SWIFT COUNTY COURTHOUSE
HVAC REVIEW AND UPGRADE PLAN
Benson, Minnesota

Prepared by:

edi

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EXECUTIVE SUMMARY

In general, the building HVAC system consists of a steam boiler plant with two boilers, three air handling units, three air conditioning condensing units and pneumatic controls. With the exception of one condensing unit, all of the equipment dates to the 1970's and have far exceeded their expected service life.

There are numerous options to consider; ranging from phased approaches to complete system replacement. When considering an option, vulnerability and risk are of major concern. In our opinion, the boiler plant represents the highest risk and, as such, must be given the most attention.

There are advantages to change the boiler system from steam to hot water. Steam systems are the least efficient and require continual trap maintenance. With new hot water boiler technologies, we now have boilers that operate with efficiencies in the 90% plus range as compared to the existing steam plant which is about 70% efficient.

We have offered, in this report, a phased approach that allows the County to upgrade HVAC equipment over time based upon priorities associated with current vulnerabilities.

This phased approach includes repairing the existing leaky boiler this year to allow the boiler plant to function through another heating season. Before the following heating season, the boiler plant would be replaced with new high efficiency hot water boilers.

The following phases include air handler replacements, condensing unit replacements and a control conversion to computer based direct digital control (DDC).

At the end of the day, the goal is to have an HVAC system that is efficient, maintainable, and sustainable and provides comfort that satisfies the occupant's expectations.

INTRODUCTION

Background:

The Swift County Courthouse was originally built in 1897 and is listed on the National Register of Historic Places. The four level building contains approximately 25,000 square feet of office space and court functions.

In general, most of the HVAC equipment date back to the 1970's and include steam boilers, constant volume air handling units with hot water coils and DX cooling with air cooled condensing units.

Purpose:

The purpose of this effort is to review existing HVAC systems, comment on their condition, note observed deficiencies and offer recommendations and options to mitigate deficiencies as well as plans for future mechanical infrastructure. Systems reviewed include the heating system, cooling system, ventilation system and control system.

In addition, the building envelope will be reviewed as related to insulation and infiltration. This data will be used to determine if additional envelope enhancements are justifiable as they relate to the HVAC energy usage.

MECHANICAL - EXISTING SYSTEMS

Heating System:

The heating system consists of two low pressure Kewanee steam boilers. The burners are dual fuel and have the capability of burning either natural gas or #2 fuel oil. Natural gas is the primary fuel with oil used during any gas curtailment. The County is enrolled in the interruptible gas program which offers a reduced gas rate for the ability to curtail gas in the event of high utility demand.

Steam Boilers 1977

An underground tank, located in the south yard, provides fuel storage for the boilers. The age of the tank is unknown.

Underground Fuel Oil Tank

Live steam, generated by the boiler, is distributed to the two air handler coils located in the attic as well as an air handling unit coil located in the basement. Steam is also converted to hot water utilizing steam to water heat exchangers (convertors). There are two convertors. One convertor serves the adjacent Law Enforcement Center (LEC) and the other convertor serves convectors located in the courthouse toilet rooms. A small gas fired hot water boiler is connected to the LEC heating loop to provide heating water to the LEC in the event that the steam boilers are not in service.

Airside Systems:

Three air handler units serve the courthouse and were installed in the 1970's. Two are located in the attic and are denoted as S-2 and S-3. One unit is located in the basement and denoted as S-1. Areas served are as follows:

S-1: Single zone unit serving basement, level 1.

S-2: Multi-zone unit serving level 2 with 6 zones.

S-3: Multi-zone unit serving level 3, 4 with 6 zones.

These air handlers provide heating (steam coils), cooling (DX coils) and ventilation to their respective zones.

