STRUCTURAL BACKGROUND

In order to support the HSS River building on top of the FDR Drive, (10) 36 meters deep caissons are anchored to the bedrock below. With this foundation, the building raises twelve stories above ground with the support of six feet by four feet-spread footings on the interior columns. Typical beam sizes are W12x26 spanning 25 feet and spacing at eight feet.

Typical girder sizes for the building are W12x65s and W12x120s spanning 25 feet and spaced at 25 feet also. The building also contains two bridges on the 3rd and 12th story to connect the HSS River Building to the existing hospital. The bridge is built on W8x24 beams with braces that are W8x24 and columns at W14x99. For lateral forces, the building uses chevron brace frames for the 3rd and 12th floors along with a truss system on the 1st and 2nd floors.

MECHANICAL SYSTEM EXISTING CONDITIONS

DESIGN OBJECTIVES AND REQUIREMENTS

The mechanical system for the HSS River building is a heat pump system that provides cooling and heating for the 100% Outdoor Air Handling Unit and also terminal heat pump units that condition each floor space. The minimum outdoor air is brought in and mixed with the return air in each terminal heat pump unit serving each area. The main heat pump provides cooling and heating for the AHU is a water-to- water heat pump where as the terminal units are water-to-air. The design of the mechanical system for the HSS River Building was developed for the following objectives:

- User-end Controllability
- Energy efficiency
- Space conservation
- Reduce spread of contaminates

With these objectives in mind, the HSS River Building uses multiple terminal heat pumps, providing user-end controllability of temperature for each serving space. To increase energy efficiency, the HSS River Building mechanical system uses a heat pump loop with a 100% air-handling unit sized for the minimum outdoor air, reducing energy needed to condition a larger amount of outdoor air and return air mixture. Lastly, by sizing the duct penetrations for the amount of outdoor air only and mixing the recirculation and outdoor air at the terminal end reduces the amount of space needed for the ductwork. By not mixing the return air with the outdoor air in the AHU, the system prevents contaminates and air borne diseases to circulate throughout the entire building.

In a heat pump system, there are two sets of temperature ranges for the heat pump to work efficiently. One set is called the load loop temperature and the other is the source loop temperature. In the HSS River Building, a steady temperature range of 90F to 100F is need for the source loop and 46F and 55F for the load loop for cooling. For heating, a range of 60F and 70F is needed for the source loop and 90F and 100F for the load loop. In order to maintain this temperature range, a cooling tower and heat exchanger are used to reject and supply additional heat to the system when needed.

The HSS River Building was designed to also meet ASHRAE Standard 62.1-2007 Ventilation requirements but did not meet all requirements set forth for ASHRAE Standard 90.1. These results were studied in *Technical Assignment 1 – ASHRAE Standard 62.1-2007 Ventilation Report and Technical Assignment 2 – Building and Plant Energy Analysis Report*.

All the mechanical components for the HSS River Building are contained inside the penthouse mechanical room except the terminal heat pump units that are concealed in the plenum on each floor. **Figure 2** below shows the layout of the mechanical room. The cooling tower is placed strategically outside the mechanical room on the rooftop surrounded by metal panels closing it off to the public's eye. The AHU air intake and cooling tower intake meets ASHRAE Standard 64.1 Section 5 requirements.

