This report section will overview the existing plumbing systems at Maine South High School. The sections will include: domestic cold water distribution, domestic hot water distribution, domestic hot water recirculation, domestic hot water generation, and recommendations.

The system replacement recommendation(s) follow each equipment's existing conditions description. To determine the recommendations, our experience with similar systems and the ASHRAE median service life tables were utilized. Estimated equipment service life, according to the 2015 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook, is defined as the economic life of a system or component, or the amount of time it remains in its original service application. The remaining service life values reported in this document are based off the ASHRAE Equipment Life Expectancy Chart, as well as the ASHRAE Preventative Maintenance Guidebook, which use median years to provide an indication of expected equipment service life. Many factors effect equipment service life and with any average, some systems may have lifetimes far from average. However, these median lifetimes provide a reasonable basis for establishing the remaining useful life of existing systems.

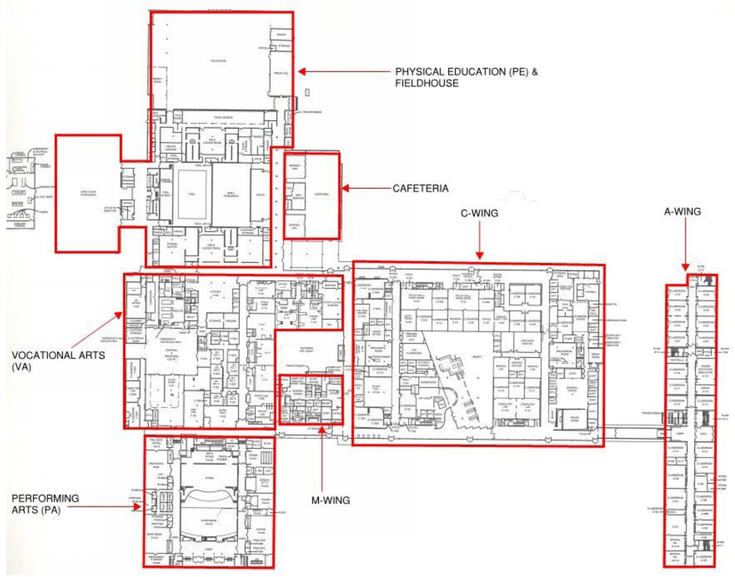
Equipment recommended for replacement is categorized into the following four groups:

1. Health Life Safety (2019) – Equipment or systems in this category present health, life, or safety risks to building occupants and may not be up to current code standards. Systems in this category are recommended to be replaced as soon as possible.
2. 1 to 2 Years (2019 to 2020) – Equipment in this category should be considered for replacement within the next couple of years.

On the following pages are two (2) floor plan graphics. The first graphic is a location key indicating the naming designations of various sections of the school and will be referenced throughout the report. The second graphic displays an overview of floor plan layouts at Maine South served by plumbing systems. These plumbing systems will be discussed in further detail in the report.

PLUMBING SYSTEMS - KEY PLAN

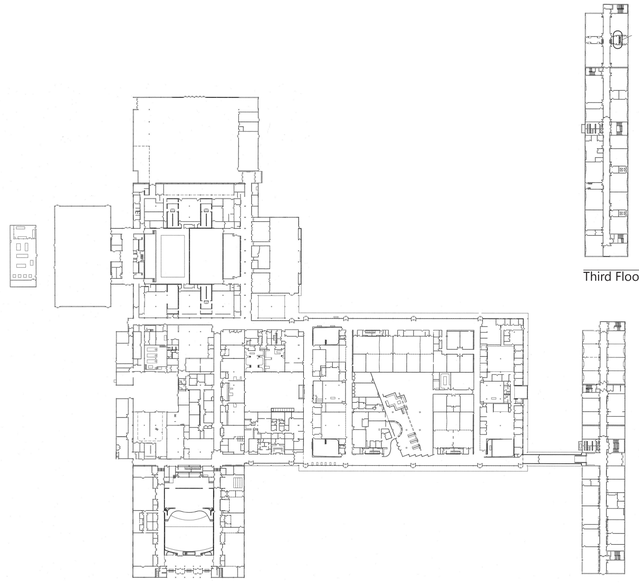
MAINE SOUTH HIGH SCHOOL



First Floor Plan

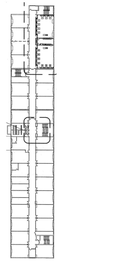
PLUMBING SYSTEMS - FLOOR PLAN OVERVIEW

MAINE SOUTH HIGH SCHOOL

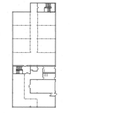


First Floor Plan

Third Floor Plan



Second Floor Plan

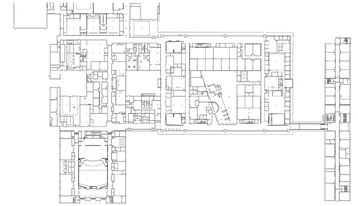


Lower Floor Plan

DOMESTIC HOT WATER PLANTS

MAINE SOUTH HIGH SCHOOL

Domestic Hot Water Plant Location



First Floor Plan

Domestic Hot Water Plant

Domestic hot water for Maine South is provided by one (1) domestic hot water plant. The plant is located in the main building mechanical boiler room (replaced in 2017).

DOMESTIC HOT WATER PLANT

The domestic hot water plant in the main building mechanical boiler room is comprised of three (3) 800-MBH high-efficiency gas-fired domestic water heaters and two (2) 500-gallon hot water storage tank. The water heaters and storage tank and localized piping were replaced in 2017. This plant serves entire building's domestic hot water load, including the cafeteria conveyor dishwasher. The pictures on the right show the equip ment and location of the domestic hot water plant.

No alterations are recommended for this equipment within the scope of this report.

DOMESTIC COLD WATER AND HOT WATER DISTRIBUTION AND RECIRCULATION

MAINE SOUTH HIGH SCHOOL

Sample of Existing Galvanized Piping

The existing original domestic water is galvanized piping. The existing original isolation valves are stem-operated valves. Hot water return piping is without adequate balancing.

DOMESTIC COLD WATER AND HOT WATER DISTRIBUTION AND RECIRCULATION

The existing original domestic cold and hot water piping is galvanized piping in various levels of failure. Galvanized piping in domestic water systems corrodes overtime and generates corrosion and rust debris. Corroded pipe walls and pipe debris settle in piping creating restrictions and impacting function of isolation valves, balancing valves, check valves, faucet aerators, shower-head flow restrictors, etc. The debris materials settle at horizontal sections of pipe and piping at/near fixtures because the pipe diameter is smaller and the debris carried with water flow.

Pipe fails via mechanisms such as pitting, pin-hole leaks, and loss of pipe thickness at threaded fittings. Also, failure of threaded fittings can result in significant leak and release a high flow rate via open pipe fitting. The threading process itself cuts away pipe wall and significantly reduces pipe wall thickness and then further corrosion over time occurs.

The existing original isolation valves may or may not properly operate when isolation is necessary for repair or remodel work.

The existing hot water recirculation path is impacted by corrosion, failed isolation valves, failed check valves, and failed balancing valves. Additionally, Maine West High School, it was observed that the original hot water return branch piping is without any check valves and without any balancing valves. Therefore, the ability to balancing the hot water delivery and return pipe paths is not possible. Balancing the pipe paths permits adjustment of the shorter pipe runs to be equivalent to longer pipe runs. Without the ability to balance, the shorter pipe runs (i.e. path of least resistance) flows easy – while the longer pipe runs do not flow any recirculation flow to maintain hot water through the longer circuits (i.e. paths).

1 TO 2 YEAR RECOMMENDATION

Due to the fact that the piping is a) galvanized, b) corroding and generating rust/debris, especially on a water shut-downs, c) isolation valves failed/failing, d) check valves fowled/failed/failing or not present, e) balancing valves fowled/failed/failing or not present, and f) the resultant impact on the ability to balance the hot water recirculation the domestic cold water and hot water piping is recommended to be replaced. If replacement is necessary to be phased, the immediate focus should be on replacement of common horizontal piping, isolation valves, check valves, and balancing valves.

THERMOSTATIC MIXING VALVES

MAINE SOUTH HIGH SCHOOL

Existing Lavatories without TMV's

Home-Economic Sinks

Thermostatic mixing valves are intended to limit hot temperature downstream of the valve. Per Code for this project, lavatories and showers require a thermostatic mixing valve either upstream of a group of fixtures or at each fixture.

THERMOSTATIC MIXING VALVES

Thermostatic mixing valves are generally present at showers either with an upstream master mixing thermostatic mixing valve or at the shower valve body. Some components such as temperature gauges are non-functional due to age.

Thermostatic mixing valves are generally not present at existing original lavatory installations.

Thermostatic mixing valves are not present at existing home-economics sinks.

HEALTH LIFE SAFETY RECOMMENDATION

For basic scald protection, thermostatic mixing valves are required and shall be immediately implemented.

Existing thermostatic mixing valves in need of repair shall be repaired/replaced as part of necessary regular maintenance program.

BACKFLOW PREVENTERS

MAINE SOUTH HIGH SCHOOL

Failed Vacuum Breaker

Backflow preventers limit unintended backflow of water distribution. These are present upstream of mechanical equipment water make-up connections, irrigation water piping, etc.

BACKFLOW PREVENTERS

A failed mop basin vacuum breaker at third floor (east side) of academic wing was observed.

HEALTH LIFE SAFETY RECOMMENDATION

For backflow prevention purposes and to protect the domestic water distribution system, failing/failed or deficient backflow preventers are required to be replaced for proper function of backflow protection.

PLUMBING COST ESTIMATES

MAINE SOUTH HIGH SCHOOL

The cost estimate tables below for recommended replacements encompass any associated mechanical, electrical, plumbing, controls, equipment, contracting, demolition, and installation costs. The anticipated start year for replacements is 2019. If equipment is recommended for replacement in the 6 to 10-year timeframe, then it has two listed costs: 2024 and 2028. These costs represent the inflated cost if the project were to be implemented that year. A 3% inflation amount was added for each year. Cost estimates were determined by referencing our experience with similar systems and the areas served by these systems. Cost estimates are as follows:

Recommended Replacement Timeframe	Existing Type	Location	Service	Recommended System Type	2019 Cost	2024 Cost
Health Life Safety (ASAP)	Thermostatic Mixing Valves (TMV)	WH Mech Room	H/E Master Mixer	New TMV	$6,000	
		At Fixtures	Fixtures	New TMV	$26,000	
	Failed Vacuum Breaker	At Fixture	At MB	New Vacuum Breaker	$500	
2019 - 2020	Domestic Cold/Hot Water	Throughout	Tunnel	New Copper Pipe	$175,000	
			Basement	New Copper Pipe	$150,000	
			1st Floor	New Copper Pipe	$1,500,000	
			2nd Floor	New Copper Pipe	$300,000	
			3rd Floor	New Copper Pipe	$300,000	
2024 - 2028	Fire Protection	Throughout	Entire Building	Automated Sprinkler		$1,400,000
				TOTALS	**$2,603,000**	**$1,750,000**

MEP COST ESTIMATES

MAINE SOUTH HIGH SCHOOL

The table below shows the total estimated replacement costs for each discipline as if they were implemented on the first recommended replacement timeframe year. For example, equipment that was recommended for replacement from 2019 to 2020 would have only the 2019 inflated cost shown.

Category	Recommended Replacement Timeframe	Existing System Type	2019 Cost	2020 Cost	2021 Cost	Year 2024 Cost
Mechanical	2019 - 2020	Air Handlers	$8,515,000			
	2024 - 2028	Unit Vents				$2,200,000
	2024 - 2028	Exhaust Fans				$266,000
	2021 - 2023	Pumps			$66,000	
Electrical	2021 - 2023	Unit Substation Replacement			$874,182	
	2021 - 2023	Distribution Panelboard Replacement			$196,691	
	2019	Thermal Inspections	$25,000			
	2021 - 2023	Arc Flash Study			$26,523	
	2019	Switch Exercise & Other Preventative Maintenance	$10,000			
	2019 thru 2021	LED Lighting & Controls	$1,600,000	$1,648,000	$1,697,440	
Plumbing	Health Life Safety (ASAP)	Thermostatic Mixing Valves (TMV)	$32,000			
		Failed Vacuum Breaker	$500			
	2019 - 2020	Domestic Cold/Hot Water Distribution and Circulation	$175,000			
			$150,000			
			$1,500,000			
			$300,000			
			$300,000			
	2024 - 2028	Fire Protection				$1,400,000
		TOTALS:	**$12,607,500**	**$1,648,000**	**$2,860,836**	**$2,466,000**
		TOTAL:	**$19,582,336**			

Note: See Budget Estimates in Part 3 for total building cost.