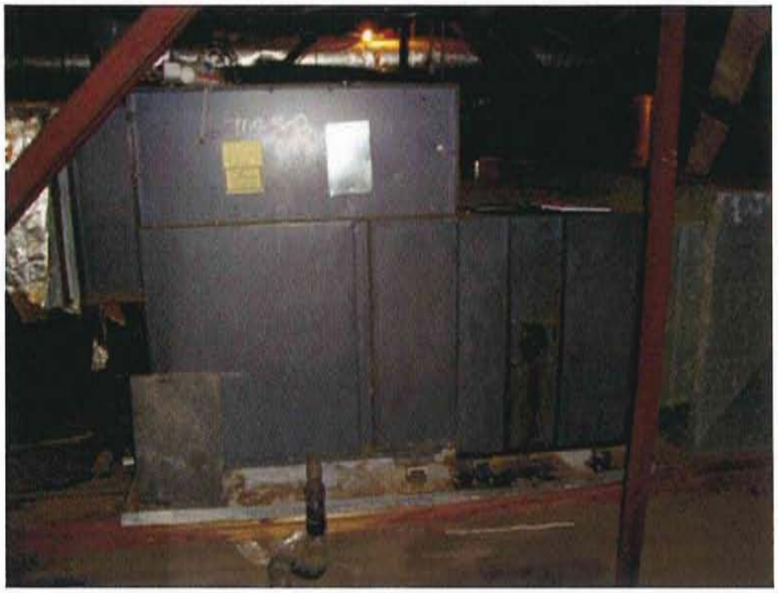
S-2 and S-3 are multi-zone units that have a cooling cold deck and a heating hot deck. Dampers and controls divert the airstream to either the hot deck or the cold deck based upon the zone requirement.

All of the air handlers deliver air at a constant rate of flow. There are no provisions to reduce the quantity of airflow, by reducing the fan speed, during periods of low building demand.

Outdoor air (OA) is introduced into each air handling unit for ventilation. Dampers located in the outdoor air duct and the return duct can be utilized to control the quantity of OA introduced.

Air Handler S-1 Serves Basement, Level 1

Air Handler S-3 in Attic, Serves Level 3



Air Handler S-2 in Attic, Serves Level 2

Three air-cooled condensing units are located on grade and reject heat absorbed from the spaces. Each is connected to their respective air handler DX cooling coil with refrigerant piping.

Air-cooled Condensing Unit that Serves S-1 Basement Unit

1977

Ductwork is routed from the attic air handlers to the various zones. The ductwork is insulated with fiberglass blanket.

Insulated Attic Ductwork

Exhaust fans provide general exhaust for toilet rooms and other spaces. The exhaust fans are located in the attic.

Exhaust Fan In Attic

Control System:

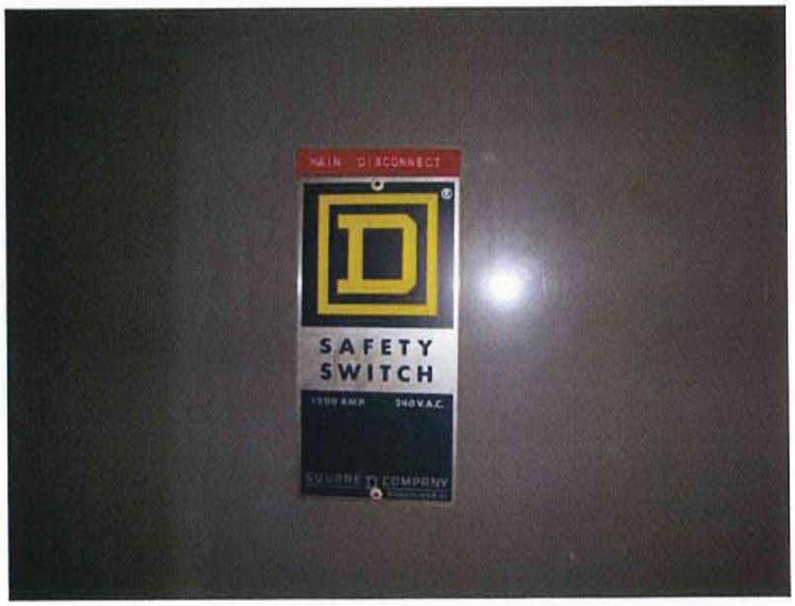
The control system consists of pneumatic control with an air compressor, located in the basement, providing air.

Air Compressor for Control System

Basement Control Panel

ELECTRICAL - EXISTING SYSTEMS

The facility is served with a 1200 amp 240 volt service.



Main Disconnect

Distribution Panels

The electrical service is in excellent condition with adequate power to accommodate any mechanical upgrades to the facility.

