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Mark Twain School HVAC Project Feasibility Study Report

Prepared for

Marathon Petroleum Company
Michigan Refining Division

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Contents

Mark Twain School for Scholars
12800 Visger Street
Detroit, MI 48217

Project Background:

The Mark Twain School for Scholars is part of the Detroit Public Schools Community District. It is located approximately 2 miles from the Marathon Petroleum Corporation Michigan Refining Division. The school is made up of an original building portion built in the 1930s and a connected annex constructed in the 1980s. The original portion of the school is approximately 60,000 sq. ft. and consists of classrooms, corridors, office areas, toilet rooms, an auditorium and a library. The newer annex is approximately 28,000 sq. ft. and is made up of classrooms, corridors, a gymnasium, locker rooms and a cafeteria.

The newer annex is a single-story building. Its heating and cooling needs are served by unitary roof-top units. These units include mechanical cooling sections that provide cool air during summer months for occupant comfort. The older original school building is comprised of two floors and a basement. In the basement are steam boilers that serve the heating needs of the original school building areas. The heated air serving the original school is distributed to areas from two air houses located in the basement. The air houses consist of steam coils, filter racks and centrifugal fans that move return and outside air across the steam coils and then distribute the heated air to the different building areas through supply air tunnels and ductwork. The air houses and air distribution system supplying the original school building has heating capabilities, however, there is no cooling capabilities.

This feasibility study is to investigate and assess how mechanical cooling can be added to the original building portion of the Mark Twain School for Scholars in an economical manner. The air filtration and odor control of the supply air will also be addressed in this assessment.

Overview:

The Marathon Petroleum Corporation Michigan Refining Division has agreed to investigate the complications and cost of adding mechanical cooling equipment to the original building portion of the Mark Twain School for Scholars. The involvement of Detroit Public School officials, mechanical contractors, consulting engineers and equipment suppliers, has led to the determination that the most cost-effective manner to add cooling capabilities to the original building is by adding cooling coils to the existing two air houses that supply air to the entire building. Other options of adding individual split cooling systems to each room or adding new, separate air handlers to the existing air distribution system would be cost prohibitive.

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The most economical cooling system would be with the use of a refrigerant in a compressor, condenser coil, expansion valve and evaporator coil cycle. Having the evaporator coil in the building's air stream and using this as the cooling coil would be the least costly and still be effective rather than using water and having a second heat transfer loop such as with a chiller. The use of an outdoor condensing unit for each air house which would include compressors and condenser coils, and having the expansion valves and evaporator coils at the air houses is the recommended equipment layout.

Air House No. 1 serves approximately 44,000 sq. ft. of the first and second floors and has a fan capacity of 40,000 CFM. To cool this air stream from inlet conditions of 76.5°F EDB/63.6°F EWB to outlet conditions of 52.4°F LDB/51.7°F LWB, two (2) 108" wide x 54" high coils would be used with an outdoor condensing unit rated at 115 tons, nominal. This condensing unit would have two (2) refrigerant circuits with three (3) compressors on each circuit and require a 225 Amp electrical circuit using 480 VAC/3-phase power.

Air House No. 2 serves approximately 14,700 sq. ft. of the first and second floors and has a fan capacity of 15,000 CFM. To cool this air stream from inlet conditions of 76.5°F EDB/63.6°F EWB to outlet conditions of 52.8°F LDB/52.2°F LWB, two (2) 60" wide x 42" high coils would be used with an outdoor condensing unit rated at 40 tons, nominal. This condensing unit would have two (2) refrigerant circuits with two (2) compressors on each circuit and require a 100 Amp electrical circuit using 480 VAC/3-phase power.

Both condensing units would be located to the north of the building's boiler room, positioned on concrete equipment pads, and a 7' high chain link fence would surround the outdoor equipment. The refrigerant piping would be routed from the condensing units along the exterior wall of the school and enter the basement through an existing window panel located high in the boiler room.

The air houses each have an existing flat filter bank of 2" pleated, throw away, MERV 8 filters. These filter banks will be removed in each air house to make clearance for the cooling coils. A new filter bank will be installed in each air house, upstream of the new cooling coils. These new filter banks that will support MERV 8 pre-filters followed by MERV 13 final filters. This increase in efficiency will increase overall school air quality.