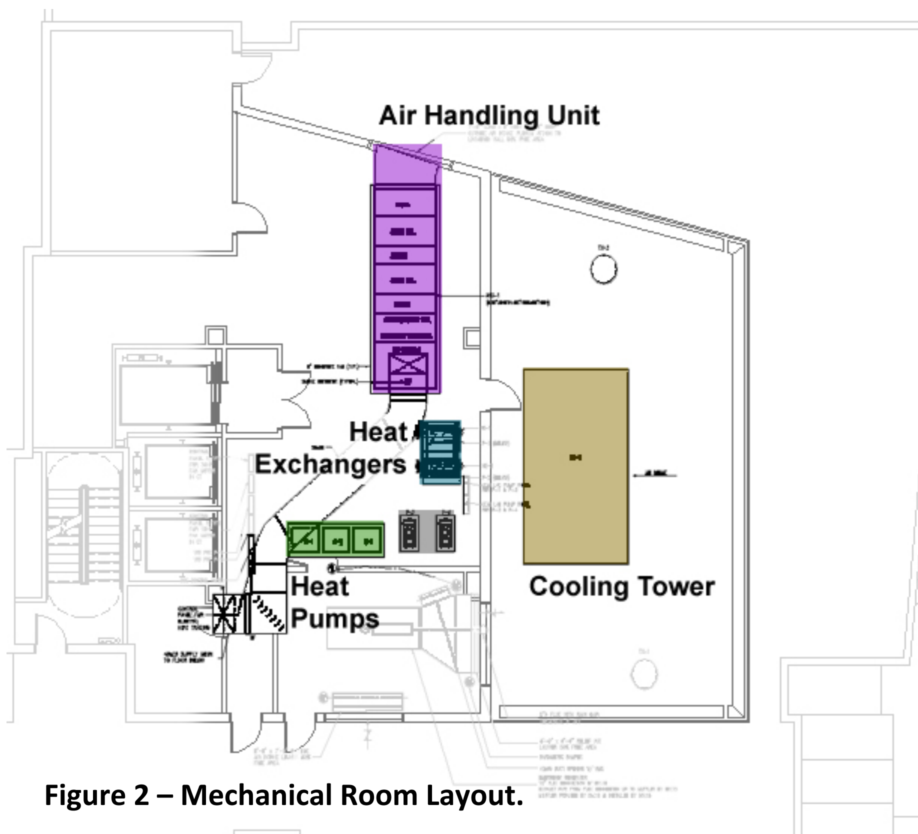

Figure 2 – Mechanical Room Layout.

EXISITING AIR-SIDE MECHANICAL SYSTEM

The HSS River Building provides 100% minimum outdoor air through the McQuay roof top unit bringing 14,000 CFM into the building. The outdoor air is filtered in two stages, first a 30% efficient throwaway filter at the outdoor air (OA) intake and a final Varicel II cartridge filter with a MERV 14 rating after the fan. The OA is conditioned by heating and cooling coils and ducted down to each floor. The outdoor air is mixed with the return room air by the terminal heat pump units in the plenum. The terminal heat pump unit then conditions the supply air again. **Table 1** provides additional details for the AHU.

Table 1 - AHU-1 McQuay CAH041-GDAM	
100% OA CFM	14,000
Total Static Pressure	5.39 In. wg
Cooling	
EAT (DB/WB)	95/75
LAT (DB/WB)	57.2/57
EWT/LWT	46.7/55
Flow Rate	225 GPM
Heating	
EAT (DB)	0
LAT (DB)	92.5
EWT/LWT	103/83.2
Flow Rate	225 GPM
Supply Fan	
Motor HP	25
Motor BHP	20.06
RPM	1750
Weight	9500 LBS.

At the terminal end, each terminal heat pump unit cools and heats the supply air mixture of outdoor air and return air. The operating supply air temperature for cooling is 67F and the return and supply mixed air temperature for heating is 105F.

The HSS River Building also contains (6) centrifugal roof up-blast exhaust fans. They are used mainly for exhausting air from bathrooms and locker rooms. Other exhaust fans are used for exhausting the exercise room on the 2nd floor and also for smoke purging all floors in case of a fire. **Table 2** provides additional details for each exhaust fans.

