HVAC STUDY

HVAC Assessment and Professional Judgement of the Existing Conditions of the Massillon Municipal Government and Justice Center

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Scope

This report is the HVAC building study of the existing conditions with long term recommendations for the existing Massillon Municipal Government and Justice Center Building and adjacent Bank building in Massillon, Ohio. It is based on our review of your existing drawings; a field visit and scope of work. It incorporates an assessment of the current HVAC systems and notes any energy improvements and maintenance items that can be made to the building.

Definitions/Abbreviations used in this Report

ASHRAE – American Society of Heating, Refrigerating, and Air Conditioning Engineers. In this report, historical data for estimated equipment service lives is used. Based on their research, ASHRAE compiled data on the 'Median Economic Service Life' of most types of HVAC equipment or the age in which the equipment may cost more to repair and maintain than to replace with new. For example, steel hot water boilers are expected to have an economic life of 25 years. This equipment may last longer with good preventative maintenance and upkeep, but in ASHRAE's research, this is the age where the data says that economically it will probably cost more to maintain and repair this existing equipment than to replace it with new.

CAV – Constant Air Volume is a type of heating, ventilating, and air-conditioning (HVAC) system. In a simple CAV system, the supply air flow rate is constant, but the supply air temperature is varied to meet the thermal loads of a space. Most CAV systems are small and serve a single thermal zone. However, variations such as CAV with reheat, CAV multizone, and CAV primary-secondary systems can serve multiple zones and larger buildings.

In mid- to large-size buildings, new central CAV systems are somewhat rare. Due to fan energy savings potential, variable air volume (VAV) systems are more common. However, in small buildings and residences, CAV systems are often the system of choice due to their simplicity, low cost, and reliability.

MZHVAC – Multizone HVAC System is a type of heating, ventilating, and/or air-conditioning (HVAC) system. Unlike constant air volume (CAV) systems, which supply a single zone at a constant airflow at a variable temperature, this system can deliver constant airflow at variable temperatures to multiple zones. The air flow for the building is split into two within the air handler, with one part being heated and one part being cooled. By generating both hot and cold air at the equipment level, the unit two airflows are then blended together with a series of linked dampers to create the right amount of heating and cooling for each space. Dedicated supply air ductwork sends this air to the dedicated zones. Also called hot deck/cold deck systems, these systems are rarely seen in new installations since the ductwork can get extensive and more energy efficient HVAC systems are available.

VAV – Variable Air Volume is a type of heating, ventilating, and/or air-conditioning (HVAC) system. Unlike constant air volume (CAV) systems, which supply a constant airflow at a variable temperature, VAV systems vary the airflow at a constant temperature. The simplest VAV system incorporates one supply duct that, when in cooling mode, distributes supply air at a constant temperature of approximately 55 °F (13 °C). Because the supply air temperature is constant, the air flow rate must vary to meet the rising and falling heat gains or losses within the thermal zone served. Often a reheat coil, usually hot water or electric resistance, is added to the VAV terminal box to provide additional level of temperature control. VAV systems provide more precise temperature control, increased dehumidification, energy saving and reduced wear than CAV systems.

VVT – Variable Volume & Temperature is a zoning system modification to a constant air volume (CAV) system that allows it to deliver a variable volume to each zone, as load dictates. It is called variable temperature because the temperature of the air supplied by the central unit varies with time. The VVT is an economical all air zone system that is ideal for many commercial jobs and works well for systems up to 25 tons of total cooling load. The system is provided with a complete factory packaged control system designed to provide multiple zones of temperature control.

Typically, the systems use a package rooftop unit for their central air source and heating/cooling capacity to the VVT boxes. Each box modulates its volume control damper in response to the zone thermostat. If in one zone the damper is starting to close, then the extra air is bypassed into a ceiling return air plenum or a ducted return. The zone airflow is variable, but the rooftop unit airflow is constant. Each box has a minimum cfm setting to ensure adequate room air circulation and outdoor air ventilation regardless of zone load reduction.

Two-Pipe HVAC Systems - A two-pipe system uses half the hydronic piping required by a four-pipe system, which results in a lower cost and a shorter installation time. The system is also more compact, reducing the space requirements of mechanical rooms. Maintenance is also simpler in a two-pipe system, thanks to the reduced number of piping fixtures and valves.

The main limitation of a two-pipe HVAC system is lack of operating flexibility. The hydronic piping circuit that runs through the building connects to either the boiler or the chiller depending on overall needs, and all building areas must operate in the same mode; heating some areas while cooling others is not possible with this system configuration.

