VILLAGE OF MCFARLAND

Library Board

NOTICE OF PUBLIC MEETING

Monday, March 20, 2023 **5:15 PM** **E.D. Locke Public Library**

AGENDA

1. CALL TO ORDER
2. PUBLIC APPEARANCES AND COMMUNICATION
3. ACTION ITEMS
4. INFORMATION ITEMS
5. ITEMS FOR DISCUSSION AND POSSIBLE ACTION
   a. HVAC Engineering report review
   b. Boiler Replacement and Relief Fan quote
6. ADJOURNMENT

Any person who has a qualifying disability as defined by the Americans with Disabilities Act that requires the meeting or materials at the meeting to be in an accessible location or format should contact the McFarland Municipal Center at (608)838-3153, 5915 Milwaukee Street, McFarland, Wisconsin, or village.clerk@mcfarland.wi.us by 2:00 p.m. at least 5 business days prior to the meeting so that any necessary arrangements can be made to accommodate each request. If the meeting or request is less than 5 business days from the meeting, requests for accommodations may still be made and reasonable efforts will be made to accommodate each request.

JDR ENGINEERING, INC.

E.D. Locke Public Library
HVAC Systems Study

JDR Project No. 22.0416

Prepared for:

E.D. Locke Public Library
5920 Milwaukee Street
McFarland, WI

Submitted by:

JDR Engineering, Inc.
5525 Nobel Drive, Suite 110
Madison, Wisconsin 53711
(608) 277-1728

03/17/2023

built on INTEGRITY, TRUST *and* LOYALTY

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ACKNOWLEDGEMENTS

PROJECT TEAM

E.D. Locke Public Library
Heidi Cox, Director
(608) 838-9030
hcox@mcfarlandlibrary.org

Engineers
JDR Engineering, Inc.
5525 Nobel Drive, Suite 110
Madison, Wisconsin 53711
(608) 819-0171

Principal:	Robert C. Stone, P.E., LEED-AP stone@jdreng.com
HVAC Engineer:	Brian R. Elmer elmer@jdreng.com

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A. INTRODUCTION

PROJECT BACKGROUND AND SCOPE

JDR Engineering was invited on behalf of Heidi Cox, director of E.D. Locke Public Library, to visit the site and review some HVAC system deficiencies that they wanted to be investigated for remediation. The library's main concerns revolved around temperature/humidity control issues across a significant amount of the building, over-pressurization of the building creating security issues, and deficiencies within the hot water system and boiler plant operation. Most of the issues are a function of inadequate system design and installation of the original construction which have led to comfort issues and costly maintenance and/or replacement procedures beyond what would be considered normal.

Acting on behalf of E.D. Locke Public Library, JDR Engineering conducted this study of the building that comprises the library located at 5920 Milwaukee Street in McFarland, Wisconsin.

This report is intended to review the existing components of the heating plant and air handling systems serving the E.D. Locke Library and to provide schematic level recommendations regarding system(s) type, age, install, and condition for the library consideration for remediation. Opinions of probable construction cost are not included as these are being provided for each recommendation by the library's HVAC service contractor.

This report will provide descriptions of the existing heating systems based upon review of existing construction documents, discussions with facility staff, discussions with the HVAC service contractor (JM Brennan), and on-site field survey(s).

SUMMARY OF DEFICIENCIES & RECOMMENDATIONS

The following summarizes the recommendations made in the report:

1. Hot Water System Recommendations
    a. Properly size boilers with provisions for future capacity.
    b. Modify primary/secondary distribution pumping.
    c. Modify boiler plant piping to improve flow and efficiency.
    d. Establish water flow requirements for all hydronic equipment.
2. Air Handling System Modifications
    a. AHU-1
        i. Modify the return air and relief air ductwork at AHU-1 to address both system operating and building pressure issues.
        ii. Add balance valve to 3-way valve bypass line.
        iii. Establish airflow setpoints (maximum/minimum/heating) for VAV boxes and implement through DDC control system.
    b. AHU-2
        i. Re-pipe the heating coil to allow proper heating operation.
        ii. Add reheat coil to allow for humidity control.
        iii. Add a humidistat to the multi-purpose room and develop a dehumidification control sequence.
3. Update DDC control programming to verify equipment operating setpoints and sequences of operation.
4. Re-balance all air and water systems

B. BUILDING SUMMARY

BUILDING DESCRIPTION

The existing library consists of a one-story building, steel frame structure with masonry/brick, and precast concrete components. The building was originally designed to allow for a second story to be added in the future. Provisions within the HVAC hot water heating plant shall be maintained to allow for this future addition. The library was originally built in 2006, totaling approximately 17,800 square feet.