ASHRAE MEDIAN SERVICE LIFE TABLE

MAINE SOUTH HIGH SCHOOL

Equipment Type	Equipment Tag	Service	Approximate Unit Age as of 2018 (Years)	ASHRAE Median Service Life (Years)
Space Heating Hot Water Boilers	B-1 to B-4	Whole Building	1	15
Domestic Hot Water Boilers		Whole Building	1	10
Chillers	CH-1 "York"	Whole Building	3	20
	CH-2 "Carrier"	Whole Building	20	20
Pumps	YRK-CHWP-1	York Chllr. & Bldg. Loop	3	25
	YRK-CHWP-2	York Chllr. & Bldg. Loop	3	25
	YRK-CWP-1	Cooling Tower	3	25
	YRK-CWP-2	Cooling Tower	3	25
	CHP1	Carrier Chllr. & Bldg. Loop	20	25
	CHP2	Carrier Chllr. & Bldg. Loop	20	25
	CP-1	Cooling Tower	20	25
	CP-2	Cooling Tower	20	25
	BWP-S1	Primary Boiler Loop	1	25
	BWP-S2	Primary Boiler Loop	1	25
	BWP-S3	Primary Boiler Loop	1	25
	BWP-S4	Primary Boiler Loop	1	25
	HWP-S1	Secondary Heating Loop	1	25
	HWP-S2	Secondary Heating Loop	1	25
	HWP-S3	Secondary Heating Loop	1	25

ASHRAE MEDIAN SERVICE LIFE TABLE

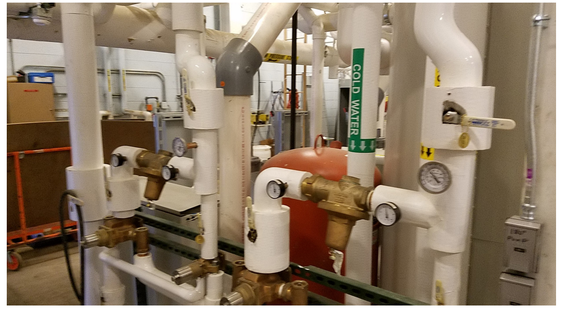
MAINE SOUTH HIGH SCHOOL

Equipment Type	Equipment Tag	Service	Approximate Unit Age as of 2018 (Years)	ASHRAE Median Service Life (Years)
Air Handling Units	AHU-A	C-South	54	37
	AHU-B	C-South	54	37
	AHU-C	C-North	54	37
	AHU-D	C-North	54	37
	AHU-E	Auditorium	54	30
	AHU-F	Auditorium Lobby and Stage	54	30
	AHU-G	Auditorium S. Classrooms and Backstage	54	30
	AHU-H	Auditorium N. Classrooms	54	30
	AHU-J	Pool	54	30
	AHU-K	Small Gym	54	30
	AHU-L	Dance Gym	54	30
	AHU-M	M-Wing	54	30
	AHU-N	Kitchen	54	30
	AHU-V	Spec Gym	54	25
	AHU-W	Spec Gym	54	25
	AHU-X	Spec Gym	54	25
	AHU-BB	Cafeteria	50	30
	A-Wing	Garage and Storage	50	25

ASHRAE MEDIAN SERVICE LIFE TABLE

MAINE SOUTH HIGH SCHOOL

Equipment Type	Equipment Tag	Service	Approximate Unit Age as of 2018 (Years)	ASHRAE Median Service Life (Years)
Roof Top Units	RT-2	Staff Lounge & Dining Area	4	15
	RT-3¬¬	Food Lab V117 & V118	4	15
	RT-4	Offices V115, V116, & V119	4	15
	RT-5	V113, V114 & Office	4	15
	RT-6	V112	4	15
	RT-7	V111	4	15
	RT-8	V109 & V110	4	15
	RT-9	Rms. V106 to V108	4	15
	RT-10	Rms. V122 & V123	4	15
	RT-11	Rm. V130	4	15
	RT-12	Rm. V131 & Adjacent Offices	4	15
	RT-13	Fitness Center & Adjacent Offices	4	15
	RT-14	Girl's Locker Rm.	4	15
	RT-15	Girl's Locker Rm.	4	15
	RT-16	Team/Visitor Locker Rms.	4	15
	RT-1S	Classrooms V124 to V127	5	15
	RTU-S1	Fieldhouse	1	15
	RTU-S2	Fieldhouse	1	15
	RTU-S3	Fieldhouse	1	15
	RTU-S4	Fieldhouse	1	15
Unit Ventilators	A-Wing UVs	A-Wing	21	20



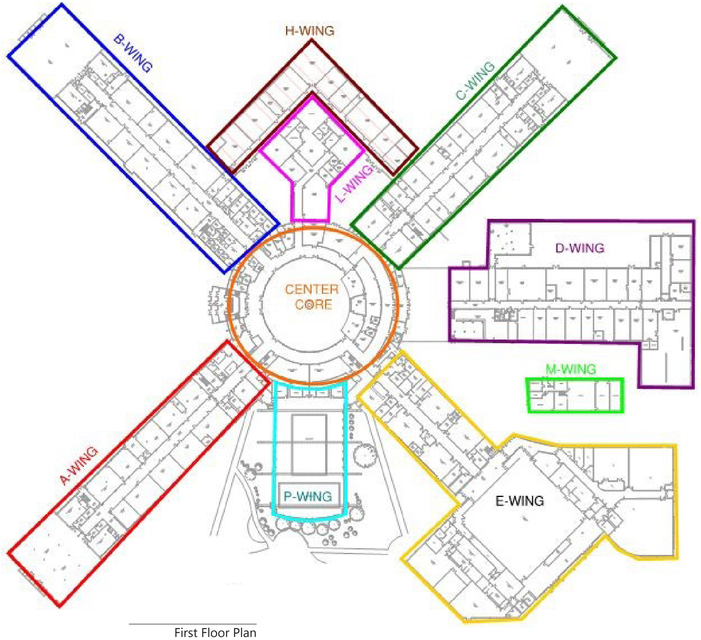
This report section will overview the existing cooling and heating systems at Maine West High School. The sections will include: building cooling plant, building heating plant, mechanical ventilation systems, unit ventilators, roof top units and recommendations.

The system replacement recommendation(s) follow each equipment's existing conditions description. To determine the recommendations, our experience with similar systems and the ASHRAE median service life tables were utilized. Estimated equipment service life, according to the 2015 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook, is defined as the economic life of a system or component, or the amount of time it remains in its original service application. The remaining service life values reported in this document are based off the ASHRAE Equipment Life Expectancy Chart, as well as the ASHRAE Preventative Maintenance Guidebook, which use median years to provide an indication of expected equipment service life. Many factors effect equipment service life and with any average, some systems may have lifetimes far from average. However, these median lifetimes provide a reasonable basis for establishing the remaining useful life of existing systems.

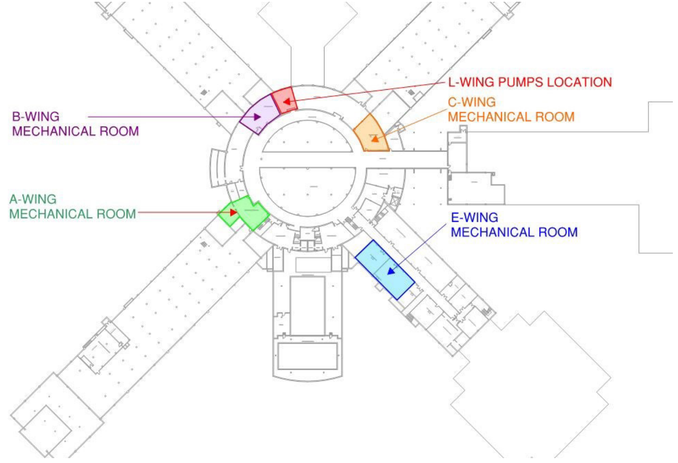
Equipment recommended for replacement is categorized into the following four groups:

1. 1 to 2 Years (2019 to 2020) – Equipment in this category should be considered for replacement within the next couple of years.
2. 3 to 5 Years (2021 to 2023) – Replacement of equipment in this category is less pressing than equipment listed in categories 1-2, but should still be considered for replacement within this timeframe.
3. 6 to 10 Years (2024 to 2028) – Replacement of equipment in this category is not an immediate need, but is still recommended for replacement within this timeframe.

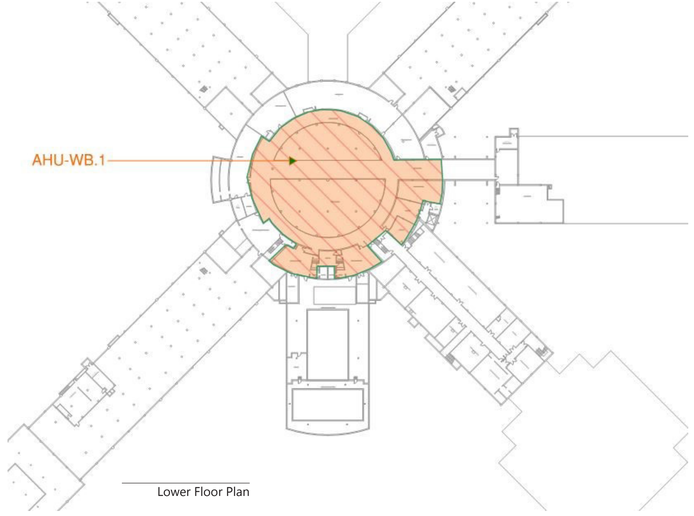
On the following pages are six (6) maps. The first map displays the names of various sections of the school and will be referenced throughout the report to denote equipment locations. The second map shows the locations of the various mechanical rooms, and the third through the sixth maps shows an overview of all the mechanical ventilation systems at Maine West.