Unwanted odors in the air being distributed throughout the original school building will be addressed by the adding a commercial grade modular needlepoint bipolar ionization system downstream of the new filter banks and downstream of the new cooling coils. These units create a plasma field of high concentration ions which attach to particles, pathogens and gas molecules. The ions help agglomerate particles, kill pathogens by removing life-sustaining hydrogen from them, and breakdown VOCs.

Controls for the cooling system will consist of temperature sensors in the return air stream and in the supply air stream. Each condensing unit will have its multiple compressors staged for partial load conditions to maintain the return air temperature from the building areas at the desired set point temperature. Controls for the odor neutralizer units will be through the air house fans. When the air house fans are energized, the units will be energized. A safety switch will be included on air house access doors that will de-energize the unit upon the access door opening.

The existing 480V power system is provided by DTE Energy from a 300kvA utility owned transformer. There is space available in the existing 480V, 3P, 4W power panels HPP1 and HPP2. New circuits will be installed to provide power for the new (2) new condenser loads.

Air House #1 and Air House #2 will each have a new ionization units requiring 120V power. The nearest existing 120V power panel will be utilized to provide a shared circuit for both ionization units IU-1 and IU-2. Each unit will be wired so the ionization unit is energized when the air fan is energized, and de-energized when the air house fan is de-energized.

One LED light fixture, light switch and convenience receptacle will be installed to service both CU-1 and CU-2. A new 20A, 120V circuit will be installed from an existing power panel in the newer school electric room.

Recommended Scope:

The following is an outline summary of the recommended scope for the project. It is not intended to provide full detail of the construction, materials, or finishes required for a complete project. When the words “provide(d)” or “install(ed)” are used in this report they refer to construction by a qualified contractor.

General Trades and Structural:

1. A new equipment pad on grade will be installed by undercutting the site subgrade by 12” below the top of the new pad, proof-rolling and proof-compacting the exposed surface to detect any soft areas and densify any surficial loose soils. A 6” layer of aggregate will be placed across the prepared subgrade. A 6” reinforced concrete pad will then be formed and poured to support the two (2) condensing units. Backfilling will take place around the perimeter of the new equipment pad. The pad will extend beyond the perimeter of the equipment by at least 12” on all sides.
2. A 6’ high chain link fence will be provided around the two (2) condensing units. Posts to be Schedule 40 galvanized, wire to be 9 gauge of galvanized steel, and 3 strand barb wire will be included. Posts to be set in concrete anchors and man-gate to be included.
3. One of the existing window panels on the north wall of the basement will be used for liquid and suction refrigerant lines that will be routed between the condensing units and the cooling coils located in the basement air houses. The lines will be copper and fully insulated with closed cell elastomeric foam insulation.

Mechanical:

1. The existing filter rack in each of the two air houses will be removed and any spacer panels between the inside walls, ceiling and floor of the air houses, and the filter frames will be cut out flush to the air house surfaces.
2. The drain pans inside each of the two air houses will be removed, and their drains will be cut back to the air house walls for use by new cooling coil drain pans.
3. Each air house will have an evaporator coil installed upstream of the fan inlets. These coils will be centered and positioned high in the sheet metal housings and will have sheet metal installed to fill all air gaps between the housings and the coil perimeters. Refrigeration inlet and outlets will be extended to the outside of the housing.
4. Each installed evaporator coil will have a condensate drip pan costume fabricated and positioned along the bottom of the coil. These pans will be sloped, made out of stainless steel, and will drain out of the air houses and routed to floor drains in the basement.
5. Two (2) condensing units, one rated at 115 nominal tons and the other rated at 40 nominal tons, will be purchased, delivered, unloaded, and installed on the new equipment pad located north of the outside staircase leading to the basement boiler room. Adequate clearance will be provided based on the manufacturer's installation recommendations.
6. ACR copper piping will be routed from each condensing unit to each condenser coil. Each condensing unit will have two (2) refrigerant circuits and each circuit will have a liquid supply line to the coil and a gas suction line from the coil. The lines will be routed from the condensing units along the school's exterior wall and will enter the basement through an existing window frame. The lines will be insulated and be sized and routed for proper oil management and pressure drop.
7. The refrigerant utilized will be R-410a. Specialties in the refrigerant circuits such as thermal expansion valves, filter dryers and recovery/charging valves will be installed.
8. Temperature transmitters will be installed upstream and downstream of the evaporator coils. The sensors will be wired back to the condensing units and a remote set point thermostat will be installed near each air house's fan VFD speed controller.
9. A modular needlepoint bipolar ionization unit will be installed downstream of each of the evaporator coils. These units will attach to the air house coils and be serviceable from inside the housing.
10. 24" x 24" filter frames will be installed in each air house upstream of the new cooling coils. Air House No. 1 will have a 5 x 5 grid of filter frames to create 100 sq. ft. of face area. Air House No. 2 will have a 3 x 4 grid creating 48 sq. ft. of filter face area. Each frame will include a neoprene filter seal, holding clips and a 2" thick MERV 8 disposable pre-filters and 12" thick disposable MERV 13 final filters. Sheet metal will be installed to fill all air gaps between the housings and the exterior frames.