MECHANICAL - EXISTING CONDITIONS

Heating System:

The boilers date back to the 1970's. The median service life expectancy for fire-tube steam boilers is 25 years, based upon ASHRAE data. These boilers are approximately 35 years old.

There have been numerous repairs on these boilers over time. We have record of significant repair work stamped on the boiler housing for 1995, 2003 and 2004.

Currently one of the boilers is leaking water. It appears that the leak is at a weld in the mud leg. This leak will need to be repaired before it can be deemed operational.

Boiler Leak

Underground Fuel Oil Tank:

We were not able to determine the age of this tank; however it is possible that it dates back to the boiler installation of the 70's. Since the system does not have a leak detection system or double wall monitoring abilities, it is impossible to determine the tank integrity by observation. This item needs to be addressed by testing the soils to confirm the tank integrity. Consideration must be given to tank removal and possibly an alternate source of back-up fuel.

Air Handling Units:

As previously mentioned these units were installed in the 70's and are generally in fair condition. The median service life expectancy for fans is 25 years and for coils (steam and refrigerant) 20 years, based upon ASHRAE data. These units have far exceeded their life expectancy.

The basement unit is quite noisy. The other two units are located in the attic and are subjected to temperature extremes that may range from 10F to over 110F. These units were designed originally to be indoor units and do not have features such as thick insulation for these conditions. Considerable amounts of air leakage through the unit casings were also observed. In addition, the spaces served by these unit experience loud air noises through the diffusers.

The systems are constant volume with a fixed quantity of zoning capability. A considerable energy saving strategy would be to replace these units with a variable air volume system that only delivers the amount of air required to serve the building load by modulating the fan speed.

Exhaust Fans:

The exhaust fans serve two purposes. They exhaust the toilet rooms and remove excess outdoor air that has been delivered to the building by the air handling units. None of the fans were observed to be running. They appear to be dated to the 1970's similar to the other HVAC equipment.

The median service life expectancy for fans is 25 years based upon ASHRAE data. These units have far exceeded their life expectancy.

Control System:

The control system is pneumatic. With the advancement of electronics, these systems are no longer installed. The transition between pneumatic control and current computer-based direct digital control (DDC) technology occurred about 20 years ago.

The current pneumatic control system is problematic at best. The following was observed:

1. Occupied/unoccupied modes of operation are manually switched. When the switch is positioned to occupied, the outdoor air (OA) damper opens fully. This will introduce more OA then required for normal operation and is a large energy burden since that air must be either heated or cooled depending on the season.
2. No scheduling observed.
3. The control system most likely enables the exhaust fans. Since the fans were not operating, controls may be a factor.
4. Economizer dampers not operating. The intent of these dampers is to modulate the return air and the outdoor air at the respective air handler to allow more outdoor air into the building when the outdoor air is favorable. For example: when the outdoor air temperature is 60F, use it to cool the building in lieu of enabling the mechanical cooling system (compressors).
5. Only one thermostat serves the entire basement. Others were visible but not operational. It is our understanding they controlled fin-tube radiation that was removed years ago.

Consideration should be given to the conversion of pneumatic controls to direct digital controls (DDC).

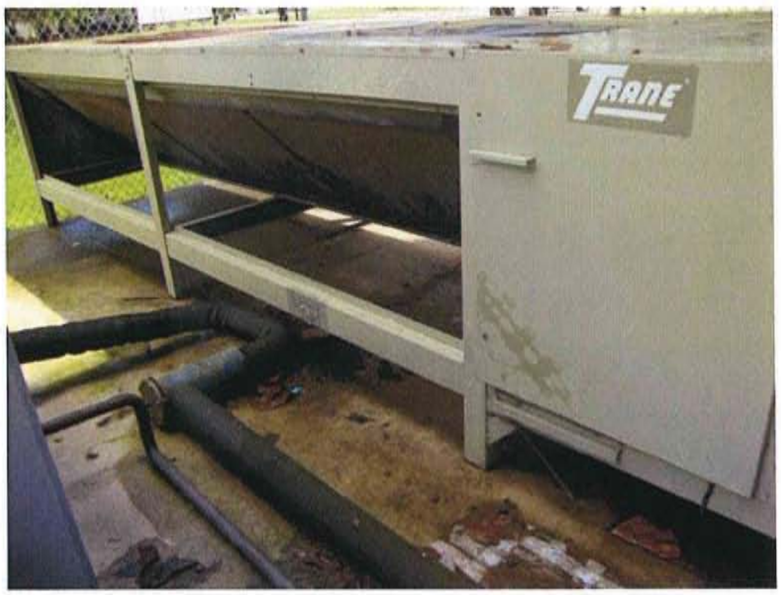
Attic Ductwork:

The insulation has deteriorated in multiple places. If the ductwork is to remain, the ductwork insulation would need to be repaired or replaced.

Air-cooled Condensing Units:

Two of the three units date back to the 70's when the other HVAC equipment was installed. The basement condensing unit is connected to S-1 and is 35 plus years old. The same can be said for the S-2 condensing unit. The condensing unit connected to air handler S-3 was installed in 2008 and is in excellent condition.

The median service life expectancy for compressors is 20 years, based upon ASHRAE data. The two units installed in the70's have exceeded that life expectancy.



Air-cooled Condensing Unit Serving S-2 (Second Level)

CODE COMPLIANCE AND INDOOR AIR QUALITY

The State of Minnesota has included ASHRAE Standard 90.1-2004 with amendments into the State Commercial Energy Code. The Standard is titled "Energy Standard for Buildings Except Low-Rise Residential Buildings". This code includes, for example, requirements for equipment efficiency, control strategies and insulation for ducts and piping.

The State has also included in the Mechanical Code ASHRAE Standard 62.1-2004 with amendments. This Standard is titled "Ventilation for Acceptable Indoor Air Quality". This code includes requirements for ventilation to insure proper indoor air quality.

Both of these codes are relative to this project.

Some relevant ASHRAE 90.1 requirements that do not currently exist are as the follows:

1. Off-hour controls, programmed scheduling and automatic shutdown.
2. Boiler supply water temperature re-set.
3. For multiple boilers, provide supply water isolation valves.
4. Ventilation controls for high-occupancy spaces.
    a. Spaces larger than 500 sq ft require carbon dioxide monitoring to control outdoor air quantities.
5. Duct sealing.
6. Air economizers to use outdoor air for cooling when it is favorable.
7. Low-leakage dampers.

In terms of indoor air quality, ASHRAE 62.1 provides a prescriptive approach to insure acceptable indoor air quality.

In general, the standard assigns a cfm per sq ft rate for each square foot of the building and a cfm per person rate. The sum of these two is the total required for the zone, with the sum of the zones equaling the total for the air handling unit.

The idea is to only introduce the quantity of outdoor air into the building that is required. Any more than required consumes energy to condition that air; any less then required is non-compliant and compromises the air quality. Typically control strategies are implemented to mitigate this challenge.

Currently, all of the existing air handlers have outdoor air dampers that are either fully open or fully closed depending on which position the switch is manually set.

One other item noted during the site visit was the rating between the attic and the space below. Typically this is a rated construction with fire dampers at the ceiling attic penetration. Dampers do exist, however there are numerous opening through the attic floor that are not protected.

MECHANICAL OPTIONS FOR CONSIDERATION

The following include options for consideration and a summary table for comparison.

Option 1: Repair Existing Steam Boiler

One of the existing steam boilers developed a leak last March. It appears that the leak is at a weld in the mud leg. Leak will need to be welded by a certified welder.

Engineers Opinion of Probable Costs: $3000.00

Option 2: Replace Existing Steam Boiler

Replace the existing leaky steam boiler with another steam boiler of similar capacity. Steam would remain as the heating source. It would be recommended that the new steam boiler be capable of conversion to hot water in the future. This boiler would be selected to fit through the roof access door. Existing control system remains.

Engineers Opinion of Probable Costs: $80,000.00

Option 3: Replace Both Existing Steam Boiler

Replace both existing steam boilers with steam boilers of similar capacity. Steam would remain as the heating source. It would be recommended that the new steam boilers be capable of conversion to hot water in the future. These boilers would be selected to fit through the roof access door. Includes boiler feed pumps and receiver. Existing control system remains.