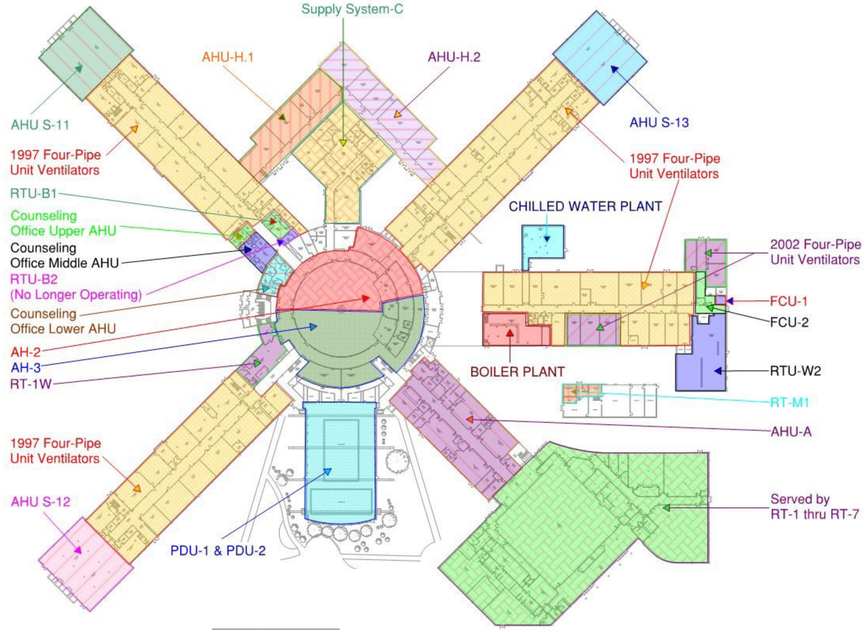
First Floor Plan



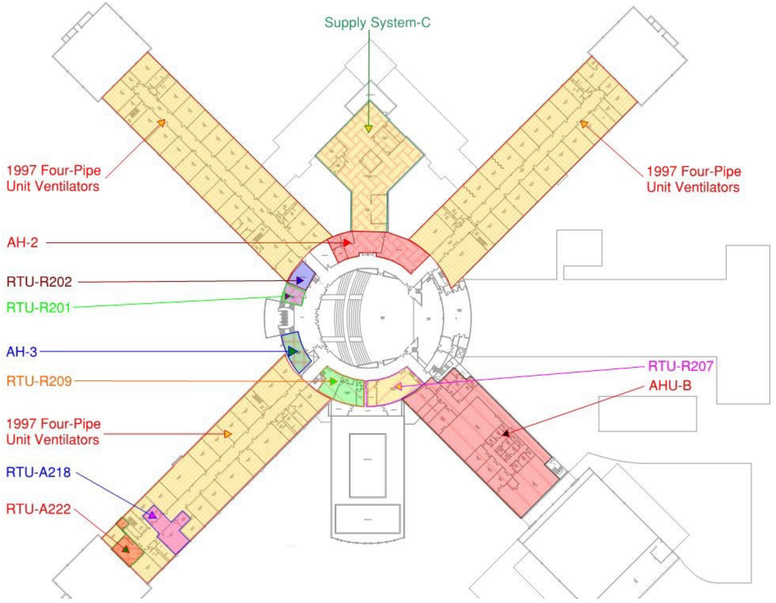
Lower Floor Plan



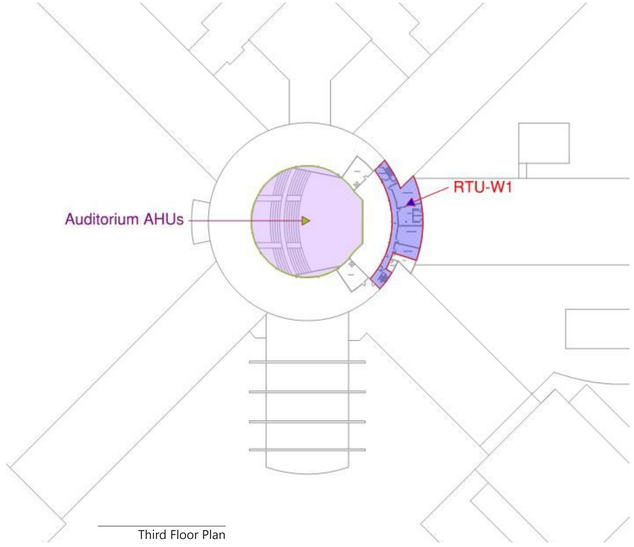
Lower Floor Plan



First Floor Plan



Second Floor Plan



Third Floor Plan

Chilled Water Plant

First Floor Plan

Space cooling for Maine West is provided by one (1) chilled water plant, located in the D-Wing mechanical room D121, indicated in the picture to the right. There are two (2) new high efficiency chillers, CH-W1.1 and CH-W1.2, that are being installed and have an expected operation date of April of 2018. The chillers serve four-pipe unit ventilators (UVs) located in classrooms as well as eight (8) air handling units (AHUs) throughout the building.

The chillers are 2017 "Carrier" electric, variable speed, water-cooled, centrifugal chillers rated for 400 nominal tons each. Chilled water system operates utilizing a primary loop and secondary loop. The primary loop supplies constant volume to the chillers via three (3) constant speed "Bell & Gossett" chilled water pumps (CHWP-1,2, and 3). The primary pumps are each rated for 20 HP, 36 ft. of head, and 1025 GPM. Chilled water is distributed throughout the secondary loop via two (2) variable speed "Bell & Gossett" pumps (CHWP-4 and CHWP-5) rated for 40 HP, 90 ft. of head, and 1050 GPM. These five (5) pumps were installed in 1997.

Heat rejection for the chillers is provided by a 1997 dual-cell "Marley" cooling tower located on the roof of the chiller room. The cooling tower was completely refurbished in 2017. The cooling tower is equipped with two (2) 1997 "Marley" tower fans, each rated for 60 HP. Condenser water is circulated by three (3) condenser water pumps. CWP-W2 is a new "Armstrong" pump that was installed in 2017. The new condenser water pump is constant speed and rated for 30 HP, 56 ft. of head, and 1428 GPM. The other two (2) condenser water pumps are "Bell & Gossett" and were installed in 1997. These two (2) existing condenser water pumps, CWP-1 and CWP-3, are constant speed and are rated for 30 HP, 56 ft. of head and 1428 GPM. The Chilled water equipment discussed above is controlled by the "Siemens" building automation system. The table on the right includes details of the pumps serving the chilled water plant.

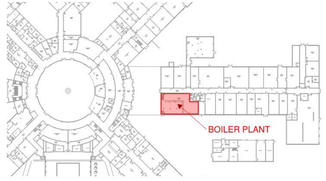
6 TO 10 YEAR RECOMMENDATION

The ASHRAE median service life for base mounted pumps such as those described above is 25 years. Chilled water pumps tagged CHWP-1 to 5, and condenser water pumps tagged CWP-1 and CWP-3 have been in operation since approximately 1997, therefore, they are 20 years old. Given the age of the pumps, it is recommended to replace them within the 6 to 10-year timeframe. Please reference the Pump Cost Estimates Section for pricing details.

Table 1: Chilled Water Plant Pumps

Tag	Service	Location	Pump Motor HP	Pump Feet of Head	Supply GMP	Fluid Medium
CHWP-1	CH-W1.1, CH-W1.2	Chiller Room	20	36	1,025	Chilled Water
CHWP-2	CH-W1.1, CH-W1.2	Chiller Room	20	36	1,025	Chilled Water
CHWP-3	CH-W1.1, CH-W1.2	Chiller Room	20	36	1,025	Chilled Water
CHWP-4	Bldg. CHW Loop	Chiller Room	40	90	1,050	Chilled Water
CHWP-5	Bldg. CHW Loop	Chiller Room	40	90	1,050	Chilled Water
CWP-W2	Chiller Condenser	Chiller Room	30	56	1,428	Condenser Water
CWP-1	Chiller Condenser	Chiller Room	30	56	1,428	Condenser Water
CWP-3	Chiller Condenser	Chiller Room	30	56	1,428	Condenser Water

Boiler Plant



First Floor Plan

2017 Condensing Hot Water Boilers

Space heating is provided by five (5) high efficiency hot water condensing boilers that were installed during the 2017 Steam to Hot Water Boiler Conversion Project. The hot water boilers serve perimeter finned tube radiators, AHUs, four-pipe UVs, fan coil units (FCUs), and unit heaters (UHs). Hot water is distributed to this equipment from the one (1) boiler plant; its location is highlighted to the right. The boilers and associated pumps are controlled by the "Siemens" building automation system. New and existing equipment located in the boiler room includes:

- Five (5) 2017 "Viessmann" condensing hot water boilers with 6,000 MBH input and combustion efficiencies capable of exceeding 94%
- Three (3) 2017 "Armstrong" primary loop hot water boiler pumps each with 25 HP, 87 ft. of head, 840 GPM and variable frequency drives (VFDs) – tagged P-W1.1, 1.2, 1.3
- Two (2) 1997 "Bell & Gossett" constant flow hot water pumps rated for 20 HP, 100 ft. of head, and 460 GPM serving D-Wing hot water heating equipment – tagged HWP-7, 8
- One (1) 2017 "Armstrong" air and dirt separator
- Two (2) 2017 hot water suspended unit heaters
- One (1) new "Armstrong" expansion tank

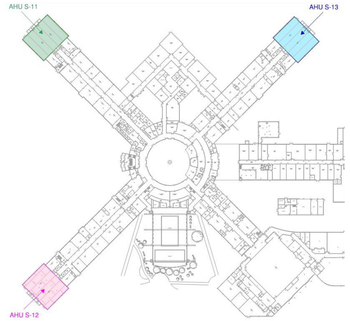
Table 2: Boiler Plant Pumps

Tag	Service	Location	Pump Motor HP	Pump Feet of Head	Supply GMP	Fluid Medium
P-W1.1	Primary HW Loop	Boiler Room	25	87	840	Hot Water
P-W1.2	Primary HW Loop	Boiler Room	25	87	840	Hot Water
P-W1.3	Primary HW Loop	Boiler Room	25	87	840	Hot Water
HWP-7	D-Wing Loop	Boiler Room	20	100	460	Hot Water
HWP-8	D-Wing Loop	Boiler Room	20	100	460	Hot Water

6 TO 10 YEAR RECOMMENDATION

The ASHRAE median service life for base-mounted pumps is 25 years. It Is recommended to replace the two (2) hot water pumps installed in 1997 with a like for like replacement within this timeframe. Please reference the Pump Cost Estimates section for additional details.

Gymnasium AHUs



First Floor Plan

Mechanical ventilation for the building is supplied by a variety of AHUs, UVs, RTUs, and FCUs. Exhaust is provided by numerous exhaust fans located throughout the building.

GYMNASIUM AIR HANDLING UNITS

The A-Wing, B-wing, and C-wing gymnasiums are provided heating and ventilation from AHUs S-12, S-11, and S-13 respectively. These AHUs are original to the building (installed in 1958) and are each equipped with a hot water coil, exhaust fan, outside air and return air dampers. These units were built in place in the basement crawl space below the gymnasium they serve and are controlled pneumatically. Note the table below for additional details and pictures to the right for the zones these AHUs serve.

Table 3: A, B, C-Wing Gymnasium AHUs

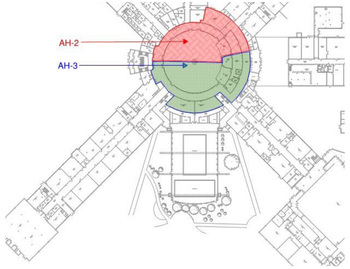
Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
AHU S-12	A-Wing Gym	A-Wing Bsmnt.	27,000	7.5	None	Hot Water
AHU S-11	B-Wing Gym	B-Wing Bsmnt.	27,000	7.5	None	Hot Water
AHU S-13	C-Wing Gym	C-Wing Bsmnt.	27,000	7.5	None	Hot Water

1 TO 2 YEAR RECOMMENDATION

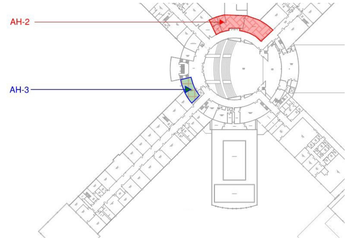
The gymnasium units are original to the building from 1958. According to ASHRAE, the median service life for these air handling units, such as those referenced above, is thirty (30) years. These units have exceeded their ASHRAE defined median equipment service life average; however, their reliability decreases with age.

Due to the limited mechanical space, it is recommended to update these units with, variable air volume packaged roof top units equipped with gas heating and DX cooling capabilities. With the transition to variable supply and cooling capabilities, considerable savings and comfort improvements would be achieved. Additionally, with the installation of a variable frequency drive (VFD) the fan motor life would be extended. The VFD allows the fan motor to "soft-start" meaning it allows the motor to slowly ramp up which reduces initial start-up shock when compared to a traditional motor start. Refer to the RTU Cost Estimates section for pricing details.

Cafeteria AHUs



First Floor Plan



Second Floor Plan

CAFETERIA AH-3 & CAFETERIA AH-2

Located in the A-Wing basement mechanical room is AH-3. AH-3 serves the south portion of the cafeteria, several adjacent first floor rooms and a portion of second floor rooms. Located in the B-Wing basement mechanical room is AH-2. AH-2 serves the North portion of the cafeteria, several adjacent first floor rooms and some offices on the second floor. Originally these units were installed in 2002, but in 2017 were furnished with a new hot water coil. Cooling for both units is provided by a chilled water coil. Both units are variable air volume operation and equipped with VFDs on both the supply and return/exhaust fans. Each unit's return/exhaust fan is remote mounted and has been in operation since 1958. Refer to the table below and colored graphic on the right for additional details.