The building is served by two main air handling units, each with a corresponding outdoor air-cooled condensing unit. One large air handling unit (AHU-1) located on a mechanical mezzanine serves the majority of the building, including the main library spaces, study rooms, and staff workspaces. A smaller, second air handling unit (AHU-2) suspended in a mechanical room supplies air to the large meeting/multi-purpose room and the lobby area. The building's primary heating is provided by a hot water boiler plant located in a first floor mechanical room. The heating system supplies hot water via pipe distribution to the air handling unit heating coils, a radiant underfloor system, and other terminal heating devices located throughout the building.

The following includes a more detailed breakdown of the different HVAC systems within the building, including the specific equipment and system components that were evaluated.

HVAC SYSTEMS SUMMARY

Air Handling Systems

The building is served by (2) main air handling units. One large Carrier unit is located on the upper mezzanine above the boiler room. The unit supply fan is on a variable frequency drive (VFD). The unit is equipped with cooling via direct expansion (DX) refrigerant coils connected to a Carrier air cooled condensing unit outside the building (on grade). The condensing unit was replaced in or around 2020 and is observed to be in good operating condition. The air-handling unit is equipped with a hot water heating coil with a circulating pump served by the central hot water plant within the building. Outside air for the unit is introduced via an intake hood located on the roof, which is in good condition. The original design included a return fan that was intended to serve the return air, relief air, and control building pressure. However, the fan has been decommissioned due to poor performance issues related to noise and vibration almost from the day the building opened. A section of 30"x24" return ductwork running parallel to the fan was added underneath to "bypass" the fan and create an alternate return air path back to the air-handling unit. However, it has been determined by JDR in the field that, given the current system airflow requirements, the ductwork is significantly undersized and does not represent a final solution to the over-pressurization problem within the building. JDR also documented in the field that a hole had been manually cut in the top of the main relief air ductwork in an attempt to "quick-fix" the building over-pressurization problem. However, the return air system within the building is ducted (not a plenum), and thus the air does not have a way of getting to the relief opening, which defeats the intent of this approach.

Air handling unit AHU-1 supplies air to the majority of the building, including the main library spaces, study rooms, and staff workspaces. Thermal zoning and temperature control of these spaces is provided by multiple variable air volume boxes equipped with hot water reheat coils located downstream in the distribution of ductwork. Hot water is supplied to the reheat coils from the central hot water heating plant. The current VAV boxes and building zoning are observed to be appropriate and in good condition.

A second air handling unit (AHU-2) is located in a mechanical closet off of the main lobby area, suspended from the structure. The unit has a constant volume supply fan, a heating coil supplied by the primary hot water system, and a DX cooling coil with refrigerant piping connected to a remote condensing unit. Outside and relief air for the unit are achieved through sidewall-mounted outside air and relief air louvers.

The unit supplies air to the main lobby/foyer area and an adjacent large meeting/multi-purpose room. According to facility staff, there are ongoing complaints related to thermal comfort in both spaces. Based on the frequent changes in occupancy/use of the multi-purpose room, the unit tends to overheat/overcool the foyer a lot. Additionally, with limited capacity control on the unit, the meeting room often gets drafty during cooling stages, and the space temperature "hunts" above and below the setpoint. JDR also identified in the field that the unit cooling coil is located downstream of the heating coil, which will contribute to the humidity control issues in the space. Lastly, there is a concern that the pumped heating coil is piped incorrectly, which could also be contributing to the heating performance issues. The heating coil piping configuration should be reviewed again to determine if this is the case.

Exhaust Systems
There are (4) existing exhaust fans serving the building. The main toilet rooms off the lobby area each have ceiling exhaust grilles ducted to an inline exhaust fan pulling air from the spaces and discharging through a soffit grille on the building exterior. Two (2) individual ducted ceiling exhaust fans serve the single toilet rooms off the children's library and staff workroom, which are routed through the north exterior wall and terminated with a duct cap. One (1) ducted ceiling exhaust fan serves the breakroom, which is routed through the north exterior wall and terminated with a duct cap. There are no known concerns with any of the exhaust systems currently.