Four-Pipe HVAC System - This system configuration uses twice as much piping as a two-pipe HVAC system, and thus it is more expensive and takes longer to install. In addition, a four-pipe system requires more space to accommodate two hydronic piping circuits that run through the building. The increased number of fixtures, valves and connection points also results in a more demanding system in terms of maintenance.

However, four-pipe HVAC systems offer performance features not available with a two-pipe system. For example, fan coils can deliver simultaneous cooling and dehumidification by using the chilled and hot water coils at the same time. The chilled water coil is used at maximum capacity to remove as much moisture as possible from the air, even if the air is cooled below the required temperature. Any excessive cooling is then compensated with the heating coil, delivering air with an acceptable temperature and humidity.

A two-pipe system does not allow this flexibility, since air temperature and humidity are fixed once it flows through the fan-coil. Increased dehumidification requires more cooling, and a higher air temperature often results in a higher humidity.

Another significant advantage of a four-pipe system is that different building areas can be cooled or heated simultaneously. It is just a matter of using the corresponding hydronic circuit in the fan-coils serving those areas.

ERV – Energy recovery ventilation is the energy recovery process of exchanging the energy contained in normally exhausted building or space air and using it to treat (precondition) the incoming outdoor ventilation air in residential and commercial HVAC systems. During the warmer seasons, the system pre-cools and dehumidifies while humidifying and pre-heating in the cooler seasons. The benefit of using energy recovery is the ability to meet the ASHRAE ventilation & energy standards, while improving indoor air quality and reducing total HVAC equipment capacity. This technology has not only demonstrated an effective means of reducing energy cost and heating and cooling loads but has allowed for the scaling down of equipment. Additionally, this system will allow for the indoor environment to maintain a relative humidity of 40% to 50%.

MERV – Minimum Efficiency Reporting Value, commonly known as *MERV,* is a measurement scale designed in 1987 by ASHRAE to report the effectiveness of air filters. The scale is designed to represent the worst-case performance of a filter when dealing with particles in the range of 0.3 to 10 micrometers. The MERV value is from 1 to 16. Higher MERV values correspond to a greater percentage of particles captured on each pass, with a MERV 16 filter capturing more than 95% of particles over the full range.

Below is a table grouping MERV values by particle size:

MERV	Min. Particle Size	Typical Controlled Contaminant	Typical Application
1-4	> 10.0 µm	Pollen, dust mites, cockroach debris, sanding dust, spray paint dust, textile fibers, carpet fibers	Residential window AC units
5-8	10.0–3.0 µm	Mold spores, dust mite debris, cat and dog dander, hair spray, fabric protector, dusting aids, pudding mix	Better residential, general commercial, industrial workspaces
9-12	3.0–1.0 µm	Legionella, humidifier dust, lead dust, milled flour, auto emission particulates, nebulizer droplets	Superior residential, better commercial, hospital laboratories
13-16	1.0–0.3 µm	Bacteria, droplet nuclei (sneeze), cooking oil, most smoke and insecticide dust, most face powder, most paint pigments	Hospital & general surgery
17-20		Deleted from ASHRAE 52.2	HEPA & ULPA

MERV Value	Filter efficiency - Particle Size		
	0.3 – 1.0 Microns	1.0 – 3.0 Microns	3.0 – 10.0 Microns
MERV 1	-	-	Less than 20%
MERV 2	-	-	Less than 20%
MERV 3	-	-	Less than 20%
MERV 4	-	-	Less than 20%
MERV 5	-	-	20% - 34%
MERV 6	-	-	35% - 49%
MERV 7	-	-	50% - 69%
MERV 8	-	-	70% - 85%
MERV 9	-	Less than 50%	85% or better
MERV 10	-	50% - 64%	85% or better
MERV 11	-	65% - 79%	85% or better
MERV 12	-	80% - 89%	85% or better
MERV 13	Less than 75%	90% or better	85% or better

MERV 14	75% - 84%	90% or better	85% or better
MERV 15	85% to 94%	90% or better	85% or better
MERV 16	95% or better	90% or better	85% or better

HEPA - High-efficiency particulate arrestance, is an efficiency standard of air filter. Filters meeting the HEPA standard require that the air filter must remove—from the air that passes through—at least 99.97% (ASME, U.S. DOE) of particles whose diameter is equal to 0.3 µm; with the filtration efficiency increasing for particle diameters both less than and greater than 0.3 µm. HEPA was commercialized in the 1950s, and the original term became a registered trademark and later a generic term for highly efficient filters. Formerly this was classified as MERV 17, but the MERV ratings from 17-20 were removed from ASHRAE Standard 52.2. There are many standards for HEPA filters, but the U.S. falls under MIL-STD-282.