Table 4: Cafeteria AHUs

Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
AH-2	North Cafeteria	B-Wing Mech. Rm.	25,000	25	Chilled Water	Hot Water
AH-3	South Cafeteria	A-Wing Mech. Rm.	19,000	20	Chilled Water	Hot Water

1 TO 2 YEAR RECOMMENDATION

Both cafeteria units have associated return fans that are original to the building and in poor condition. Due to their age, replacement parts can be costly and challenging to find.

It is recommended to replace the exhaust/return fans with a "like for like" replacement. This upgrade would provide increased reliability and efficiency due to new motor technologies. For additional details, please reference the Exhaust/Return Fan Cost Estimates section.

Table 5: A, B, & C-Wing Pumps

Tag	Service	Location	Pump Motor HP	Pump Feet of Head	Supply GMP	Fluid Medium
P-WB.2	AH-3 HW Coil	A-Wing Mech.	0.75	17	85	Hot Water
HWP-A.1	A-Wing Loop	A-Wing Mech.	20	100	460	Hot Water
HWP-A.2	A-Wing Loop	A-Wing Mech.	20	100	460	Hot Water
P-WB.1	AH-2 HW Coil	B-Wing Mech.	1	18	110	Hot Water
P-WB.3	L-Wing Loop	B-Wing Storage.	5	50	150	Hot Water
P-WB.4	L-Wing Loop	B-Wing Storage.	5	50	150	Hot Water
HWP-B.1	B-Wing Loop	B-Wing Mech.	20	100	460	Hot Water
HWP-B.2	B-Wing Loop	B-Wing Mech.	20	100	460	Hot Water
P-WB.5	AHU-WB.1	C-Wing Mech.	0.33	16	40	Hot Water
P-WB.6	Run-around Coil	C-Wing Mech.	1	132	15.5	40% Ethylene Glycol
HWP-C.1	C-Wing Loop	C-Wing Mech.	20	100	460	Hot Water
HWP-C.2	C-Wing Loop	C-Wing Mech.	20	100	460	Hot Water
HWP-E.1	E-Wing Loop	E-Wing Mech.	10	60	340	Hot Water
HWP-E.2	E-Wing Loop	E-Wing Mech.	10	60	340	Hot Water

A-WING MECHANICAL ROOM PUMPS

Three (3) hot water pumps are located in the A-Wing basement mechanical room. P-WB.2 is a constant volume "Armstrong" pump installed in 2017 with 0.75 HP, 17 ft. of head and 85 GPM. This pump circulates hot water through heating coil of AH-3. The other two (2) hot water pumps (HWP-A.1 and HWP-A.2) distribute secondary hot water throughout the A-Wing and serve UVs, FTRs and other A-Wing hot water equipment. These (2) "Bell & Gossett" pumps were installed in 1997 and have recently been outfitted with a VFD for variable flow. They are rated for 20 HP, 100 ft. of head and 460 GPM.

B-WING MECHANICAL ROOM PUMPS

There are five (5) hot water pumps in the B-Wing mechanical room. The first pump, P-WB.1, is a constant volume "Armstrong" pump rated for 1 HP, 18 ft. of head and 110 GPM. This pump was installed in 2017 and circulates hot water through the heating coil of AH-2. The next two (2) pumps (P-WB.3 and P-WB.4) distribute hot water throughout the L-Wing AHU, FTRs and other L-Wing hot water equipment. These pumps are constant volume "Armstrong" pumps rated for 5 HP, 50 ft. of head and 150 GPM. The final two (2) pumps (HWP-B.1 and HWP-B.2) receive hot water from the boiler plant and serve it to equipment throughout the B-Wing including: UVs, FTRs and UHs. These "Bell & Gossett" pumps were installed in 1997 and were recently equipped with VFDs for variable flow. They are rated for 20 HP, 100 ft. of head and 460 GPM.

C-WING MECHANICAL ROOM PUMPS

Pumping equipment located in the C-Wing mechanical room is as follows:

- P-WB.5, is a "Armstrong" hot water recirculation pump installed in 2017 serving the hot water coil of AHU-WB.1. It is rated for 1/3 HP, 16 ft. of head and 40 GPM.
- P-WB.6, is a "Goulds" runaround coil loop pump installed in 2017. This pump circulates a 40% ethylene glycol mixture fluid through the runaround energy recovery coil for the basement track AHU and is rated for 1 HP, 132 ft. of head, and 15.5 GPM.
- HWP-C.1, and HWP-C.2 are "Bell & Gossett" pumps rated for 20 HP, 100 ft. of head, and 460 GPM. These pumps were installed in 1997 and supply variable flow hot water from the boiler plant to typical hot water equipment throughout the C-WING.

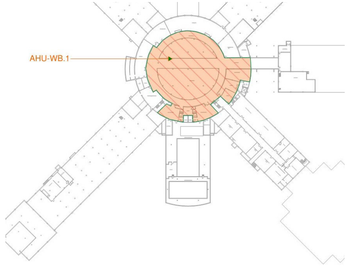
E-WING MECHANICAL ROOM PUMPS

Two (2) "Bell & Gossett" pumps are located in the E-Wing mechanical room. These pumps, operating since approximately 1967. They supply hot water to E-Wing equipment including: unit ventilators, air handlers, and finned tube radiators. These pumps were outfitted with VFDs and new motors in 2014. They are rated for 10 HP, 60 ft. of head and 340 GPM.

1 TO 2 & 6 TO 10 YEAR RECOMMENDATIONS

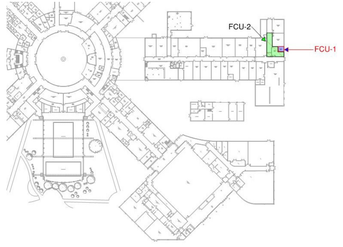
The ASHRAE median service life for base-mounted pumps is 25 years. It Is recommended to replace the 1997 hot water pumps with a "like for like" replacement within 6 to 10 years. Further, it is recommended that the 1967 pump impellors be replaced within 1 to 2 years. Please reference the Pump Cost Estimates section for additional details.

Basement Track AHU



Lower Floor Plan

FCU-1, FCU-2 ZONE



First Floor Plan

C-WING MECHANICAL ROOM: BASEMENT TRACK AHU

AHU-WB.1 was installed in 2017. This constant volume makeup air unit supplies the basement fitness center with conditioned air and is located in the C-Wing basement mechanical room. AHU-WB.1 is equipped with a chilled water coil, hot water coil, exhaust fan and an energy recovery coil. The energy recovery coil absorbs heat leaving the building from the exhaust air airstream via an energy recovery coil located in the exhaust airstream. The heated water is then pumped to the energy recovery coil located inside the air handling units outdoor airstream where the heat extracted from the exhaust is utilized to precondition the incoming outside air to the unit. This unit is controlled by the "Siemens" building automation system.

D-WING: FAN COIL UNITS

Two (2) small fan coil units (FCUs) installed in 2002, are located in the ceiling above office room D126 and serve the office spaces in the D-Wing. These units are equipped with a chilled water coil and receive outside air, or return air from a roof mounted intake ventilator. The remainder of the D-Wing is served by unit ventilators; this will be covered more in the Unit Ventilator section of this report.

Examine the pictures on the right and the table below for additional details.

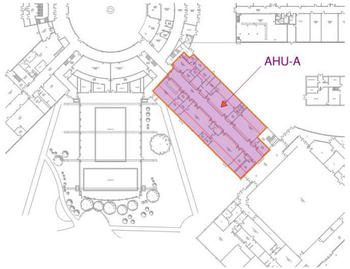
Table 6: Basement Track AHU & D-Wing FCUs

Tag	Area Serve	Location	Supply CFM	Supply Fan HP	CoolingMedium	Heating Medium
AHU-WB.1	Basement Track	C-Wing Mech. Rm.	5,500	2 @ 3	Chilled Water	Hot Water
FCU-1	Office D126A	Office D126	255	1/10	Chilled Water	Hot Water
FCU-2	Office D126 & Adjacent Hallway	Office D126	480	1/10	Chilled Water	Hot Water

No alterations are recommended for this equipment within the scope of this report.

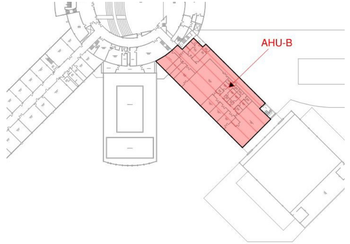
N.T.S.

E-WING: AHU-A



First Floor Plan

E-WING: AHU-B



Second Floor Plan

E-WING AHUs

AHU-A and AHU-B are located in the basement E-Wing mechanical room. They are both constant volume multi-zone units installed in 1967. These AHUs serve the E-Wing 1st and 2nd floors. In 2017, these AHUs were outfitted with new modulating hot water control valves because their coils were switched from steam to hot water. These units are controlled pneumatically and are on the buildings "Andover" building automation system. Both units are each equipped with a chilled water coil, hot water coil, and separate return fan.

Table 7: E-Wing AHUs

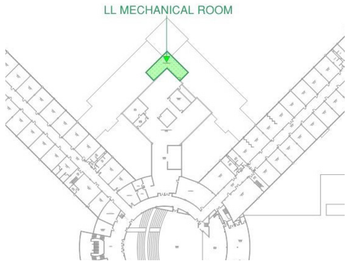
Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
AHU-A	E-Wing 1st Floor	E-Wing Mech. Rm.	10,300	7.5	Chilled Water	Hot Water
AHU-B	E-Wing 2nd Floor	E-Wing Mech. Rm.	12,305	10	Chilled Water	Hot Water

1 TO 2 YEAR RECOMMENDATION

Multi-zone systems like the E-Wing AHUs, operate using a "hot deck" and "cold deck." Air passes through both a "hot deck" and "cold deck" and then mixes to an appropriate discharge air temperature at the AHU before being delivered to a zone. This type of system is inefficient because simultaneous heating and cooling occurs at each air handler to serve the "hot deck" and "cold deck". Additionally, the opportunity exists to convert the units from constant volume to variable volume. Variable volume systems operate based on space demands and, therefore are more energy efficient. Furthermore, each of these AHUs is aged beyond their ASHRAE median equipment service life of 30 years, therefore, the reliability of these units continues to decrease with age.

Because of the age and inefficiency of the E-Wing AHUs, it is recommended to replace the existing air handlers with variable flow AHUs that support either fan powered box (FPB) terminal units or variable air volume (VAV) box terminal units equipped with hot water reheat coils. Both FPB and VAV systems would provide significant energy savings due to their variable operation and ability to provide heating or cooling based on the needs of the space at any given time. Reference the AHU Cost Estimates section for further information.

H-Wing AHUs Location



Second Floor Plan

H-Wing AHUs

First Floor Plan

H-WING AHUs

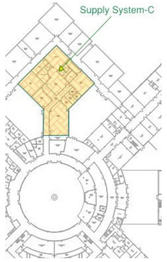
The H-Wing is served by two (2) AHUs that were installed in 2002. These AHUs are also tagged as AHU-A and AHU-B, but for clarity, shall be identified as AHU-H.1 and AHU-H.2 within this report. Both AHUs are equipped with: a VFD on the supply and the return fan, hot water coil, chilled water coil, and are located in the 2nd floor area "LL" mechanical room. These units serve variable air volume (VAV) terminal units and are controlled with DDC controls. The units are on the "Andover" building automation system. The table below and graphics adjacent provide additional specifications.

Table 8: H-Wing AHUs

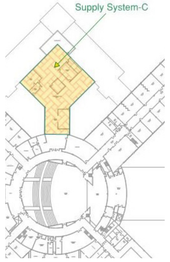
Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
AHU-H.1	H-Wing	LL Mechanical	9,200	10	Chilled Water	Hot Water
AHU-H.2	H-Wing	LL Mechanical	9,600	10	Chilled Water	Hot Water

No alterations are recommended for this equipment within the scope of this report.