Boiler Plant / Hot water System
The central boiler plant serves as the primary heating source for the building. The system includes (2) Harsco Patterson-Kelley gas-fired hot water boilers, model C-1050, with an input capacity of 1,050 MBH. They currently operate in a lead-lag. It has been noted that the pump motors have been replaced frequently.

There are (2) secondary Taco pumps running in parallel with each other and in series with the boilers. Each pump has a VFD, however, it is unclear how they are controlled. According to facility staff, there was significant noise from the pumps during operation, requiring additional support from the wall to minimize this effect. The pump motors have been replaced frequently due to excessive vibration and flow issues.

The hot water system has an air separator, expansion tank, and make-up water line with backflow preventer. All three components are in good condition. A chemical feeder was added to the system due to concerns of calcification in hot water pipes. The system had previously been operating without water treatment for 12+ years.

A gas-fired humidifier exists in the mechanical room. However, it has been taken out of service and abandoned in place due to calcification from receiving non-softened domestic water and a lack of regular maintenance.

Hot Water Radiant In-floor
The building has a radiant underfloor system, which is supplied off the primary hot water system. There are approximately ten (10) manifolds located throughout the building behind access panels. It is unclear how the system is controlled, and it was observed that not all manifold control valves seem to open for a typical heating design day. Additionally, facility staff mentioned during the site visit with JDR that there seems to be no radiant floor covering the kitchenette and storage room off the large meeting room as the floor is cold back there. The original design documents do not clearly indicate the extent of the radiant floor system.

DX Split System
An AC unit serves the existing Server Room, with an air-cooled condensing unit located outside. The system is observed to be in good condition.

Controls
The building has an online Carrier i-Vu system but provides very little information about the building control system in general. Real time tracking of VAV setpoints and space temperatures could be observed in the past but there is little information on the primary heating system and air handling systems. The library's HVAC service contractor is working to restore the trending and control schemes within the system.

Thermostats were not observed to have setpoint adjustment. The system includes a combination of two-way and three-way control valves. Both air handling units are equipped with three-way control valves and include circulating pumps

for freeze protection. We need to confirm the control logic related to the freeze protection pumps to verify they are operating when required and disabled when not needed.

The in-floor radiation is zoned with supply/return manifolds with approximately 6 circuits per manifold. Each manifold has a circulating pump and mixing valve to control supply water temperature to the slab. Temperature sensor locations for radiant floor system are unknown and not observed in the field. The HVAC service contractor will be consulted to determine control sequence and modify as appropriate for proper operation and integration with the other building heating systems.

C. HVAC System Deficiencies and Recommendations

General

The existing library is equipped with a central boiler plant and (2) air handling systems which were constructed with the original building. Over time, components such as pump motors have had to be replaced several times, and the relief fan for the building has been decommissioned, leading to patchwork attempts to relieve air from the building. These maintenance procedures are a result of inadequate design and/or construction of these systems, which have led to air balancing/pressure issues, temperature/humidity control issues, and frequent replacement of certain components within the building HVAC system. It is believed that continued operation of these systems as they are will only lead to more costly maintenance and/or replacement procedures beyond typical maintenance over time.

The intent of this study is to identify existing conditions, deficiencies, and propose a renovation plan for reworking the boiler plant, addressing air balancing issues, and improving overall thermal comfort to the library, to provide a more efficient system and reduce maintenance requirements.

The following recommendations are based upon field investigation, computer simulated load calculations, and code analysis.

HVAC Basis Of Design

The following represents the HVAC design information as it relates to the proposed HVAC upgrades including the boiler plant and terminal heating and cooling units.