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Electrical:

1. New power circuits shall be provided for the (2) two new condensers from the existing 480Y/277 V, 3P, 4W power panels HPP1 and HPP2, located in the electric room of the newer building. New fusible switches will be furnished and installed in the empty spaces in each of these panels as follows;

Panel Name	Equip. Serviced	Switch/Fuse Size	Eaton C-H Part #
HPP1	CU-1 (115 Ton)	400AS / 225AF	FDPW365J
HPP2	CU-2 (40 Ton)	100AS / 100AF	FDPW363J

2. Above grade inside conduit/wire, continued with underground outside conduit/wire shall be routed, from their respective existing panels to each of the new condensers disconnect switches as follows;

Equip. Serviced	Conduit / Wire Size
CU-1 (115 Ton)	2"C – (3)1/C #4/0AWG W/#2GND
CU-2 (40 Ton)	1½"C – (3)1/C #2AWG W/#8GND

3. A ¾" x 10' copper weld ground rod will be installed between the new condenser units. Cadweld (2) two #2/0 bare copper ground wires to the ground rod. Route one to each of the condensers, and mechanically connect to the frames of CU-1 and CU-2.

4. Power circuits shall be provided for each of the (2) two new needlepoint bipolar ionization units from the nearest existing 120/208V, 3P, 4W2 power panels. IU-1 is located in Air House #1 and IU-2 is located in Air House #2, in the basement of the older building. Provide new 20A, 1-pole circuit breakers in an empty spaces that are compatible with the existing panel as follows;

Equip. Serviced	Exist. Panel-Breaker Space
IU-1 (120V)	LPJ-17
IU-2 (120V)	LPX-11

5. Conduit/wire shall be routed from each of the existing panel to each of the new ionization unit controller as follows;

Equip. Serviced	Conduit / Wire Size
IU-1	¾"C – (2)1/C #12AWG W/#12GND
IU-2	¾"C – (2)1/C #12AWG W/#12GND

Wire so the ionization unit is energized when the air fan is energized.

6. Wall mount (1) one GFCI convenience receptacle and (1) one light switch with (2) two LED light fixture at condenser units CU-1 and CU-2. One new power circuit shall be provided 120V power circuit will be provided from an existing 120V power panel located in the electric room of the newer building. Above grade inside conduit/wire, continued with underground outside conduit/wire shall be routed from the panel to the GFCI receptacle, switch and (2) LED lights. Weather proof covers shall be installed on

the switch and receptacle. A new 20A/1-pole circuit breaker will be provided if no existing is available and installed in an empty space in the existing panel as follows;

Exist. Panel	Equip. Serviced (voltage/amperage)	Breaker
RP-X	Receptacle, switch and (2) LED lights	20A/1-pole

7. Conduit/wire shall be routed from the existing 120/208V 3P, 4W panel in the electric room to receptacle, switch and (2) LED lights as follows;

Equip. Serviced	Conduit / Wire Size
Receptacle, switch and (2) LED lights	¾"C – (2)1/C #12AWG W/#12GND

Construction Strategy, Milestones and Costs:

The most effective construction strategy is executing the entire project from demolition to new construction in one phase. Since disruption to the school's HVAC system will need to occur, this work will have to be completed during summer months when students are on break.

The selected delivery method should provide independent and competitive pricing, pre-qualification of bidders, invitation only bidding, and have a mechanical contractor act as the prime contractor for this project.