L-Wing AHU: Supply System-C



First Floor Plan



Second Floor Plan

L-Wing AHU Roof Location

L-WING AHU

Supply System-C serves the 1st and 2nd floors of the L-Wing. This 1967 unit is located on the L-Wing roof inside of an enclosed mechanical room. Supply System-C is a constant volume, multi-zone unit that is controlled via pneumatics and is equipped with chilled water and hot water coils.

Table 9: L-Wing AHU

Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
Supply System-C	L-Wing	L-Wing Roof	23,000	20	Chilled Water	Hot Water

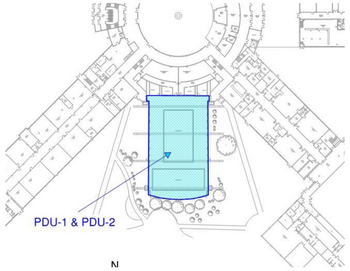
1 TO 2 YEAR RECOMMENDATIONS

As mentioned previously, with a multi-zone system air passes through a "hot deck" and "cold deck" and then mixes to an appropriate discharge air temperature at the AHU before being delivered to a zone. Multi-zone systems are inefficient because simultaneous heating and cooling occurs at each air handler to serve the "hot deck" and "cold deck." Additionally, constant volume systems are always running at full speed, even when the demand is low. Due to the units age there is a greater possibility of unit failure. There are two options for replacement:

OPTION 1 - Demolish the existing penthouse structure and to replace it with a variable volume RTU furnished with DX cooling, and gas heating.

OPTION 2 - Rebuild the penthouse and replace with a variable air volume AHU equipped with a chilled water coil and install terminal VAV boxes equipped with hot water reheat coils within the spaces. With both options, energy would be saved due to variable volume operation and the ability to provide heating or cooling based on space demands. Examine the AHU and RTU Cost Estimates section for further details regarding these recommended replacement options.

P-Wing Pool Dehumidification AHUs



Second Floor Plan

2017 Pool Dehumidification Unit

P-WING AHUS

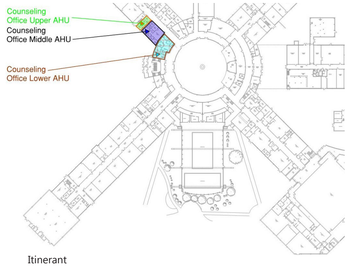
The pool was upgraded with two (2) new pool dehumidification air handling units in 2017. The "Innovent" AHUs are located outside on the West and East side of the pool and utilize a DX cooling coil, and gas furnace to condition and dehumidify the pool space. There are two (2) supply fans and two (2) return fans per unit and each set of fans is equipped with a VFD. Air enters the units from a combination of outside air and return air ducts.

Table 10: P-Wing AHUs

Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
PDU-1	Pool	Pool Exterior	14,250	2 @ 10	DX	Gas
PDU-2	Pool	Pool Exterior	14,250	2 @ 10	DX	Gas

No alterations are recommended for this equipment within the scope of this report.

Counseling Office AHUs



First Floor Plan

Counseling Offices Upper AHU

Counseling Offices Middle AHU

COUNSELING OFFICES AHUs

There are three (3) small AHUs that serve the 1st floor counseling offices in the B-Wing.

The first AHU is commonly referred to as the "Upper Unit" and is a "Carrier" AHU that is located in room B102K and reported to be original to the building. The Upper Unit supplies constant volume air and is equipped with DX cooling with an associated condensing unit. This unit has electric heating coils that reportedly no longer work.

The second AHU is commonly referred to as the "Middle Unit." This unit supplies constant volume air, is located in a crawl space in room R101E, and is equipped with DX cooling, and electric heating coils. It was also reported that the Middle Unit is believed to be original to the building.

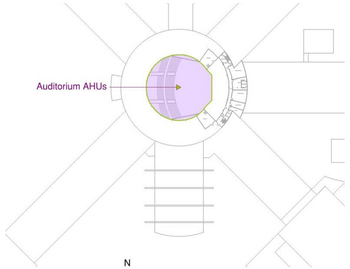
The final AHU was replaced in the summer of 2012. This unit is known as the "Lower Unit" and is equipped with DX cooling and hot water heating coils. This AHU distributes constant volume supply air and is located in an attic space in the counseling office. Examine the graphic on the right for the zones served by these three (3) AHUs.

1 TO 2 YEAR RECOMMENDATION

According to conversations with building maintenance staff, the Upper and Middle AHUs are reportedly difficult to control, cause some areas to overheat/overcool, and do not supply an adequate amount of ventilation air. The unequal temperature distribution is partly due to the single zone perimeter finned tubed radiators that provide additional heat for spaces near windows. Furthermore, the ASHRAE median service life for a packaged medium-duty air handling unit is 25 years.

It is recommended to replace the aged Upper and Middle units with variable volume supply AHUs and DDC capabilities. Benefits from this upgrade include: increased comfort control, reliability improvements, and reduced operating costs. Please reference the AHU Cost Estimates section for pricing details.

Auditorium AHUs



Third Floor Plan

AUDITORIUM AHUs

Two (2) new "Temtrol" AHUs (AHU-3.1 and AHU-3.2) were installed in 2017. Each are equipped with hot water coils and DX coils with new associated condensing units on the roof. Each AHU has a return air duct, exhaust fan, and four (4) supply fans. These units are on the "Siemens" building automation system. Examine the table below for additional unit details.

Table 11: Auditorium AHUs

Tag	Area Serve	Location	Supply CFM	Supply Fan HP	Cooling Medium	Heating Medium
AHU-3.1	Auditorium	South Fan Room	9,500	3 each	DX	Hot Water
AHU-3.2	Auditorium	North Fan Room	9,500	3 each	DX	Hot Water

No alterations are recommended for this equipment within the scope of this report.

MISCELLANEOUS VENTILATION UNITS

1. Room E-106 Dark Room AHU – This unit has a failed hot water coil and does not provide adequate fresh air for the space.

2. Spectator Gym Foyer Units – There are two (2) hot water cabinet unit heaters located above the concession stand that serve the foyer in the spectator gym. It has been reported that these units are from 1969 and are no longer capable of providing heating.

1 TO 2 YEAR RECOMMENDATION

Item 1: E106 Dark Room AHU – It is recommended to add a make-up air unit for this space.

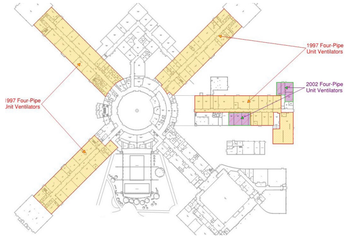
Item 2: Spectator Gym Foyer Units:

OPTION #1 - It is recommended to provide a direct replacement of the cabinet unit heater equipment and tie into the existing ductwork which will be reused.

OPTION #2 - As an alternate scope of work, it is recommended to add cooling via direct expansion air cooled condensers located on the lower roof.

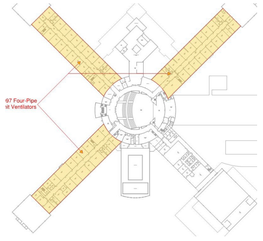
Please reference the AHU Cost Estimates section for pricing details

First Floor UVs



First Floor Plan

2nd Floor UVs



Second Floor Plan

UNIT VENTILATORS (UVs)

Four-pipe unit ventilators serve the classrooms in the A, B, C, and D wing classrooms on the first floor and the A, B, and C-Wing classrooms on the 2nd floor. During a 1997 noise abatement project conducted by the Federal Aviation Administration (FAA), most classroom UVs located in the wings were replaced; It is our understanding that Maine West did not have much or any input regarding the specs of these UVs. In 2002 there were a few additional classroom UV upgrades. Refer to the graphic to the right for an overview on UV zones.

6 TO 10 YEAR RECOMMENDATION

Temperature control and noise can be an issue, and part replacements are often costly. Additionally, these UVs are not equipped with face and bypass dampers and, as a result, during below-freezing temperatures, cooling coils commonly “pop” due to the temperature differences causing the fluid to expand and burst the coil.

There are two options for UV replacement: Option 1 is to replace with vertical change air UVs. This would provide increased comfort control and reliability, as well as the option of installing UVs with face and bypass dampers to eliminate coil “pops.” Option 2 is to install a variable flow, dedicated outdoor air supply unit (DOAS) on the roof that serves local fan coil units with hot water heating and chilled water cooling coils. This system provides optimum temperature control and would yield long-term energy savings due to its variable volume supply. Please reference the UV Cost Estimates section for pricing details.

N.T.S.

ROOF TOP UNITS (RTUs)

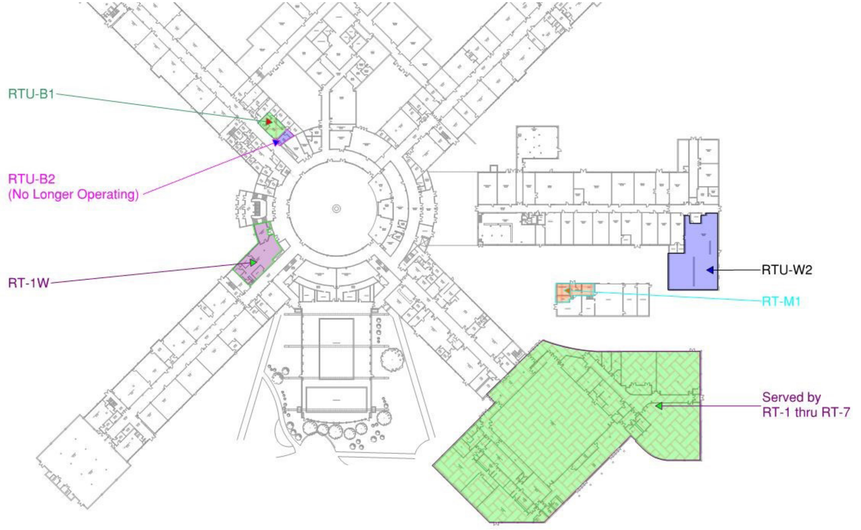
The following table summarizes information for the packaged roof top units including: year installed, reference tag (if not available, one was assigned), make, roof location, areas served, heating and cooling type, tonnage and additional notes regarding unique attributes of the unit. Additionally, the figure on the following page highlights the areas served by each RTU. Reference the RTU Recommendations and RTU Cost Estimates section for additional information.

Roof Top Unit Details

Year Installed	Reference Tag	Make	Location	Area Served	Heating	Cooling	Tonnage	Notes
1992	RTU-A222	Carrier	A-Wing	Room A-222 & Office(s)	Electric	DX	2	Significant Rust, Poor Condition, Operating, R-22
1992	RTU-A218	Carrier	A-Wing	Room A-218 & Office(s)	Electric	DX	2	Significant Rust, Poor Condition, Operating, R-22
2013	RT-1W	AAON	A-Wing	A-Wing Admin. Offices	None	DX	11	Serves 4 VAV Zones
1984	R209	York	Rotunda	Classroom R209 and Offices	None	DX	7.5	Operating, Poor Condition, Control Board has been Hot Wired to Maintain Operation
1984	R207	York	Rotunda	Choral Room R207 and Office	None	DX	7.5	Operating, Bad shape, Control Board has been Hot Wired to Maintain Operation
1999	*RTU-R201	Carrier	Rotunda	SPS Conference Rm.	Electric	DX	4	-
1999	*RTU-R202	Carrier	Rotunda	Rm R202 - Warriors Rm.	Electric	DX	4	Poor Condition
2017	RTU-W1	Carrier	Rotunda	Back of House Auditorium	Natural Gas	DX	15	
2017	RTU-W2	Valent	D-Wing	Auto Shop Lab	Natural Gas	DX	23	MAU, Equipped with VFD
1992	*RTU-B1	Carrier	B-Wing	Dean's Office B101	Heat Pump	DX	3	Heat Pump can't heat below freezing temps Poor Condition
1992	*RTU-B2	Carrier	B-Wing	B-Wing Conference Rm.	None	DX	3	No Longer operating
2002	*RT-M1	Trane	M-Building	West Half of M-Building	Natural Gas	DX	3.3	Full Economizer and Powered Exhaust
2014	RT-1	Carrier	E-Wing 2014 Addition	E-Wing 2014 Addition	Hot Water coil	DX	40	VAV, CO2, VFD on Supply & Return
2014	RT-2	Carrier	E-Wing 2014 Addition	E-Wing 2014 Addition	Hot Water coil	DX	40	VAV, CO2, VFD on Supply & Return
2014	RT-3	Carrier	E-Wing 2014 Addition	E-Wing 2014 Addition	Hot Water coil	DX	40	VAV, CO2
2014	RT-4	Greenheck	E-Wing 2014 Addition	E-Wing 2014 Addition	20 kW Electric Preheat & Hot Water Coil	None	60	CV, CO2, Variable Speed Enthalpy Wheel
2014	RT-5	Greenheck	E-Wing 2014 Addition	E-Wing 2014 Addition	15 kW Electric Preheat & Hot Water Coil	None	60	CV, Variable Speed Enthalpy Wheel
2014	RT-6	AAON	E-Wing 2014 Addition	E-Wing 2014 Addition	Hot Water coil	DX	10	VAV, CO2
2014	RT-7	Carrier	E-Wing 2014 Addition	E-Wing 2014 Addition	Hot Water coil	DX	3	CV