<u>Load Calculation Assumptions:</u>

- Design Conditions (Based on Madison, WI):
  - Summer:
    - Outdoor: 87 F db, 75 F wb (per 2015 International Energy Code – WI Amendments)
    - Indoor: 75 F db, 50% RH
  - Winter:
    - Outdoor: -15 F
    - Indoor: 70 F db
- Envelope Assumptions:
  - Exterior wall construction: Per the existing building plans the wall construction is made of brick, concrete, stud wall framing, and gypsum wallboard. A U-factor of 0.08 was be used for the purpose of thermal load calculations.
  - Roof construction: The Roof appears to be original membrane roofing over rigid insulation and a U-factor of 0.05 was used for the purpose of thermal load calculations.
  - Glazing: U Value of 0.5 with a Shading Coefficient of 0.55.

  - Klein Dickert was the original glass provider for the building. JDR contacted KD but were unable to obtain the actual performance data for the glass due to the age of the building.

- Lighting and Equipment Loading
  - Lighting: Average of 0.75 Watts/SqFt.
    - Lighting densities based on the assumption of fluorescent lights hung below ceiling
  - Office Equipment: 150 Watts/Person in Office Spaces.
  - Assumptions were made based on room type and field verification for other miscellaneous equipment loads not specifically noted.
- Occupants
  - People count is based upon actual occupancy and/or occupancy density defined within the International Mechanical Code.

Applicable Codes and Standards:

The System will be designed in accordance with the following published codes, guidelines, and standards:

- International Code Council (ICC) - 2015
  - International Energy Conservation Code
  - International Mechanical Code
  - International Fuel Gas Code (NFPA-54)
- State of Wisconsin -Wisconsin Administrative Code
  - Chapter 63 Energy Conservation (Amendments to IECC)
  - Chapter 64 Heating, Ventilating, and Air-Conditioning (Amendments to IMC)
  - Chapter 65 Fuel Gas Appliances

Utilities:

- WE Energies – Local Gas and Electric utility provider

General System Design Requirements:

- All piping shall be protected during construction to prevent the entrance of construction dust and debris.
- All new hot water piping shall be Schedule 40, black, ASTM A53 Type F, standard weight steel pipe.
  - Contractor may use ASTM B88 seamless, Type L, hard temper copper tube with brazed or solder joint fittings for piping 2" and smaller.
  - Mechanically grooved piping and fittings may be allowed if permitted by Owner.
- All new hot water piping shall be insulated per industry standards and Wisconsin mechanical code requirements.
- Testing and Balancing:
  - Provide air and water testing, adjusting, calibration, and balancing for all equipment.
- All new gas piping downstream of gas meter to all gas fired equipment shall be provided by the HVAC contractor. Existing gas meter service provides 2 PSIG downstream of existing meter.
  - Gas piping shall be Schedule 40, black, ASTM A53 Type E, standard weight steel pipe.
  - Provide gas pressure regulators at individual appliances and vent to outdoors where required.

BOILER PLANT MODIFICATIONS

The heating system has (2) 1,050 MBH rated boilers as the primary heating source, each with a primary boiler pump, and two (2) secondary system pumps piped in parallel to each other. JDR has prepared computer simulated heating load calculations for the building considering space, envelope, and ventilation loads to evaluate existing equipment sizing and capacity. Based on the data, JDR has found the boilers are oversized for heating the current space. Original sizing appears to have been done to account for the future expansion. Unfortunately, the oversizing and poor piping

configuration has resulted in poor modulation and control for the current building. Replacing and re-sizing the current boilers would be beneficial to provide a more efficient means to heat the building while still accommodating the option of possible future expansion.

It was noted by the facility staff that secondary pumps/pump motors have been replaced frequently. During our site visit, JDR identified the absence of a decoupler between the hot water supply and return piping mains in the boiler plant hot water loop. Review of the original design documents shows that the current install was done in accordance with the original design schematics. The absence of the decoupler defeats the intent of having a primary/secondary pumping system. A primary/secondary pumping systems allows for independent operation/flowrates between the boiler pumps and the system pumps. Current install does not allow for this. In the current install, the pumps operate in series. When the boilers turn off, the associated boiler pump(s) turn off. The system pumps continue to run and have to push water through the system loop and also must overcome resistance from the boilers and boiler (primary) pumps. The pumps were not designed for this, ultimately degrading the pumps over time. It was also noted that the existing boilers have rated flowrates of 80 GPM each, while the main system (secondary) pumps are only sized for 32 GPM each. The plant design requires coordination between the flowrates and control to provide an efficient operation. The design/install issues align with the facility staff acknowledging noise and vibration issues with the pumps.