<u>Existing Conditions/Current State of the HVAC system</u>

Municipal Government and Justice Building

General

The 60,000 square foot Municipal Government and Justice Building was constructed in 1974 and is a three-story building consisting of a basement level, main and second floors. The building is constructed with an ‘A’ building and ‘B’ building connected only on the basement and second floor levels. The building is primarily heated and cooled by six, multizone, indoor air handling units with hot water heat and chilled water cooling.

The building is broken into six (6) main thermal areas, one per multi-zone HVAC unit, and each area is further divided up into multiple zones. The number of zones range from 4 to 7 per unit. Additionally, there are eight, stand-alone fan coil HVAC units that provide additional zoning. Adding up the number of zones, we have a total of 44 thermal zones between all of the systems.

Although the supply air ductwork is extensive with these 44 thermal zones, the return air ductwork is minimal, utilizing the space above the lay-in ceiling as a return air plenum. This approach is common in office buildings and helps reduce first cost of the HVAC systems.

The building piping is set up in a ‘four-pipe’ configuration and in the peak cooling season the boiler is often taken offline. Correspondingly, during the peak heating season, the chiller is taken off line and the lines are drained. This strategy contributes to energy savings and provides an opportunity to perform preventative maintenance.

Chiller Plant

The primary cooling system for this building is two, air cooled chillers located on the roof of building A. The chillers are manufactured by York in May of 2000 and have a capacity of 64 tons each. The original chillers from 1974 were most likely replaced by these in the summer of 2000. These unit have 6 scroll compressors on two refrigeration circuits. These units utilize a refrigerant called HCFC-22 or R-22, which was phased out (no longer manufactured) by the Montreal Protocol Agreement in 2010. This refrigerant is available on the secondary market for the repair and recharge of existing equipment, but is extremely expensive.

Chiller #1 – all coil fins are bent over. This was probably due to a hailstorm or coil pressure washing at some point. With the coil fins damaged, the unit is not able to reject heat and is not as efficient. One of the compressors is missing an electrical cover. At a minimum, the fins will need to be straightened with a fin comb.

Chiller #2 – Same condition as chiller #1. One compressor is disconnected (most likely failed and needs replaced).

Figure 1 York Chiller on roof. Note damaged fins on coils. Second picture shows missing electrical cover and disconnected compressor.

According to ASHRAE, the air-cooled chillers can be expected to have an economic life of 20 to 25 years. At 21 years old, these chillers are at or near the end of their expected life. These units can last longer with continued maintenance, but we have reached the point in their service life where it will cost more to maintain the units than to replace them with new.

Boiler Plant

The existing boiler plant appears to be original to the building and consists of two cast iron boilers. Manufactured in 1975, these Burnham boilers are 1.5 MBTU is capacity and are equipped with North American burners of the same vintage. These burners have the dual capability of burning either natural gas or fuel oil, however the fuel oil piping not connected. The fuel oil option was most likely a redundant fuel supply in case of a natural gas interruption, but probably was not used or seldom used in its 46-year-old life. The boilers appear to be in good operating condition. According to ASHRAE, boilers of this style have an economic life of 35 years. Having exceeded the expected life by 11 years, these boilers are due for replacement.

Boilers of this vintage were approximately 75% efficient when new. Due to its age, it is most likely around 65-70% efficient. Today, modern hot water boilers range in efficiency from 92 to 98% and are equipped with microprocessor controls to match the load of the building more accurately. A significant natural gas savings would be realized by replacing these boilers with new.