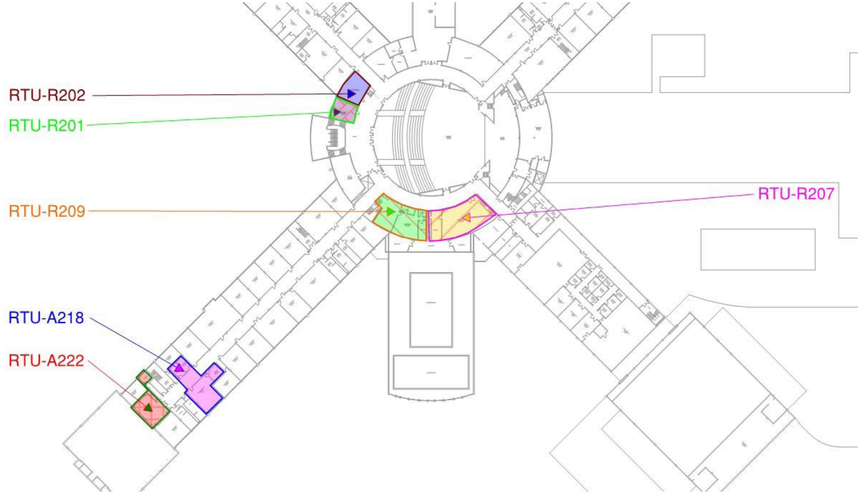
**Note: No RTU tag name was found, so tags were assigned for RTUs with **

Term Clarifications
VAV = Variable Air Volume MAU = Make-Up Air Unit VFD = Variable Frequency Drive CO2 = Unit is controlled to maintain safe levels of indoor CO2
Variable Speed Enthalpy Wheel = Energy recovery wheel that transfers heat from exhaust air to supply air CV = Constant Volume Supply



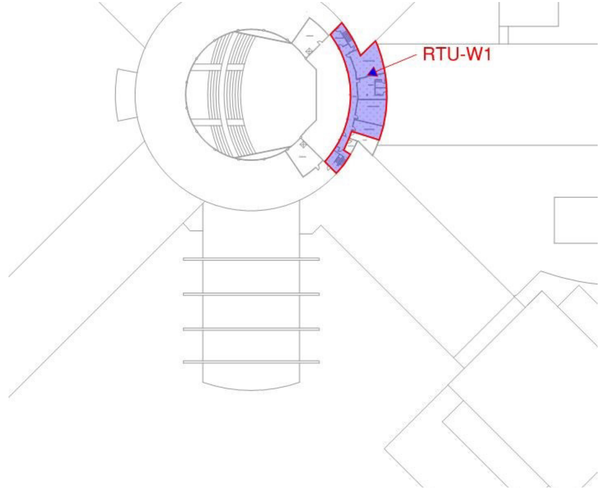
First Floor Plan

N.T.S.



Second Floor Plan

MECHANICAL, ELECTRICAL, PLUMBING, AND FIRE PROTECTION CONDITIONS
ROOF TOP UNITS ZONES
MAINE WEST HIGH SCHOOL



Third Floor Plan

ROOF TOP UNIT RECOMMENDATIONS

The ASHRAE median service life for packaged roof top units is 15 years. Roof top units are exposed to the elements which can cause corrosion and reduce their useful service life. Therefore, the units recommended for replacement are those greater than 15 years in age. Please reference the RTU Cost Estimates section for pricing details.

COST ESTIMATES

The cost estimate tables below for recommended replacements encompass any associated mechanical, electrical, plumbing, controls, equipment, contracting, demolition, and installation costs. The anticipated start year for replacements is 2019. It should be noted that two costs will be shown for future recommendations. For example, if an item is recommended for replacement from 2019 – 2020 then the 2019 costs and the 2020 inflated costs would be shown. A 3% inflation rate was utilized. Cost estimates were determined by referencing our experience with similar systems and the areas served by these systems. Cost estimates are as follows:

ROOF TOP UNIT COST ESTIMATES (1 TO 2 YEARS)

Recommended Replacement Timeframe	Year Installed	Tag	Make	Roof Location	Area Served	Heating	Cooling	Toonage	Year 2019 Cost	Year 2020 Cost
2019 - 2020	1984	R209	York	Rotunda	Classroom R209 and Offices	None	DX	7.5	$25,000	$26,523
	1984	R207	York	Rotunda	Choral Room R207 and Office	None	DX	7.5	$25,000	$26,523
	1992	RTU-A222	Carrier	A-WING	Room A-222 & Office(s)	Electric	DX	2	$6,000	$6,365
	1992	RTU-A218	Carrier	A-WING	Room A-218 & Office(s)	Electric	DX	2	$6,000	$6,365
	1992	RTU-B1	Carrier	B-Wing	Dean's Office B101	Heat Pump	DX	3	$10,000	$10,609
	1992	RTU-B2	Carrier	B-Wing	B-Wing Conference Room	None	DX	3	$10,000	$10,609
	1999	RTU-R201	Carrier	Rotunda	Rm R201 - SPS Conf. Rm.	Electric	DX	4	$15,000	$15,914
	1999	RTU-R202	Carrier	Rotunda	Rm R202 - Warriors Rm.	Electric	DX	4	$15,000	$15,914
	2002	RT-M1	Trane	M-Building	West half of M-Building	Natural Gas	DX	3.3	$15,000	$15,914
								TOTAL:	$127,000	$134,734

AIR HANDLING UNIT COST ESTIMATES (1 TO 2 YEARS)

Recommended Replacement Timeframe	AHU	Location	Service	Existing System Type	Recommended System Type	Year 2019 Cost	Year 2020 Cost
AHU S-12	A-Wing Sub Basement	A-Wing Gymnasium	6,721	Single Zone	VAV RTU	$300,000	$318,270
AHU S-11	A-Wing Sub Basement	B-Wing Gymnasium	6,721	Single Zone	VAV RTU	$300,000	$318,270
AHU S-13	A-Wing Sub Basement	C-Wing Gymnasium	6,721	Single Zone	VAV RTU	$300,000	$318,270
AHU-A	E-Wing Mech.	E-Wing 1st Floor	13,164	Multi Zone	VAV AHU	$550,000	$583,495
AHU-B	E-Wing Mech.	E-Wing 2nd Floor	14,208	Multi Zone	VAV AHU	$550,000	$583,495
Supply System-C	L-Wing Penthouse	L-Wing	19,804	Multi Zone	VAV AHU	$500,000	$530,450
UPPER	B102K	Counseling offices	500	Single Zone	VAV AHU	$25,000	$26,523
MIDDLE	R101E	Counseling offices	1,394	Single Zone	VAV AHU	$70,000	$74,263
LOWER	Counseling Above Ceiling	Counseling offices	1,346	Single Zone	VAV AHU	$70,000	$74,263
Dark Room	E-106	E-106	990	Single Zone	CAV AHU	$25,000	$26,523
Spectator Gym	Foyer Ceiling	Spec Gym Foyer	3,174	Single Zone	Like for Like - Option #1	$65,000	$68,959
					TOTALS:	$2,755,000	$2,922,780

SUPPLY SYSTEM-C: ALTERNATE OPTION #2 (1 TO 2 YEARS)

Rebuild the penthouse and replace with a variable air volume AHU equipped with a chilled water coil and install terminal VAV boxes equipped with hot water reheat coils within the spaces.

- **2019 Cost: $800,000**
- **2020 Cost: $848,720**

SPECTATOR GYM FOYER UNITS: ALTERNATE OPTION #2 (1 TO 2 YEARS)

This estimate includes the addition of DX cooling coils and associated roof-mounted condensing unit(s).

- **2019 Cost: $125,000**
- **2020 Cost: $132,600**

UNIT VENTILATOR COST ESTIMATES: 2 RECOMMENDATIONS (6 TO 10 YEARS)

UV	Location	Service	Area Served (ft2) or Quantity	Existing System Type	Recommended System Type	Year 2019 Cost	Year 2020 Cost
UV	Classroom UVs	Classroom UVs	147,539	UV	FCU-DOAS	$6,000,000	$6,955,644
OR							
UV	Classroom UVs	Classroom UVs	179	UV	Vertical Change Air UVs	$4,000,000	$4,637,096

EXHAUST FANS: (6 TO 10 YEARS)

According to ASHRAE, the median useful service life for indoor centrifugal exhaust fans is twenty-five (25) years and the median useful service life for roof mounted exhaust fans is twenty (20) years. According to the existing engineering drawings that we have on file there are approximately (64) exhaust fans that have already, or will exceed their ASHRAE recommended service life within the next ten years. Therefore, it is recommended to upgrade these exhaust fans with a like for like replacement within the 6 to 10-years. This estimate also includes the cost to replace the stand-alone exhaust fans for cafeteria units AH-2 and AH-3. The cost estimates are as follows:

- **2024 Cost: $ 300,000**
- **2028 Cost: $ 352,980**

PUMPS: (1 TO 2) AND (6 TO 10 YEARS) REPLACEMENT COST ESTIMATES

Recommended Replacement Timeframe	Tag	Service	Recommended Replacement Type	2019 Cost	2020 Cost	2024 Cost	2028 Cost
2019 - 2020	HWP-E.1	E-Wing Loop	Like for Like	$8,000	$8,240		
	HWP-E.2	E-Wing Loop	Like for Like	$8,000	$8,240		
2024 - 2028	CHWP-1	CH-W1.1, CH-W1.2	Like for Like			$15,000	$16,883
	CHWP-2	CH-W1.1, CH-W1.2	Like for Like			$15,000	$16,883
	CHWP-3	CH-W1.1, CH-W1.2	Like for Like			$15,000	$16,883
	CHWP-4	Bldg. CHW Loop	Like for Like			$30,000	$ 33,765
	CHWP-5	Bldg. CHW Loop	Like for Like			$30,000	$33,765
	HWP-7	D-Wing Loop	Like for Like			$15,000	$16,883
	HWP-8	D-Wing Loop	Like for Like			$16,000	$18,008
	CWP-1	Chiller Room	Like for Like			$25,000	$28,138
	CWP-3	Chiller Room	Like for Like			$25,000	$28,138
	HWP-A.1	A-Wing Loop	Like for Like			$15,000	$16,883
	HWP-A.2	A-Wing Loop	Like for Like			$15,000	$16,883
	HWP-B.1	B-Wing Loop	Like for Like			$15,000	$16,883
	HWP-B.2	B-Wing Loop	Like for Like			$15,000	$16,883
	HWP-C.1	C-Wing Loop	Like for Like			$15,000	$16,883
	HWP-C.2	C-Wing Loop	Like for Like			$15,000	$16,883
			TOTALS:	$16,000	$16,480	$276,000	$310,640

MECHANICAL COST ESTIMATES

MAINE WEST HIGH SCHOOL

TOTAL MECHANICAL COST ESTIMATES

Category	Recommended Replacement Timeframe	Equipment Type	Year 2019 Cost	Year 2020 Cost
Mechanical	2019 - 2020	RTUs	$127,000	
	2019 - 2020	AHUs	$2,755,000	
	2024 - 2028	UVs		$4,000,000
	2024 - 2028	Exhaust Fans		$300,000
	2019 - 2020	Pumps	$16,000	
	2024 - 2028	Pumps		$276,000
		TOTALS:	**$2,898,000**	**$4,576,000**

Note: The Unit Ventilator cost shown above is for the direct replacement option. The alternate cost estimates for UV replacements are shown on page 194. Also, the alternate AHU cost estimates are excluded from the table above and are shown on page 193.

