CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☐ Commercial Buildings	☐ New	☐ Existing or	☐ EBCx
Institutional Buildings:			
☒ Educational Facilities	☐ New	☒ Existing or	☐ EBCx
☐ Other Institutional	☐ New	☐ Existing or	☐ EBCx
☐ Health Care Facilities	☐ New	☐ Existing or	☐ EBCx
☐ Industrial Facilities or Processes	☐ New	☐ Existing or	☐ EBCx
☐ Public Assembly	☐ New	☐ Existing or	☐ EBCx
☐ Residential (Single and Multi-Family)			

2. Name of building or project: CPS Christopher Elementary School

City/State: Chicago, Illinois

3. Project Description: MEP Renovation and Energy Upgrade

Project Study/Design Period: 03/2019 (Begin date (mm/yyyy)) to 12/2021 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Malone, Brian M.; Hidaka, Sean M.
Last First Middle

Membership Number: 8050506 (BMM); 8304150 (SMH)

Chapter: Illinois

Region: VI

b. Address (including country): 30 N. Wolf Road, Second Floor

City	State	Zip	Country
Hillside	IL	60162	USA

c. Telephone: (O) 708-236-0300 d. Email: bmalone@elaraeng.com

e. Member's Role in Project: Principal in Charge (BMM); Project Engineer (SMH)

f. Member's Signature:

5. Engineer of Record: Brian M. Malone

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

CPS Christopher Elementary School MEP Renovation and Energy Upgrade

Gross Square Footage: 65,500
Number of Floors: 1
Space Types: Classrooms, Offices, Auditorium, Cafeteria, Gymnasium, Pool.
MEP Systems: Steam boiler plant, Steam radiation (for low ambient conditions), Air-source VRF, DOAS RTUs with energy recovery wheels, Mixed-air RTU for Cafeteria and Auditorium with energy recovery wheel, Displacement ventilation and DCV for all RTUs, BAS.
Original Building Construction: 1930
Construction Cost: $3,500,000
Designed: 2019-2021

Project Summary

Originally, Elara was enlisted by Chicago Public Schools (CPS) to perform a Net Zero Study to identify, evaluate, and recommend updated architectural and engineering design criteria for new CPS facilities that would meet the intent of the Living Future Institute's recognized definition of Net Zero Energy. In order to demonstrate the developed alternative design approach within an existing CPS facility, Elara was selected as the MEP design engineer for the CPS Christopher Elementary School renovation project. This venture was intended to act as a pilot project to showcase the feasibility of the CPS committee's design objectives and the benefits with regard to energy efficiency.

Upon initial evaluation of the CPS Christopher building, it was noted that almost all major mechanical, electrical, and plumbing (MEP) systems were original to the building construction and approximately 90 years old. In addition to being past their useful service lives, much of the major equipment was in poor condition and was either inoperable or operating inefficiently. Building heat was provided by (2) steam boilers that fed steam radiators equipped with pneumatic actuators; these actuators were typically failed and unresponsive at the onset of the project. Cooling was provided by individual thru-the-wall A/C units located throughout the building. Ventilation was accomplished via air intakes on the roof ducted down to steam heating-only unit ventilators which were in various states of disrepair, thereby mitigating their contribution to effective ventilation. Some spaces also received ventilation via an original air handling unit located in the basement of the school, which mixed outside air with basement return air.

Initially, the scope of this design project was a complete redesign of the building's MEP systems, including new hydronic boilers, air-source VRF systems, rooftop ventilation units, all new lighting, power panel upgrades, and new plumbing piping and fixtures. Each design element that could reduce the building's energy and carbon footprint was evaluated for impact, value, and affordability. This process required the conceptual design of multiple elements which were, after further evaluation, either rejected or altered to accommodate the variable project budget while simultaneously continuing to address the main project goals of increased energy efficiency, improved indoor air quality, and upgraded equipment.

The final scope of the implemented project includes (3) new makeup air units (MAUs) on the roof providing ventilation air to all classrooms and offices via a displacement ventilation strategy using existing infrastructure when feasible. The new ventilation system utilizes specialized air diffusers to introduce cool, fresh air at low velocities to occupied spaces which enhances indoor air quality and supports space cooling. This ventilation system also includes demand controlled ventilation (DCV) based on local carbon dioxide levels which results in energy savings. An additional mixed air rooftop unit (RTU) provides displacement ventilation air to the cafeteria and auditorium spaces by utilizing existing floor and wall openings with new displacement ventilation air diffusers. Each of these (4) aforementioned units was also provided with an energy recovery wheel to reclaim energy from the exhaust air. Space heating and cooling was also upgraded to a new air-source VRF system which included terminal units in each space and air compressors located on the roof. Existing steam radiators were kept as a means of supplemental heat during low ambient conditions (below 10°F) and new control valves were installed on the existing radiators to provide improved control. A new direct digital control (DDC) system was also installed along with electrical upgrades associated with each impacted system. Lastly, plumbing domestic water piping was also replaced in the basement area.

Energy Efficiency: Highly efficient equipment selection and a new building automation system contributed to an energy efficient retrofit of the mechanical systems. The new air-source VRF and energy recovery systems significantly upgrade the energy efficiency compared to the original heating and cooling systems. Energy recovery on the rooftop systems and an improved controls system mitigates energy usage and provides tighter control of systems to meet locally monitored requirements. Various leaky ventilation openings along the roof were also patched and closed as part of this project. DCV implemented via carbon dioxide monitoring to supply ventilation as required which results in energy savings.