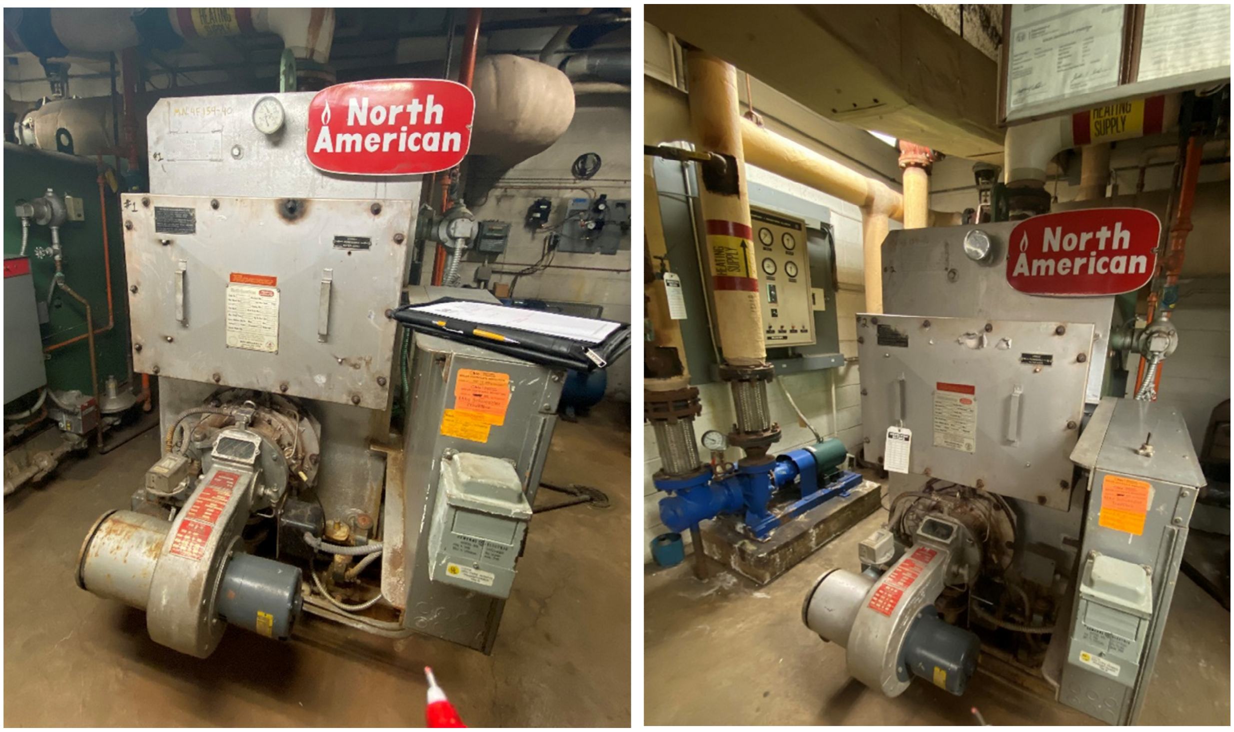

Figure 2 Existing Heating Hot Water Boilers.

Exhaust Fans

The building was originally designed with seven exhaust fans:

EF-1 – This fan is located on the roof of building A and serves the ground and first-floor restrooms in building A. This fan was not operational at the time of our visit.

EF-2 – This ceiling mounted exhaust fan serves the mayors restroom. Condition of this fan is unknown.

EF-3 – This fan is located on the roof of building A and serves the second-floor restrooms in building B. This fan was operational but is in very poor condition.

EF-4 – This fan is located on the roof of building B and serves the first-floor restrooms in building B. This fan was not operational at the time of our visit.

EF-5 – This fan is located inside of the penthouse on building B and serves the second-floor restrooms in building B. The age of this fan is not known, but it appears to be original. The motor replaced in the fan at some point and the belt opening on the fan shroud was enlarged. The belt guard is missing, and a new guard was fabricated out of wire mesh. This should be replaced with a new belt guard that is OSHA compliant. This fan is in serviceable condition.

EF-6 – This inline fan serves the pistol range. Condition of this fan is unknown.

EF-7 – This propeller wall fan is in the boiler electrical room and is controlled by a thermostat. This fan appears to be operational and in good condition.

The condition if these fans range from serviceable to poor. According to ASHRAE, the economic life of these exhaust fans is 15-25 years depending on type. All these fans have greatly exceeded their expected life and are due for replacement.

Figure 3 Exhaust fans. Note belt guard on EF-5 in the picture on the left.

Multizone Air Handling Units

There are six Multizone air handlers serving the Municipal building.

MZ-1 – This air handler is located in the basement level of building A and serves this level. This unit has 5 zones.

MZ-2 – This air handler is located in the penthouse of building A and serves the first floor of building A. This unit has 5 zones.

MZ-3 – This air handler is located in the penthouse of building A and serves the second floor of building A. This unit has 7 zones.

MZ-4 – This air handler is located in the basement level of building B and serves this level. This unit has 4 zones. The auditors and income tax areas share a zone even though they are separated by walls. The thermostat is located in income tax area.

MZ-5 – This air handler is located in the penthouse level of building B and serves the first floor of building B. This unit has 6 zones. Due to a renovation, the zones do not match the current floorplan and several spaces are haphazardly served by two zones. Two zones are manually operated due to the failure of the pneumatic operator.

MZ-6 – This air handler is located in the penthouse of building B and served the second floor of building B. This unit has 6 zones.