This report section will review the existing electrical systems at Maine West High School. Subsections will include: primary distribution, secondary distribution, receptacle and lighting panelboards, lighting systems, and fire alarm.

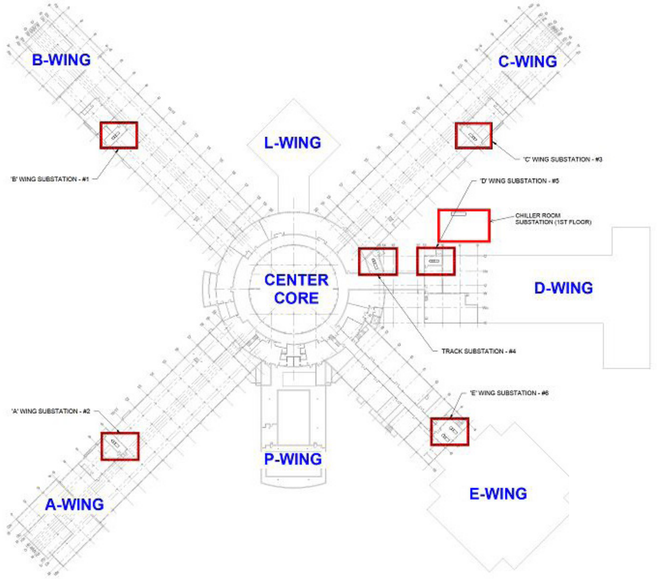
Once the existing systems are described, we will present recommendations for the upgrade of each system, if required, along with an estimated cost of replacement. These recommendations are based on our understanding of the current local electrical and life-safety codes, as well as observation of what similar facilities have implemented in recent projects. The recommendations are not to be used in place of a fully-designed system. Detailed designs for replacement may be further evaluated at a later date.

Determinations are made regarding service life by visually evaluating the equipment, determining the availability of replacement parts, and comparing the known age of the equipment to what the average service life may be for a similar unit. There is no exact standard for what the service life is of a given piece of electrical equipment due to the myriad of environmental and maintenance factors that can impact the health of elements like copper busses, switches, transformers, enclosures, and the like. Our understanding of service life is then based around the observed average age of similar equipment when it was replaced.

Recommendations will be presented in two groups:

1. Health Life Safety (2019) – These items are considered the most critical to maintain the health of the existing electrical system, or in some cases the most beneficial to occupants. Recommendations in this category often address safety risks for building occupants or maintenance personnel.
2. 1 to 2 Years (2019 to 2020) – Equipment in this category should be considered for replacement within the next couple of years or routine maintenance should be performed as soon as possible.
3. 3-5 year (2021-2023): These items typically represent equipment or systems that should be upgraded for compliance with electrical codes, or certain equipment that may be aged beyond the anticipated service life, but is not expected to be a significant safety risk.

On the next page is a map indicating the naming designations of various sections of the school. These names will be referenced throughout this report.



Lower Floor Plan

B-Wing Substation 4160V Switch

4160V Service Conduits

BUILDING PRIMARY ELECTRICAL DISTRIBUTION

The primary electrical distribution system for Maine West is provided by an outdoor utility automatic transfer switch and transformer from Oakton Street, on the north side of the facility. The service voltage is 4160V. This service enters an indoor metal-clad switchgear in the school's B-wing, which divides the service into two feeder lines, and also contains a current transformer section and a utility meter. One of the lines routes to the B-Wing and A-Wing unit substations, while the other routes underground to the C-Wing, D-Wing, E-Wing, and Track (Center Core) substations. The substations are set up to power only the section of the school in which they are located.

The indoor switchgear in the B-Wing substation room consists of (2) load break, metal-clad 4160V switches manufactured by S&C which feed a total of (6) substations. The switches have been exercised, maintained, and cleaned within the last 12 months.

3 to 5 Year Recommendation:
During the summer of 2017, preventative maintenance and switch exercising work was performed on the main metal-clad switchgear. It is recommended to perform this same exercise every two years. The estimated cost per procedure is $10,000.

The building's substations are described in detail in the following sections.

B-Wing Substation Transformer and Circuit

B-Wing Substation Load Break Switch

B-WING SUBSTATION

The first section of the B-Wing substation consists of a 4160V load break switch manufactured by Olsun Electric, the second section contains a 500 KVA transformer to step the voltage down to 120/208V. The third section has a 1600A circuit main secondary breaker, a 70A circuit breaker for an emergency panelboard, (7) circuit breakers for normal power, and a local ammeter. The substation was manufactured by General Electric, aside from the load break switch. The substation is original to the building, and the equipment is past its expected lifespan. Some older feeders in the substation are cloth-insulated.

The substation's 4160V primary switch and the secondary distribution circuit breaker have been exercised (but not cleaned) within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR B-WING SUBSTATION

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other electrical equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR B-WING SUBSTATION

The B-Wing substation is original to the building from 1959. The unit is aged beyond its expected lifespan, and the various sections of the board contain parts that are outdated and difficult to obtain for replacement purposes. Due to the inherent reliability issues of an aged unit, it is recommended to replace this substation in the coming years.

A like-for-like replacement can be implemented by custom switchboard manufacturers, replacing the primary switch, transformer, and main and distribution breakers in a package of the same size as the existing. We recommend the replacement of all cloth-insulated cables with copper thermoplastic-insulated wire. Any cables that are not cloth-insulated may remain.

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash and coordination study at the same time the switchboards are replaced.

A-Wing Substation Transformer and Circuit

A-Wing Tennis Court Lights Transformer Load

A-WING SUBSTATION

The first section of the A-Wing substation consists of a 4160V load break switch manufactured by Olsun Electric, the second section contains a 300 KVA transformer to step the voltage down to 120/208V. The third section has a 1600A circuit breaker for the building's distribution load, a 50A circuit breaker for an emergency panelboard, (9) circuit breakers for normal power, and a local ammeter. The substation was manufactured by General Electric, with the exception of the load break switch. The substation is original to the building, and the equipment is past its expected lifespan. Some older feeders in the substation are cloth-insulated.

The substation room also contains a 4160V load break switch manufactured by Olsun Electric, which routes a feeder from the substation room to a transformer at the outdoor tennis courts for the purposes of powering outdoor lighting.

The substation's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR A-WING SUBSTATION

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR A-WING SUBSTATION

The A-Wing substation is original to the building from 1959. The unit is aged beyond its expected lifespan, and the various sections of the board contain parts that are outdated and difficulty to obtain for replacement purposes. Due to the inherent reliability issues of the unit, it is recommended to replace this substation in the coming years.

A like-for-like replacement can be implemented by custom switchboard manufacturers, replacing the primary switch, transformer, and main and distribution breakers in a package of the same size as the existing. We recommend the replacement of all cloth-insulated cables with copper thermoplastic-insulated wire. Any cables that are not cloth-insulated may remain.

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash and coordination study at the same time the switchboards are replaced.

C-Wing Substation Transformer and Circuit Breakers

C-Wing Substation 4160V Load Break Switch

C-WING SUBSTATION

The first section of the A-Wing substation consists of a 4160V load break switch manufactured by Olsun Electric, the second section contains a 300 KVA transformer to step the voltage down to 120/208V. The third section has a 1600A circuit breaker for the building's distribution load, a 50A circuit breaker for an emergency panelboard, (9) circuit breakers for normal power, and a local ammeter. The substation is made up of parts from a number of different manufacturers. The substation is original to the building, and the equipment is past its expected lifespan. Some older feeders in the substation are cloth-insulated.

The substation's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR C-WING SUBSTATION

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR C-WING SUBSTATION

The C-Wing substation is original to the building from 1959. The unit is aged beyond its expected lifespan, and the various sections of the board contain parts that are outdated and difficulty to obtain for replacement purposes. Due to the inherent reliability issues of the unit, it is recommended to replace this substation in the coming years.

A like-for-like replacement can be implemented by custom switchboard manufacturers, replacing the primary switch, transformer, and main and distribution breakers in a package of the same size as the existing. We recommend the replacement of all cloth-insulated cables with copper thermoplastic-insulated wire. Any cables that are not cloth-insulated may remain.

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash and coordination study at the same time the switchboards are replaced.

D-Wing Substation Transformer and Circuit Breakers

D-Wing Substation Emergency Panel

D-WING SUBSTATION

The first section of the D-Wing substation consists of a 4160V load break switch manufactured by Olsun Electric, the second section contains a 500 KVA transformer to step the voltage down to 120/208V. The third section has a 1600A circuit breaker for the building's distribution load, a 50A circuit breaker for an emergency panelboard, (13) circuit breakers for normal power, and a local ammeter. The substation was manufactured by General Electric aside from the load break switch. The substation is original to the building, and the equipment is past its expected lifespan. Some of the substation's older feeder wires are cloth-insulated.

The substation's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR D-WING SUBSTATION

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR D-WING SUBSTATION

The D-Wing substation is original to the building from 1959. The unit is aged beyond its expected lifespan, and the various sections of the board contain parts that are outdated and difficulty to obtain for replacement purposes. Due to the inherent reliability issues of the unit, it is recommended to replace this substation in the coming years.

A like-for-like replacement can be implemented by custom switchboard manufacturers, replacing the primary switch, transformer, and main and distribution breakers in a package of the same size as the existing. We recommend the replacement of all cloth-insulated cables with copper thermoplastic-insulated wire. Any cables that are not cloth-insulated may remain.

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash and coordination study at the same time the switchboards are replaced.

E-Wing Substation #1 - Front

E-Wing Substation #1 – Load Center

E-WING SUBSTATION #1

The first section of the E-Wing substation #1 consists of a 4160V load break switch manufactured by Westinghouse Electric, the second section contains a 500 KVA transformer to step the voltage down to 120/208V. The third section has a 1600A circuit breaker for the building's distribution load, a 125A circuit breaker for an emergency panelboard, (12) circuit breakers for normal power, and a local ammeter. The substation was manufactured by Westinghouse Electric. The substation is original to the building's E-Wing expansion, and the equipment is approximately at the end of its expected lifespan.

The substation's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR E-WING SUBSTATION #1

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR E-WING SUBSTATION #1

This substation is original to the building's E-Wing expansion from 1967. The unit is aged beyond its expected lifespan, and the various sections of the board contain parts that are outdated and difficulty to obtain for replacement purposes. Due to the inherent reliability issues of the unit, it is recommended to replace this substation in the coming years.

A like-for-like replacement can be implemented by custom switchboard manufacturers, replacing the primary switch, transformer, and main and distribution breakers in a package of the same size as the existing. We recommend the replacement of any cloth-insulated cables with copper thermoplastic-insulated wire. Any cables that are not cloth-insulated may remain.

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash and coordination study at the same time the switchboards are replaced.

E-Wing Substation #2 – Load Break Switch and Transformer

E-Wing Substation #2 Branch Circuit Breakers

E-WING SUBSTATION #2

The first section of the E-Wing substation #2 consists of a 4160V load break switch manufactured by Square-D, the second section contains a 750/1000 KVA transformer to step the voltage down to 277/480V. The third section has a main 1200A circuit breaker for the building's distribution load and a local meter, and the fourth section contains (4) branch breakers with (2) active currently, some spaces for additional circuit breakers, and a surge protection module. The substation is manufactured entirely by Square-D. The substation was installed concurrent with the upgrades to the Spectator Gymnasium, performed within the last ten years. The substation is in good condition overall.

The substation's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR E-WING SUBSTATION #2

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR E-WING SUBSTATION #2

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash study and apply the labels in a timely manner to comply.