Indoor Air Quality: Improved indoor air quality was a key goal of this project and was accomplished by the introduction of dedicated makeup air units providing ducted DOAS air to each space which filters and conditions air before entering the building with no mixing between classrooms. Displacement Ventilation was utilized in each classroom and serves as the primary cooling source for the cafeteria and auditorium spaces. This design utilizes thermal buoyancy and controlled air temperatures to induce vertical flow of ventilation air, thereby displacing contaminants and prioritizing clean ventilation air in the lower occupied zone of spaces.

Innovation: Various aspects of innovation were required to meet the project budget and schedule. Approximately 48 existing floor openings in the auditorium were re-used and retrofitted with displacement ventilation diffusers in order to improve air quality and aid in the distribution of cooling to a space that was previously cooled with fans and thru-the-wall A/C units. Existing ductwork infrastructure in the basement area was also re-used to minimize project cost and invasiveness to existing areas. The existing steam plant was also re-used in an innovative fashion as it handles heating for the building at low ambient temperature conditions when the VRF system is less efficient. The hybrid solution to space heating that was ultimately derived from the design process utilizes both VRF and existing steam heating, which allowed for existing windows to be re-sued rather than replaced, resulting in significant cost savings.

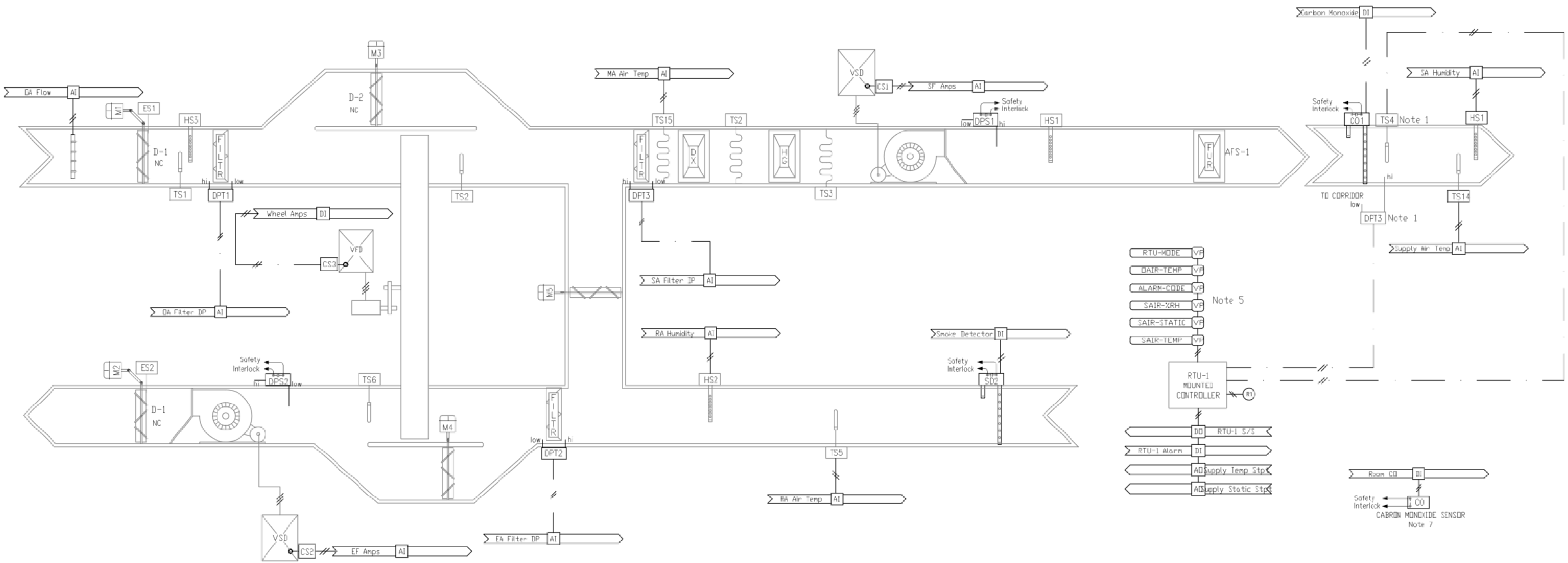
Operation and Maintenance: The installation of new equipment proper service clearances improves overall operation and maintenance. The new controls system allows for virtual monitoring of the building, whereas the existing controls were pneumatic only and failing in several instances. Most filters are located such that replacement does not require a ladder. The compressorized equipment is centralized and the total quantity is reduced. Furthermore, the existing steam boiler system provides redundancy for the heating system.

Cost Effectiveness: As stated previously, this project initially included a much larger scope but was reduced and modified significantly in order to fit within given variable cost parameters. Aspects that were modified include the re-use of portions of the existing steam system, re-use of existing windows, and modification to existing ductwork distribution systems. The VRF system was implemented with a hybrid approach incorporating existing heating systems for supplemental heat to reduce implementation costs. Innovative solutions were required throughout the design in order to meet the project budget and remain within a cost effective structure. In doing so, the project budget was maintained, while the air-source heat pumps system conditions the building for over 95% of the operating hours.

Environmental Impact: The improved efficiency of the HVAC system reduces carbon emissions. The air source VRF units in lieu of inefficient steam heating electrifies the heating system for most of the systems heating hours and reduces direct use of fossil fuel heating. Window A/C units having a shorter life and requiring more frequent replacement are eliminated. Environmental conditions in the basement of the building were also improved as part of this project, removing potentially harmful material and allowing for full access to and maintenance in the basement.

VRF ON ROOF

AUDITORIUM FLOOR DISPLACEMENT DIFFUSERS



DISPLACEMENT ROOFTOP UNIT – GAS HEAT, DX COOLING, REHEAT, AND ENERGY RECOVERY

ELARA