All of these air handlers are original to the building and have exceeded their economic life. According to ASHRAE, 25-year lifespan is expected before they become an economic burden. The pneumatic controls on all of these units are failing. Most currently work in some fashion, but replacement parts are becoming harder and harder to obtain. The units show signs of corrosion, coils have been repaired and the control valves on the heating and cooling piping shows signs of seepage.

Single Zone Air Handling Units

There is one air handling unit and eight fan coil units located throughout the building.

AH-1 – This air handling unit is located in the basement of building B. Part of the unit has been removed and the unit is no longer functional. This unit appears to serve the shooting range. If this area is still in operation, this unit should be replaced.

Figure 4 Air Handler tag AH-1. Note the missing section of the unit.

Fan coils– These eight fan coils are located above the ceiling in various room throughout the building:

FC-1 – (HR) Not operating at time of visit. Turned on and heard motor operating, but no air flow.

FC-2 – Not operational at time of visit.

FC-3 – Not operational at time of visit.

FC-4 – (Judge Elam) Not operating at time of visit. Turned on and heard motor operating, but no air flow.

FC-5 – Not operational at time of visit. No air flow.

FC-6 – Not operational at time of visit. No air flow.

FC-7 – Not operational at time of visit. No air flow.

FC-8 – (Detective) Not operating at time of visit. Flipped to occupied and turned fan to on. Appeared to operate but needs serviced. Air filter was found to be fully loaded with dust.

Like the multizone air handlers, these single zone air handlers and fan coils are original to the building and have exceeded their economic life. Most of these units have failed and all are due for replacement.

Hydronic system (pumps and piping)

There are two chilled water pumps located in the penthouse and two heating hot water pumps in the boiler room. The chilled water pumps appear to be original to the building, but the motors have been replaced. The heating hot water pumps are newer and appear to be in good condition. According to ASHRAE, base mounted pumps, such as these, are expected to have an economic life of 20 years. The chilled water pumps are in poor condition and should be replace when the chiller is replaced.

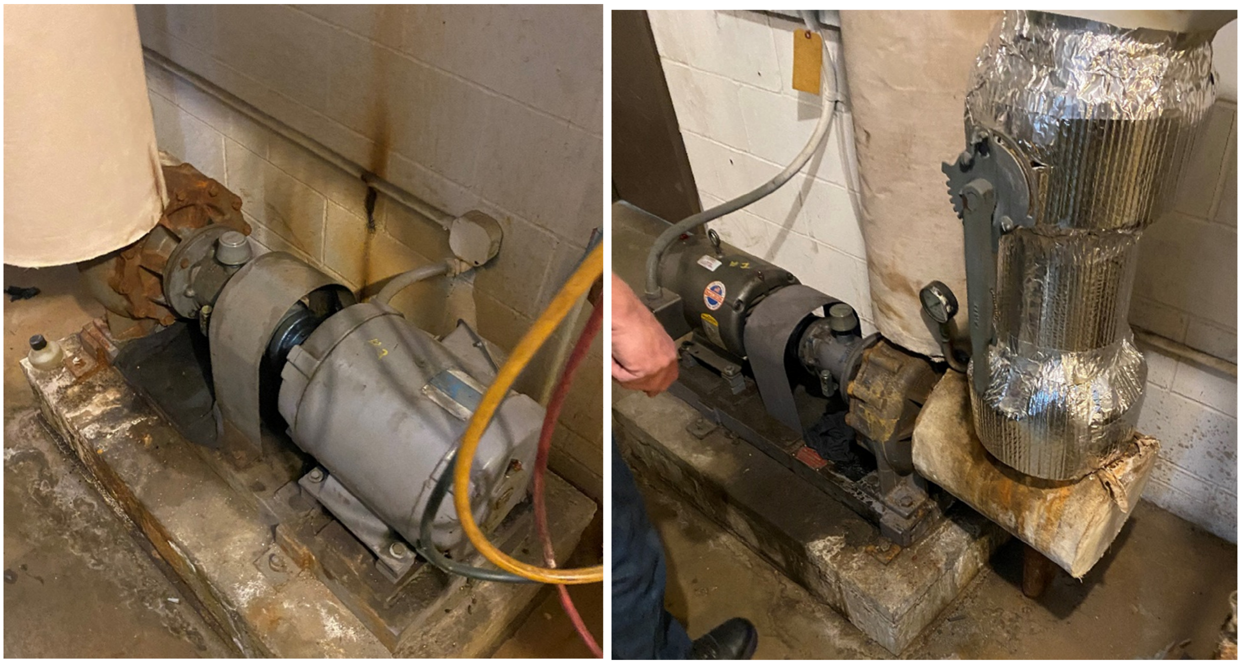

Figure 5 Chilled water pumps.