Center Core Substation – Transformer and EM Breaker

Center Core Substation – Wiring in Rear

TRACK (CENTER CORE) SUBSTATION

The first section of the Center Core substation consists of a 4160V load break switch manufactured by Olsun Electric, the second section contains a 1000 KVA transformer to step the voltage down to 120/208V. The third section has a 1600A circuit breaker for the building's distribution load, a 150A circuit breaker for an emergency panelboard, (18) circuit breakers for normal power, and a local ammeter. The substation was manufactured by General Electric aside from the load break switch. The substation is original to the building, and the equipment is past its expected lifespan. Some of the substation's older feeder wires are cloth-insulated (pictured to the right).

The substation's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR TRACK (CENTER CORE) SUBSTATION

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR TRACK (CENTER CORE) SUBSTATION

The Center Core substation is original to the building from 1964. The unit is aged beyond its expected lifespan, and the various sections of the board contain parts that are outdated and difficulty to obtain for replacement purposes. Due to the inherent reliability issues of the unit, it is recommended to replace this substation in the coming years.

A like-for-like replacement can be implemented by custom switchboard manufacturers, replacing the primary switch, transformer, and main and distribution breakers in a package of the same size as the existing. We recommend the replacement of all cloth-insulated cables with copper thermoplastic-insulated wire. Any cables that are not cloth-insulated may remain.

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash and coordination study at the same time the switchboards are replaced.

Chiller Room – MDP and MCC

Chiller Room – Outdoor Transformer

CHILLER ROOM

The chiller room electrical distribution is currently undergoing an upgrade as part of a chiller replacement project. The room is fed via a 4160V service from the B-Wing substation that travels through a load break switch in the corner (manufactured by Cutler-Hammer), then heads outside underground to a new 1000KVA, 4160-480V transformer. The feeder then re-enters the room and connects to a 1200A distribution panelboard which feeds the two new chillers and the existing 6-section motor control center located in the room. All indoor distribution equipment were manufactured by Cutler-Hammer/Eaton, and the outdoor transformer was manufactured by ABB. The existing equipment appeared to be in good condition from a visual inspection.

The room's primary 4160V switch and the secondary distribution circuit breaker have been exercised within the last 12 months.

1 TO 2 YEAR RECOMMENDATION FOR CHILLER ROOM

We recommend to continue exercising the existing 4160V switches every two years to verify proper operation and reduce risk of becoming stuck in a certain position at an inopportune time. Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

3 TO 5 YEAR RECOMMENDATION FOR CHILLER ROOM

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information on all distribution equipment. It is recommended to perform an arc flash and coordination study for the motor control center and primary distribution switch.

GE "Original" Panel – Located in Track Area

New 480V Panel – From E-Wing Substation #2

BUILDING PANELBOARDS

The school's lighting and power panelboards are distributed throughout the school, only a few are located in the substation rooms where the main power distribution resides. The condition of the panels are varied, many having been replaced over the course of the facility's history from GE original panels to newer units from Challenger, GE, Square-D, and Cutler-Hammer. Almost all panelboards are three-phase units, with supply voltages that are either 120/208V or 277/480V throughout the school.

1 TO 2 YEAR RECOMMENDATION FOR BUILDING PANELBOARDS

OSHA 2015 regulations require the application of an arc flash label that provides information on arc flash protection boundary, incident energy, working distance, PPE class, and available short circuit information. It is recommended to perform an arc flash study and apply the labels as soon as possible to comply.

Additionally, we recommend annual thermal inspections of the substation, switches, distribution panels, and other equipment in order to more easily identify problematic areas of unwanted heat buildup in the system.

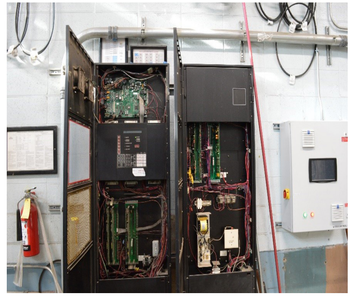
3 TO 5 YEAR RECOMMENDATION FOR BUILDING PANELBOARDS

Certain panelboards found in the school are original to the building, manufactured by GE. These panels are beyond their expected lifespan, and it is recommended to replace them in the near future with a new unit. We recommend the new panels to contain additional spare circuits inside them to help anticipate future electrical needs.

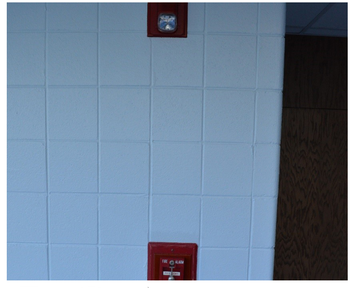
Other panelboard candidates for replacement may be determined based on thermal scans or maintenance requirements over time. Building staff may have knowledge of specific problematic panelboards that can be replaced to create a more reliable distribution system, and panels that have high thermal readings may be experiencing material deterioration that is most easily alleviated through replacement.

Any panelboards fed via cloth-insulated wiring should be re-fed with equivalent thermoplastic-insulated wire.

Fire Alarm Panel



Fire Alarm Pull Station and Visual Device



FIRE ALARM

The building contains a Simplex fire alarm system with a Cerberus Pyrotronics main fire alarm control panel, consisting of audio, visual, heat detector, smoke detector, and pull station devices. The system is outdated and does not meet present code in certain areas.

1 TO 2 YEAR RECOMMENDATIONS FOR FIRE ALARM SYSTEM

The requirement of addressable devices requires the installation of new expansion cards in the existing fire alarm panel. There is not enough space in the existing fire alarm panel to install new cards, and due to the magnitude of new code requirements, it is recommended to install a completely new system that meets all requirements.

Exit Sign

Pool Fluorescent Lighting

LIGHTING

The lighting system within the building contains several types of fixtures. The primary lighting method is T8 lamps, but several corridors and some classrooms have been retrofitted with direct-wire LED T8 retrofit lamps by the building electrician. The entrance to the auditorium uses can-style LED downlights. Some T12 fixtures are still encountered at points in the school, with the understanding that they are retrofitted to T8 style when the lamps burn out. The Spectator Gym area consists of new LED troffers and T5HO high-bay fixtures. The swimming pool contains LED pendant high-bay fixtures, LED floodlights retrofitted inside a metal-halide fixture, and several fluorescent fixtures along the side of the room. The auditorium/theater contains several bi-pin compact fluorescent lamps as a retrofit for incandescent lights. Canopy lights outdoors are large compact fluorescent lamps retrofitted from metal halide.

Many mechanical spaces within the building, including all substation rooms, use screw-in lamp types which house either CFL lamps, metal halide lamps, or LED retrofit lamps. The mechanical spaces renovated during the summer of 2017 have new LED lighting fixtures installed. Certain spaces (such as the Spectator Gym and new locker rooms) employ a Leviton lighting control system, but the facility is largely contactor and toggle switch-based.

EMERGENCY AND EXIT LIGHTING

The building uses individual battery back-up for emergency and exit lighting, and does not have a backup generator. Emergency fixtures are powered from "emergency" panels, fed from one separate breaker on each substation. The existing exit signs house mostly incandescent and fluorescent bulbs, and the emergency lights vary between incandescent, halogen, and LED units. The emergency lights are typically either wall or ceiling-mount with two light heads.

1 TO 2 YEAR RECOMMENDATIONS FOR LIGHTING SYSTEM

The primary recommendation for the lighting system is the conversion of all fixtures, including emergency and exit lighting, to LED. LED technology carries significant benefits and cost-savings in energy usage and maintenance that in many cases will turn into a payback to the facility over time. Fixtures that have been retrofitted with LED T8 tube replacements should eventually be removed and replaced with fixtures that contain integrated LEDs and drivers, due to the higher quality and longer life of a dedicated fixture.

Another lighting recommendation is to expand the capabilities of the lighting control system to implement more modern technologies such as daylight harvesting in corridors and exterior areas, occupancy sensing in offices and other interior rooms, and more precise zoned controls. The new controls will offer additional energy savings for the school, and provide an extra level of precision for staff to customize the light output for the facility.

Cost estimates for recommended replacements encompass any associated demolition, general contracting, installation, and equipment costs. Inflation was accounted for by adding a 3% increase per year. Cost estimates were determined by referencing our experience with similar systems and the areas served by these systems. It should be noted that two costs will be shown for future recommendations. For example, if an item is recommended for replacement from 2019 – 2021 then the 2019 costs and the 2021 inflated costs would be shown. Cost estimates are as follows:

SUBSTATIONS: UNIT SUBSTATION REPLACEMENT ONLY (3 TO 5 YEAR)

Substation	Location/Service	Normal Power Panels	EM Power Panels	2021 Cost	2023 Cost
A	A-Wing (Southwest)	9	1	$109,273	$115,927
B	B-Wing (Northwest)	7	1	$109,273	$115,927
C	C-Wing (Northeast)	9	1	$109,273	$115,927
D	D-Wing (East)	13	1	$109,273	$115,927
E-1	E-Wing (Southeast)	7	1	$109,273	$115,927
Track	East Center Core	18	1	$163,909	$173,891
			TOTALS:	$710,273	$753,528

CLOTH WIRING REPLACEMENT

The cost to install new conduit and thermoplastic-insulated wiring in place of cloth wiring, on an average per-linear-foot basis and including labor, is estimated to be as follows:

Ampacity	Cost (per linear foot)
65	$19.5
100	$30
150	$50
200	$67
400	$134
600	$200
800	$267
1000	$334
1200	$400

SUBSTATIONS - DISTRIBUTION PANELBOARD REPLACEMENT ONLY (3 TO 5 YEARS)

Substation	Location/Service	Normal Power Panels	EM Power Panels	2021 Cost	2023 Cost
A	A-Wing (Southwest)	12	1	$56,822	$60,282
B	B-Wing (Northwest)	7	1	$34,967	$37,097
C	C-Wing (Northeast)	15	1	$69,935	$74,194
D	D-Wing (East)	13	1	$61,193	$64,919
E-1	E-Wing (Southeast)	8	1	$39,338	$41,734
Center Core	East Center Core	21	1	$96,160	$102,016
			TOTALS:	**$358,414**	**$380,242**

THERMAL INSPECTIONS

The estimated cost for complete thermal inspections is **$20,000**.

ARC FLASH STUDY

The cumulative approximate cost for the arc fault and coordination study for the school **$25,000**. This is assuming that the study is done concurrent with the substation replacement.

EXERCISING OF SWITCHES AND OTHER PREVENTATIVE MAINTENANCE

The cost to perform maintenance as described in this report is approximately **$10,000**.

LIGHTING

The cost to replace lighting is variable depending on the type and number of fixtures selected, as well as the level of control desired in the new system. We consider a square-foot cost of $10/ft2 to retrofit the system with new LED fixtures. Modern controls are included as well, consisting of daylight harvesting in corridors and exterior areas, occupancy sensing and dimming in interior classrooms and offices, and basic zoned control. Since the school is about **650,000 ft2**, the total cost of the retrofit is estimated to be **$6,500,000**.

FIRE ALARM

The estimated cost of completing a replacement of the fire alarm system sufficient to bring the facility up to code is approximately **$1,000,000**. This new system includes a complete one-way speaker system installed throughout the school.

TOTAL ELECTRICAL COST ESTIMATES

Catergory	Recommended Replacement Timeframe	Equipment Type	Year 2019 Cost	Year 2021 Cost	Year 2024 Cost
Electrical	2021 - 2023	Unit Substation Replacement		$710,273	
	2021 - 2023	Distribution Panelboard Replacement		$358,414	
	2019	Thermal Inspections	$20,000		
	2021 - 2023	Arc Flash Study		$25,000	
	2019	Exercising Switches & Preventative Maintenance	$10,000		
	2019 - 2021	LED Lighting & Controls	$2,166,667	$2,298,617	$2,511,760
		Fire Alarm	$1,000,000		
		TOTALS:	**$3,196,667**	**$3,392,304**	**$2,511,760**

Note: The cost to install new conduit and thermoplastic-insulated wiring was not included in this table; this is shown on page 212.