Based upon the above information, the following recommendations are provided for the central heating plant.

- Furnish and install (2) two high-efficiency, condensing boilers each sized for approximately 67% of total building capacity to provide partial redundancy. Provisions for one (1) additional boiler with capacity for future expansion. The plant will be sized for efficient operation for both the existing building and potential future addition. Existing piping that serves the library shall be reconnected within the existing boiler room.
- The controls strategy for the boilers will be upgraded as well. Newer boilers have integral controllers that can stage each boiler in the system automatically to ensure that the boiler plant will operate at its highest capable efficiencies.
- Balance valves shall be provided for each branch of hot water return distribution piping within the mechanical room.
- Existing air separator shall be maintained. Review existing install and determine modifications required.
- Existing diaphragm expansion tank(s) shall be reviewed for proper sizing. Replace as needed.
- Chemical feeder to remain.
- Remove and replace all the existing secondary pumps with (2) new end suction pumps.

AIR-HANDLING UNIT MODIFICATIONS

As previously mentioned, the library is served by two (2) main air-handling units. The primary unit serves the majority of the building's library spaces, study rooms, and staff work areas, and secondary unit serves the lobby and an adjacent meeting room. According to the load calculations prepared by JDR, both units are adequate in terms of supply air capacity. However, each unit has some individual concerns.

AHU-1:

Air-handling unit (AHU-1) has an existing return fan that has been decommissioned, leading to ongoing pressure issues within the entire building. Decommissioning the return fan impacted the overall design of the system and brings into question the air balance throughout the building as it relates to areas served by AHU-1. As an attempt to improve return airflow, a section of return duct was installed parallel to the fan as a "by-pass". The space available to install the duct was limited and thus the duct itself is significantly undersized for the current return air required. Additionally, the relief opening within the mixed air plenum at AHU-1 has been capped. An opening was cut into the top of the relief duct leading to the relief louver, however, as noted earlier, the building does not utilize a return air plenum and thus there is currently no relief air system related to AHU-1. This results in positive pressure issues whenever AHU-1 goes into economizer. The positive pressure prevents doors from closing properly and represents a security issue.

To improve the current relief air / pressurization issues, JDR recommends the following system modifications:

- Provide an additional section of return ductwork connected to the existing 50/18 ductwork, route to AHU-1, and make connection to the existing return air plenum. The ductwork shall be sized such that, combination of the existing "by-pass" duct and the new ductwork, the total amount of return air shall pass through the ductwork at standard design pressure drop.
- New relief grilles shall be located in the staff workroom ceiling and ducted back to existing relief louver. A motorized damper shall be installed in the return air ductwork and interlocked with the return air and outside air dampers for economizer operation.

JDR also noticed in the field that there is currently no balancing valve in the bypass piping of the unit's hot water coil. It is recommended that a balance valve be installed in the bypass piping. The balance valve is intended to match the pressure drop of the coil when the hot water system is in the bypass mode. Missing this valve can result in increased (bypass) flow exceeding the normal design flow to the coil. This will reduce flow to the remainder of the system when operating in bypass potentially causing heating problems.

AHU-2:

Air-handling unit AHU-2 has been noted to have complaints related to thermal comfort in the meeting/multi-purpose room and lobby area. It was observed in the field by JDR that the cooling coil for the unit is located downstream of the heating coil. This, combined with the hot water coil piping issues, is contributing to the temperature/humidity control issues.

JDR recommends adding a duct-mounted hot water reheat coil downstream of the cooling coil to allow implementation of a humidity control sequence. Control upgrades including install of a space humidity sensor and programming will be required to implement the dehumidification sequence.

DDC Control Programming Updates

There is little knowledge of the current building control system according to the facility staff. With upgrades to the boiler system and air-handling unit components, it would present a good opportunity verify equipment operating setpoints and sequences of operation.

The existing control system is believed to have adequate control components and functionality to achieve the desired operating modes. JDR can work with the library's HVAC/Controls service contractor to implement the appropriate control sequences.

Re-Balancing of Air and Water Systems

Based upon the level of work recommended and the unknown status of the system setpoints, JDR recommends contracting a test and balance agent to provide air and water balancing of all building systems.