It is unknown if the water treatment has been maintained over the life of the building. The chilled water and heating hot water should be tested annually. Corrosion inhibitors and microbiological treatment needs to be maintained in order to preserve the integrity of the hydronic piing system. During a system shutdown, the inside of the piping systems should be spot examined to measure wall thickness and determine the condition of the piping. When the HVAC systems are replaced, consideration should b given to replacing the piping to ensure that it lasts as long as the new equipment.

Temperature Controls

The temperature controls are a Barber Coleman pneumatic system that is original to the building. A newer Quincy air compressor in the boiler room powers the pneumatic system and appears to be in good condition. However, the remainder of the control system has reached the end of its life. Numerous air leaks from various devices cause the air compressor to operate more than it should to maintain air pressure in the air lines. Failed zone dampers are disconnected and either fixed in position or operated manually. Control valves are leaking, and thermostats are not able to control the zones accurately.

Figure 6 Control valve and zone actuators. Note disconnected actuator – second from right.

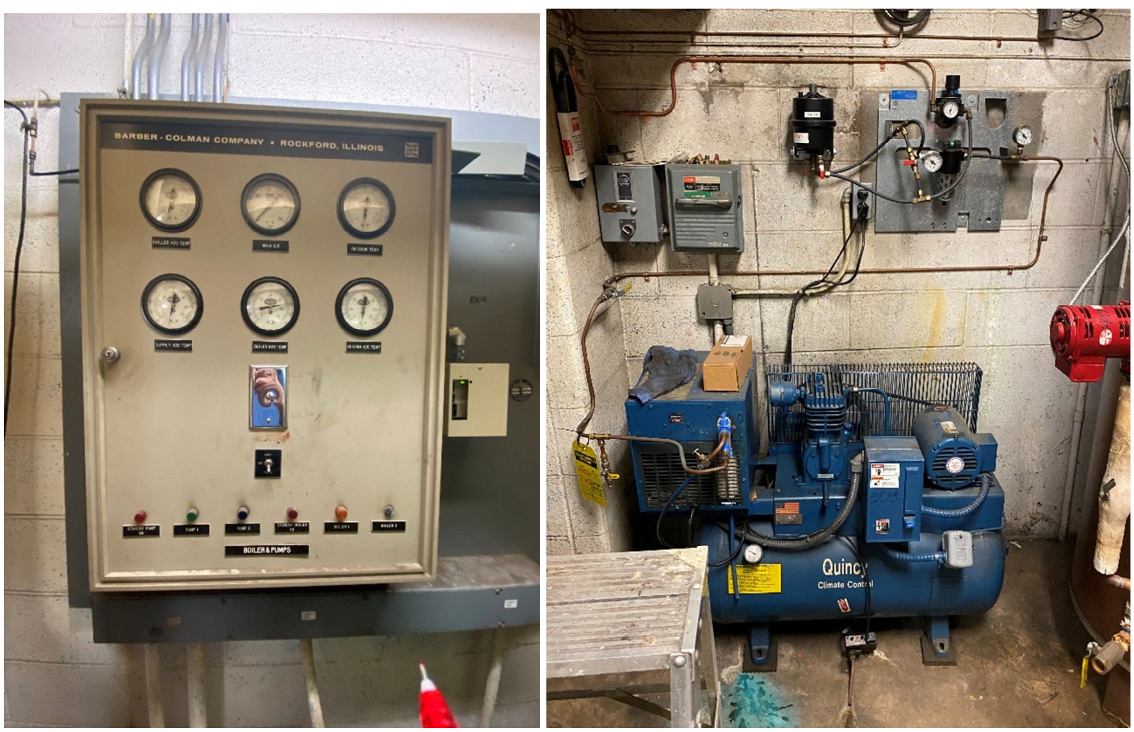

Figure 7 Pneumatic control panel and temperature control air compressor.

Ductless Split Air Conditioner

A Lennox ductless slit air conditioner was found on the roof and appears to provide additional air conditioning to a computer room or other such space. Although the equipment nameplate was severely faded and could not be read completely, this unit appears to be in operating condition. The serial number indicates that the unit was manufactured in July of 2013. The insulation around the refrigeration piping is damaged by exposure to UV rays and should be repaired. It should be anticipated that this ductless split system will need to be replaced in the next 5-10 years.

Figure 8 Nameplate of ductless split air conditioner.