Major Milestones:

Feasibility Study Completion	August 20, 2020
Detail Design Completion	December 18, 2020
Bid Invitation, Review and Contractor Selection	Spring 2021
Construction Start and Completion	Summer 2021

Costs:
The summation of material and labor estimates to add cooling capacities, odor control and upgrades to the filtration of the two air houses serving the original building portion of the Mark Twain School for Scholars is $628,724.

Mark Twain School HVAC Project Feasibility Study Report

Appendix A - Cost Estimate

Marathon Petroleum Company LP

MPMP Refining

Detroit
Mark Twain School HVAC - Feasibility/Definition
Project Summary

TAR Direct MH:		
N-TAR Direct MH:	1,408	100%

Project Title:	Mark Twain School HVAC - Feasibility/Definition		Phase:	Feasibility
Unit:	N/A		Prep. By:	+30%/-30%
PJN:	1#####	Revision: 1	Estimate Date:	15-Oct-20
Budget ID	Budget ID#	Construction Start:	Start-up Date:	

Account	Qty	Unit	MH/ Unit	Direct MH	S/C MH	Wage Rate	Labor Cost	Non Field Mat'l	Field Mat'l	Sub-Contract	Total Cost	Percentages	
(1) Demolition		LT.											of TDC
(2) Site Work and Civil		CY											of TDC
(3) Concrete		CY		78		$72	$5,632		$8,000		$13,632	4%	of TDC
(4) Steel		TN											of TDC
(5) Buildings		EA											of TDC
(6) Equipment		EA		830		$82	$68,218		$168,000		$236,218	72%	of TDC
(7) Piping Avg Dia.=		LF											of TDC
(7A) Piping Fabrication		LB											of TDC
(8) Electrical		LF		500		$84	$42,200		$28,000		$70,200	21%	of TDC
(9) Control Systems		EA											of TDC
(10) Paint		SF											of TDC
(11) Insulation		LF											of TDC
(12) Fireproofing/Refractory		CY											of TDC
(13) Critical Lift/Heavy Haul		LT.											of TDC
(14) Craft Per Diem		LT.											of TDC
(15) Overtime		LT.		Base Work Sch:			$9,284				$9,284	3%	of TDC
Total Direct Field Costs				1,408		89.02	$125,333		$204,000		**$329,000**		
				(TDMH)	(TSCMH)		(TDL)	(TDM) = $204,000		(TDSUB)	(TDC)		
Scaffolding (% DMH)											$22,691	18%	of TDL
Firewatch/Holewatch (% DMH)											$1,816	1%	of TDL
NonTAR Construction Indirects											$97,846	78%	of TDL
TAR Construction Indirects													of TDL
													of TDL
													of TDL
Indirect Field Costs										**(IFC)**	**$122,000**	97%	of TDL
Freight (% Direct Materials)													of TIC
Sales Tax													of TIC
													of TIC
Other (Specify)													of TIC
Freight & Tax Costs										**(OFC)**			**of TIC**
Total Field Costs										**(TFC)**	**$451,000**	**75%**	**of TIC**
				MH	LS Budget		Proj Mgmt	Discipline	Support	Misc/Travel			
Definition Engineering								$20,000			$20,000	3.3%	of TIC
Detailed Design								$40,000			$40,000	6.7%	of TIC
Engineering Construction Support													of TIC
Other Engineering								$10,000			$10,000	1.7%	of TIC
													of TIC
													of TIC
Total Engineering Costs										**(TEC)**	**$70,000**	**11.7%**	**of TIC**
Total Field and Engineering Costs										**(TF&EC)**	**$521,000**	**87%**	**of TIC**
Owners Cost													of TIC
Construction Management ($/DMH)				$9.0							$12,729	2.1%	of TIC
Catalyst													of TIC
Escalation													of TIC
Contingency											$94,309	15.7%	of TIC
Startup & Commissioning													of TIC
Permits & Licensing Fees													of TIC
Uninstalled Spare Parts													of TIC
Other (Specify)													of TIC
Total Other Costs										**(TOC)**	**$107,038**	**17.8%**	**of TIC**
										Total (TIC)	**$600,000**		

Low Range		-30%	***Capital***	**$628,724**	105%
High Range	**$1,000,000**	30%	***Expense***		