Engineers Opinion of Probable Costs: $170,000.00

Option 4: Replace Existing 10 ton Condensing Unit Serving Basement

This option is just the condensing unit replacement only with the basement air handling unit retained. The project would be similar to the 3rd level condensing unit replacement project that was previously completed in 2008. Existing control system remains.

Engineers Opinion of Probable Costs: $20,000.00

Option 5: Replace Existing 30 ton Condensing Unit Serving Second Level

This option is just the condensing unit replacement only with the second floor air handling unit retained. The project would be similar to the 3rd level condensing unit replacement project that was previously completed in 2008. Existing control system remains.

Engineers Opinion of Probable Costs: $50,000.00

Option 6: Replace Existing Steam Boilers with High Efficiency Hot Water Boilers

This option converts the heating system from steam generating to hot water. It allows the introduction of high efficiency condensing boiler technology for heating purposes. This option requires the steam coils in the three air handling units to be replaced with hot water coils and steam piping from the boiler room to the attic to be replaced with hot water piping.

The boilers would need to be dual fuel to remain in the interruptible gas curtailment program. Since the fuel oil tank is aged and of unknown condition, this option includes removing the underground tank and providing LP gas as a back-up fuel source with an LP tank either above ground or underground. This choice of fuel is based upon the fact that a natural gas/LP boiler is much less expensive than a natural gas/oil high efficiency hot water boiler.

The existing air handlers would remain as well as the existing control system.

Engineers Opinion of Probable Costs: $325,000.00

Option 7: Replace Existing Exhaust Fans

Engineers Opinion of Probable Costs: $6,000.00

Option 8: Replace Existing HVAC System with Hot Water Heating and DX Cooling

This option includes the replacement of the following:

1. Steam boilers replaced with high efficiency hot water boilers. Steam piping replaced with hot water piping.
2. Underground fuel oil tank replaced with LP tank/system.
3. Replace all three air handlers and associated coils. Provide variable air volume VAV system and new ductwork.
4. Replace the two remaining old condensing units.
5. Replace pneumatic control system with direct digital controls (DDC).
6. Replace the exhaust fans. Ductwork to remain.

Engineers Opinion of Probable Costs: $1,125,000.00

Option 9: Replace Existing HVAC System with Geothermal Heat Pump System

This option includes water-to-air heat pumps for zone control and a geothermal bore field. Since the site has limited space for a bore field, it is proposed that each bore be drilled to a depth of 350 ft. This depth would minimize the quantity of bores and property required to meet the building demand. It is anticipated that 35 bore, spaced approximately 15-20 feet apart would be required.

The bore field could be located in the parking lots and/or the lawn area. If in the parking lot, paving would need to be re-done; if in the yard, landscaping would need to be addressed.

There are numerous mature trees on the site which would need to be worked around. A rule of thumb is to not disturb any ground under the span of the branches.

Indoors, it is anticipated that 24-30 water-to-air heat pumps would be required. Each heat pump would be dedicated to a comfort zone. These units could be located in the attic, basement and suspended ceiling plenums. Fluid from the bore field would be connected to each of the heat pumps. The heat pumps would either reject heat to the bore field or absorb heat from the bore field.

Ventilation (fresh air) that is required for the building would be introduced into each heat pump from a dedicated outdoor air system (DOAS) equipped with energy recovery.

Engineers Opinion of Probable Costs: $1,235,000.00

If it is the desire to pursue geothermal further, the first step is to perform a thermal conductivity test. This test includes the drilling of one bore to 350 feet. This bore will verify the geology and will be used to test the thermal performance of the bore. The resulting data is then used to design the field and solidify the bore field cost. The bore is not wasted and would become one of the active bores if this choice of system is chosen.

Engineers Opinion of Probable Costs for the Test Bore: $8,800.00

Option 10: Replace Existing HVAC System with Heat Pump System Utilizing a Boiler and Fluid Cooler

This option is the same as option 9 except that in lieu of a borefield, a boiler and fluid cooler is utilized. In this system, the temperature of the water in the loop feeding each heat pump is controlled by the boiler and fluid cooler. If the loop temperature drops below setpoint, the boiler adds heat. If the loop temperature rises above the setpoint, the fluid cooler rejects the heat and cools down the loop.