Filtration

All of the air handling units use 2” pleated, MERV 8 filters. MERV 8 filters have 70-85 percent efficiency on particles that are 3 to 10 micrometers in size. In today’s Covid-19 environment, higher efficiency filters are recommended and any new or replacement equipment should consider at least a MERV level of 13. This upgrade, however, will introduce a larger air pressure drop on the system and the associated fans will need to be rebalanced to overcome this increase in static pressure.

Ventilation

The building HVAC equipment is equipped with outdoor intake dampers that once opened and closed based on building occupancy via a time clock. It is unclear from our field investigation if this part of the control system is still functional. If not functional, the dampers may be left in an open position and the building ventilated 24/7 at a large energy penalty. If the dampers are failed closed, the prescribed amount of outdoor air is not being introduced into the building, which can contribute to a poor indoor air quality environment.

If the building outdoor air is not controlled by a demand-controlled ventilation strategy, the outdoor air settings were, most likely, determined during construction by the engineer and set in the building automation system as a percentage. The outdoor air levels in the recommendations section have been calculated based on ASHRAE 62.2 minimum ventilation requirements for an office occupancy. These calculations may not match the values in the building automation system, but should be close.

The Building Automation System operates the penthouse HVAC units on a programmed occupancy schedule. During scheduled unoccupied times, the building HVAC system shuts off the outdoor air and allows the building temperatures to drift to a wider setpoint - saving energy.

Bank Building

General

Although the age is not known, the bank building appears to be considerably older than the Municipal and Justice building.

Chiller plant

A single, Carrier, air cooled chiller is located on the roof of the bank building. This unit has a capacity of 64 tons and was manufactured on the 28th week of 2009. It has some bent coil fins, probably from a hailstorm and the fins should be straightened with a fin comb. This chiller is in good condition and with continued maintenance last 20 – 25 years.

Figure 9 Bank building chiller.

Boiler Plant

Two, modular, heating hot water boilers are located in the penthouse near the main air handler. Both boilers are manufactured by Hydrotherm. Boiler #1 appears to be 10 years old and Boiler #2 was recently replaced in September of 2020. These boilers appear to be in good condition. Boiler #1 should last another 10 years and Boiler #2 should last 20 years with continued maintenance.

Figure 10 Bank building boilers.

Exhaust fans

Three exhaust fans were found on the roof of the bank building. The fans are very old, probably from the 60’s, in poor condition and not working. According to ASHRAE, the economic life of these exhaust fans is 15-25 years depending on type. All these fans have greatly exceeded their expected life and are due for replacement.

Figure 11 Bank building exhaust fans.

Air Handling Unit

The air handler serving the bank building was built into the structure as the building was constructed. It has a hot deck and cold deck design similar to the multizone air handlers in the municipal building. It has been heavily modified over the years, with the cooling coils replaced and the temperature controls modified and semi-upgraded. There is no manufacturer data plate on the air handler, so the exact age could not be determined. The unit was equipped with a Honeywell electric air cleaner that has been disabled and abandoned in place. While operational, this unit is not very efficient and considerable work has been done to keep it operation well past its economic life. This system is on need of replacement.

Figure 11 Bank building main air handler.

Temperature controls

The temperature controls for this building is pretty scary. Most of the controls appear to have been heavily modified several times over the years. These controls are pneumatic and have more than reached the end of their economic life.

Figure 11 Bank building temperature control panel.

Recommendations

With the exception of the chiller on the bank building, almost all of the HVAC equipment and temperature controls has reached the end of it's economic life and is due for replacement.

Either as a stand-alone project or part of a larger building renovation, the existing multizone HVAC system, exhaust fans, temperature controls, coilers, chillers, etc. to be replaced. There is the potential that a project of this magnitude can be installed in several phases over different budget years, but the entire project should be engineered at one time.

- Municipal Bldg - Demolish existing air-cooled chiller and associated pumps and replace with new. The integrity of the existing piping will need to be evaluated and may warrant replacement as well. This could be a standalone project.
- Municipal Bldg - Demolish existing heating hot water boiler and associated pumps and replace with new. Possibly replace the heating hot water piping if the interior of the piping is found to be in poor condition. This could be a standalone project.
- Both buildings - Demolish existing multizone air handlers, fan coils and single zone air handlers. Install new modular air handlers with energy recovery ventilators (ERV) in same location (or on the roof) with vav boxes serving each zone. These VAV boxes are to be equipped with hot water reheat coils and the existing ductwork to each zone will be reused.
- Both buildings – Demolish the existing exhaust fans and replace with new equipment. These exhaust fans to be resized per the current code prescribed exhaust requirements and unused areas deleted.
- Both buildings - Demolish the existing pneumatic temperature controls and replace with new Direct Digital Controls (DDC). A new control system will result in more efficient temperature control, energy savings and greater comfort.
- Modify existing ductwork in previously renovated areas for better zone temperature control.