New airflows and water flowrates may be recommended based JDR's heating and cooling load calculations for the building. Balancing efforts to be conducted following the completion of the system upgrades.

D. Opinion of Probable Construction Costs

Opinions of probable construction cost are not included as these are being provided for each recommendation by the library's HVAC service contractor. Once the costs are assembled, they can be added to this report.

JMBrennan,inc
MECHANICAL CONTRACTORS

TO	E D Locke Public Library	DATE	3-15-2023
	5920 Milwaukee St	PROJECT	Replacement of boilers.
	McFarland, Wi, 53558	ATTN	Heidi Cox

SUBJECT TO THE FOLLOWING PROVISIONS AND CONDITIONS LISTED ON THIS PAGE AS WELL AS ANY OTHER ATTACHED PAGES,

J.M. BRENNAN, INC. PROPOSES:

Project:

Replacement of boilers, boiler pumps, system pumps and fixing of system leaks in Mechanical room.
Fixing of hot water piping issues at AHU #1 and #2.
Changing of return air duct to help get more air back to AHU #1.
Changing of relief duct to help control building relief pressures.

To provide labor and material as follows:

Draining and refilling of hot water system for replacement of boilers
Remove existing Pure Humidifier for making room for new boilers
Remove (Qty 2) PK boilers and boiler pumps
Remove exist (Qty 2) Taco System pumps
Remove existing piping required to install new Lochinvar boilers.
Replace leaking 3" supply piping next to in floor manifolds in mechanical room
Increase existing size of concrete pads for new boilers
Furnish and install (Qty 2) Lochinvar FTXL 400 boilers
Furnish and install (Qty 2) Taco 2440 1.5 Circulator pumps
Furnish and install (Qty 2ea) 2"and3" Y-Strainers, Check Valves, Balancing valves and multi-purpose valve
Furnish and install (Qty 2) Taco ACUF-2" ECM Circulator pumps
Furnish and install required piping to connect to existing water distribution system.
Furnish and install new gas piping and Dungs gas regulators to boilers
Factory boiler startup of boilers and pumps
Furnish provisions to add 3rd boiler for possible future building addition
Furnish all line voltage wiring required to connect to existing disconnects
Furnish all control wiring and BAS graphic programming and updating Graphics as needed
Insulating of new water piping
Testing and balancing of boiler system flows with documentation.
Air Balance of supply grills.
Install circuit setter in AHU #1 3-way bypass valve to help control system flow.
Remove bypass ball valve with broken handle from supply/return line feeding AHU #1
Correct piping of Ahu #2 circulating pump to help coil from possible freeze ups.
Install circuit setter in AHU #2 3-way bypass valve to help control system flow.

Fixing of return/Relief duct for better airflow to AHU #1

Includes:
Removing and reinstalling ceiling once job is completed.
Removing existing outdoor air fiber duct and dispose of.
Remove existing outdoor air dampers and dispose of.
Removing of existing return duct and disposing of.
Make up and install new return duct plenum to connect to existing return duct.
Furnish and install new low leak relief dampers.
Makeup and install new Relief duct.

Lining of return and relief with 1” duct liner to help keep air noise down.
Furnish and install (Qty 8) new ceiling eggcrate grills for building relief.
Furnish and install required flex duct and takeoffs to connect grills to relief duct.
Required controls work needed for building relief damper actuators

Base bid …… $ 167,467.00

Excludes:
Replacement of electrical disconnects.
Repairing of any water leaks in hot water system other than ones noted.
Chemical treatment of boiler system.
Replacement of air separator
Replacement of bladder tank
All work to be performed during the hours of 7:00 am -3:30pm

Thank you for this opportunity.

Terms of Payment CASH 30 DAYS NET

Work completed and billed in one month is due and payable on the 30th day of the following month. Balance due within thirty days following completion of job and final billing. This proposal is subject to written acceptance within thirty days of its date. There are no representations, promises, warranties, agreements, or understandings not expressed herein. All prices subject to additional applicable sales tax.

Respectfully submitted,

J.M. Brennan, Inc.

ACCEPTED THIS _____ DAY, 20____

Dave Gundlach

BY_____(SEAL)

BY_____(SEAL)

Dave Gundlach
HVAC Service Fitter/Service Sales
dgundlach@jmbrennan.com
Mobile: 608-712-6143