	Median Years
Air terminals	
Diffusers, grilles, and registers	27
Induction and fan coil units	20
VAV and double-duct boxes	20
Air washers	17
Ductwork	30
Dampers	20
Fans	
Centrifugal	25
Axial	20
Propeller	15
Ventilating roof-mounted	20
Coils	
DX, water, or steam	20
Electric	15
Heat Exchangers	
Shell-and-tube	24
Reciprocating compressors	20
Packaged chillers	
Reciprocating	20
Centrifugal	23
Absorption	23
Cooling towers	
Galvanized metal	20
Wood	20
Ceramic	34

Equipment Item	Median Years
Air-cooled condensers	20
Evaporative condensers	20
Insulation	
Molded	20
Blanket	24
Pumps	
Base-mounted	20
Pipe-mounted	10
Sump and well	10
Condensate 15	
Reciprocating engines	20
Steam turbines	30
Electric motors	18
Motor starters	17
Electric transformers	30
Controls	
Pneumatic	20
Electric	16
Electronic	15
Valve actuators	
Hydraulic	15
Pneumatic	20
Self-contained	10