This system could be converted to a geothermal system in the future quite easily.

In addition, this option is negates the issue of access to the attic for equipment as multiple heat pumps are much smaller than a larger centralized air handling room.

Engineers Opinion of Probable Costs: $1,100,000.00

HVAC SYSTEM COMPARISONS

SYSTEM OPTION (#)	MEDIAN SERVICE LIFE (YRS)	INSTALLATION COSTS	REBATES	$ ANNUAL ENERGY SAVINGS	% ANNUAL ENERGY SAVINGS
1. Repair Leaky Boiler	Exceeded	$3,000	NA	NA	0
2. Replace Leaky Steam Boiler	25 for new boiler	$80,000	$1,300	$1,050	5.5
3. Replace Both Steam Boilers with Steam	25	$170,000	$2,600	$2,200	11.6
4. Replace 10 ton Condensing Unit	20	$20,000	$500	$325	1.7
5. Replace 30 ton Condensing Unit	20	$50,000	$1,500	$875	4.6
6. Replace Steam Boilers with High Eff HW Boilers	25-35	$325,000	$6,600	$3,350	17.6
7. Replace Exhaust Fans	25	$6,000	NA	NA	0
8. Replace HVAC with Hot Water Heating and DX Cooling	25-30	$1,125,000	$8,600	$7,750	41
9. Replace HVAC with Geothermal Heat Pumps	19	$1,235,000	$13,000	$9,550	50.1
10. Replace HVAC with Heat Pumps and Boiler/Fluid Cooler	19	$1,100,000		$1,550	8.1

Notes:
1. Installation costs are the Engineers opinion at probable costs.
2. Rebates are based on current programs. Option 10 is not listed in the program, but is eligible for rebate.
3. Fees for professional design services are not included in the construction costs. These typically range from 9-10% of the construction costs and is in addition to the costs listed above.

RECOMMENDATIONS

If a phased approach is desired we recommend the following:

Phase I: Repair the existing leaky boiler. This will allow time to properly design and bid a new boiler system for the long term. In addition, troubleshoot the reason why the exhaust fans do not work. $3,000.00

Phase II: Replace existing steam boiler plant with a high efficiency hot water boiler system. Replace the steam coils in the air handlers with hot water coils. $ 325,000.00

Phase III: Replace air handlers and associated condensing units, ductwork and control system. $ 800,000.00

SCHEDULES AND CONSTRUCTION PHASES

The recommended phased approach schedule is as follows:

Phase I

Before November 2013: Repair leaky boiler and troubleshoot existing exhaust fans.

Phase II

August -November 2013: Design phase for bid documents associated with the steam to water boiler plant replacement.

December 2013: Bidding phase.

January 2014: Receive bids, complete Contracts with successful bidder.

February-May 2014: Shop drawings and equipment orders.

June 2014: Commence work at site.

September 2014: Substantial Completion and punch list.

October 2014: Owner training and closeout documents.

Note: No disruption to occupied spaces.

Phase III

Summer-Fall 2014: Design phase for bid documents associated with the air handlers, condensing units, ductwork and controls replacement.

October 2014: Bidding phase.

November 2014: Receive bids, complete Contracts with successful bidder.

December -February 2015: Shop drawings and equipment orders.

April 2015: Commence work at site.

June 2015: Substantial Completion and punch list.

July 2015: Owner training and closeout documents.

Note: For Phase III work, one floor will need to be vacated at a time for a period of approximately 4 weeks.

An example of a schedule for the geothermal option:

Bid Package 1:

Fall - Winter 2013-2014: Construction of the geothermal borefield.

Bid Package 2:

August -November 2013: Design phase for bid documents associated with the steam to water boiler plant replacement.

December 2013: Bidding phase.

January 2014: Receive bids, complete Contracts with successful bidder.

February 2014: Shop drawings and equipment orders.

April 2014: Commence work at site.

July 2014: Substantial Completion and punch list.

August 2014: Owner training and closeout documents.

Note: At minimum, one floor will need to be vacated at a time for a period of approximately 4 weeks.

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Information on this topic will be distributed Tuesday, July 16.