Magnitude of Probable Construction Cost – $800,000 to $1,200,000.

Additional features and COVID-19 precautions to consider in replacing HVAC equipment

Upgrade the air filters from MERV-8 to MERV-13. The current MERV-8 filters have 70-85 percent efficiency on particles that are 3 to 10 micrometers in size. While this is good filtration level with low pressure drop for general HVAC use, this filtration level is inadequate for capturing viruses such as SARS-CoV-2. Reference the charts listed in the definition's section for the filtration levels at each MERV level.

ASHRAE recommends at least a MERV 13 to be efficient in capturing viruses, MERV 14 filters are preferred. MERV 13 filters have less than 75% efficiency on particles that are 0.3 to 1 micrometer in size. MERV 14 filters are between 75% and 85% efficient at the 0.3 to 1 micrometer size. When selecting the replacement filter, the initial filter pressure drop will need to be reviewed as some styles of filter have high pressure drops.

The additional pressure drop from the replacement filter will require an air balance to increase the fan speed. Measuring the fan motor current draw before and after the filter changeout will indicate if the fan is working harder. This air balance will, most likely, result in a sheave/belt change. In some cases, the fan motor may need to be upgraded. If the fan speed is controlled by a VFD, as in the case of the WVDEP and Logan buildings, the VFD speed may only require adjustment.

Additional precautions for air filter changeout during the COVID-19 pandemic are recommended by ASHRAE. Workers performing maintenance and/or replacing filters on any ventilation system with the potential for viral contamination should wear appropriate personal protective equipment (PPE): a properly-fitted respirator (N95 or higher), eye protection (safety glasses, goggles, or face shield), and disposable gloves. When feasible, filters can be disinfected with a 10% bleach solution or another approved disinfectant, before removal.

Changing the filers more frequently is not recommended. ASHRAE recommends that consideration should be given to letting the filter load up further to reduce the frequency of filter changes. As a filter loads up with particulate, the filtration efficiency increases. However, do not let the filter pressure drop further than usual as this will affect the system airflows.

Install UVGI in duct. Consider UVGI (ultraviolet/germicidal irradiation), protecting occupants from radiation, particularly in high-risk spaces such as waiting rooms, break rooms and conference rooms. This ultraviolet energy inactivates viral, bacterial, and fungal organisms so they are unable to replicate and potentially cause disease. The entire UV spectrum is capable of inactivating microorganisms, but UV-C energy (wavelengths of 100 – 280 nm) provides the most germicidal effect, with 265 nm being the optimum wavelength. The majority of modern UVGI lamps create UV-C energy with an electrical discharge through a low-pressure gas (including mercury vapor) enclosed in a quartz tube, similar to fluorescent lamps.

In this recommendation, banks of UV-Lamps are installed inside HVAC systems or associated ductwork. This system requires high UV doses to inactivate microorganisms on-the-fly as they pass through the irradiated zone due to limited exposure time. These systems typically designed for 500 fpm moving airstream so the location of the equipment is critical. The minimum irradiance zone of two feet and the minimum UV exposure time of 0.25 second.

UVGI in duct systems should always be coupled with mechanical filtration at a minimum of a MERV 8 filter for dust control. Highest practical MERV filters are recommended. The UVGI light bulbs generally have a lifespan of about 12-16 months depending on usage. After this time period, the light do not burn out, but become significantly less effective.

Install Photo Catalytic Oxidation (PCO) Air Cleaners. This air cleaning technology utilizes a process called Photo Catalytic Oxidation (PCO) to oxidizes airborne biological contaminants (mold spores, bacteria, and viruses) to a non-viable state. This PCO module, installed in the air handler downstream of the filters and coils, is comprised of bank of ultraviolet/germicidal lights (UVGI) and a catalyst of a titanium dioxide treated media. As the air passes through the air handling unit, any microorganisms present are exposed to UV radiation from the UGVI lights – penetrating the microorganisms such as fungi, bacteria, and viruses by damaging their RNA & DNA bonds, sterilizing them.

The air then passes through the PCO module – a mesh panel coated with titanium dioxide. When the UV photons hit the panel, free hydroxy radicals are created - oxidizing gaseous organic compounds (odors and VOCs). These hydroxy radicals and UV light work together to inactivate and destroy organic contaminants.

Although Trane has marketed these PCO modules for use in their equipment, they purchase them from a manufacturer called Genesis air. Below is a link to a video from Trane that visually describes the process:

https://www.youtube.com/watch?v=z3zaIBt8Opc