Table 2- Exhaust Fans – Greenheck Cube-240XP							
Unit No.	Service	CFM	SP IN. WG	RPM	Motor		
					BHP	HP	Electric
SX-1	Smoke Purge	10,000	1.5	875	4.72	5	460/3/60
TX-1	Toilet Exhaust	2,360	1.5	1,601	1.26	1.5	460/3/60
TX-2	Toilet Exhaust	2,755	1.5	1,752	1.62	2	460/3/60
TX-3	Toilet Exhaust	1,784	1.5	1,784	1.7	2	460/3/60
GX-1	General Exhaust	3,240	1.5	627	1.92	3	460/3/60
GX-2	Gym Exhaust	1,250	1.0	1,741	.54	.75	460/3/60

EXISTING HEAT PUMP SYSTEM

The mechanical system contains (3) water-to-water heat pumps to condition the 100% outdoor air and (157) terminal water-to-air heat pump units on all floors to condition each space. The heat pumps are all connected to a common source loop. The heat pump source and load loop system contains a mixture of water and 35% propylene glycol to prevent the loop from freezing. The (3) water-to-water heat pumps provides the entering water temperature needed for the terminal heat pump units to reject and absorb heat during cooling and heating seasons. This being said, the terminal heat pump units provide their leaving condenser water temperature as the entering temperature needed for the source loop for the (3) water-to-water heat pumps. This delicate balance is kept in check by a cooling tower and heat exchanger to reject or add more heat to the system to maintain constant temperature differences. **Table 3** provides additional details for the water-to-water heat pumps. **Table 4** provides additional details for (10) different sized water-to-air terminal heat pump units.

Table 3 - Water-to-Water Heat Pump - McQuay WGRW		
	Source	Load
Flow Rate	75 GPM	75 GPM
Water Pressure Drop	21.88	16.68
Cooling		
EWT/LWT	90/100.2	55/46.7
Heat Rejection	382,944 BTUH	
Total Capacity	299,133 BTUH	
Heating		
EWT/LWT	70/60.1	90/103
Heat Absorption	375,685 BTUH	
Total Capacity	464,365 BTUH	

Table 4 - Water-to-Air Terminal Heat Pump Units – McQuay WCMS									
	CFM	EER	COP	Flow Rate (GPM)	WPD (ft)	**Cooling**		**Heating**	
						Total Capacity	Heat Rejection	Total Capacity	Heat Absorption
A	300	11.01	3.23	2	6.06	8,420	11,176	11,792	8,968
B	400	10.69	3.13	2.5	10.47	12,047	16,188	16,895	12,583
C	500	12.49	3.66	3.5	15.37	15,258	19,683	20,168	15,153
D	630	11.86	3.47	4	16.64	19,039	24,907	24,711	18,714
E	800	11.61	3.40	5	6.61	23,683	30,981	29,248	22,201
F	1000	12.35	3.62	7	14.43	31,558	40,759	38,614	29,087
G	1200	12.08	3.54	8	11.17	35,228	45,697	45,645	34,574
H	1400	12.19	3.57	10	13.68	40,952	52,999	52,367	39,330
I	1600	11.60	3.40	11	16.94	46,117	60,387	53,991	40,813
J	2000	11.46	3.36	14	16.98	59,724	78,501	77,619	57,981

SOURCE AND LOAD LOOP COOLING DIAGRAM

To understand the heat pump cycle in more detail, **figure 3** below demonstrates the flow path and temperatures of the source and load loops during cooling. Starting with the Load Loop, the heat pump provides 46F water to the cooling coils in the AHU, which returns back to the heat pump by pumps 3 and 4 at 55F. In order for the heat pump to cool 55F water down to 46F, it rejects heat to the Source Loop. The Source Loop absorbs the heat from the Load Loop and heats up the water from 90F to 100F. The 100F water is then by-passed from the floor loads and directed to the cooling tower to reject heat from 100F water down to 90F. The 90F water is then pumped through by pumps 1 and 2 to each floor serving each terminal water-to-air heat pump. There, the 90F water provides heat rejection for the refrigerant in the heat pump to provide cooling from 80F return air to 67F supply air, returning back again to the cooling tower at 100F water. **Figure 3** shows the cooling flow diagram.

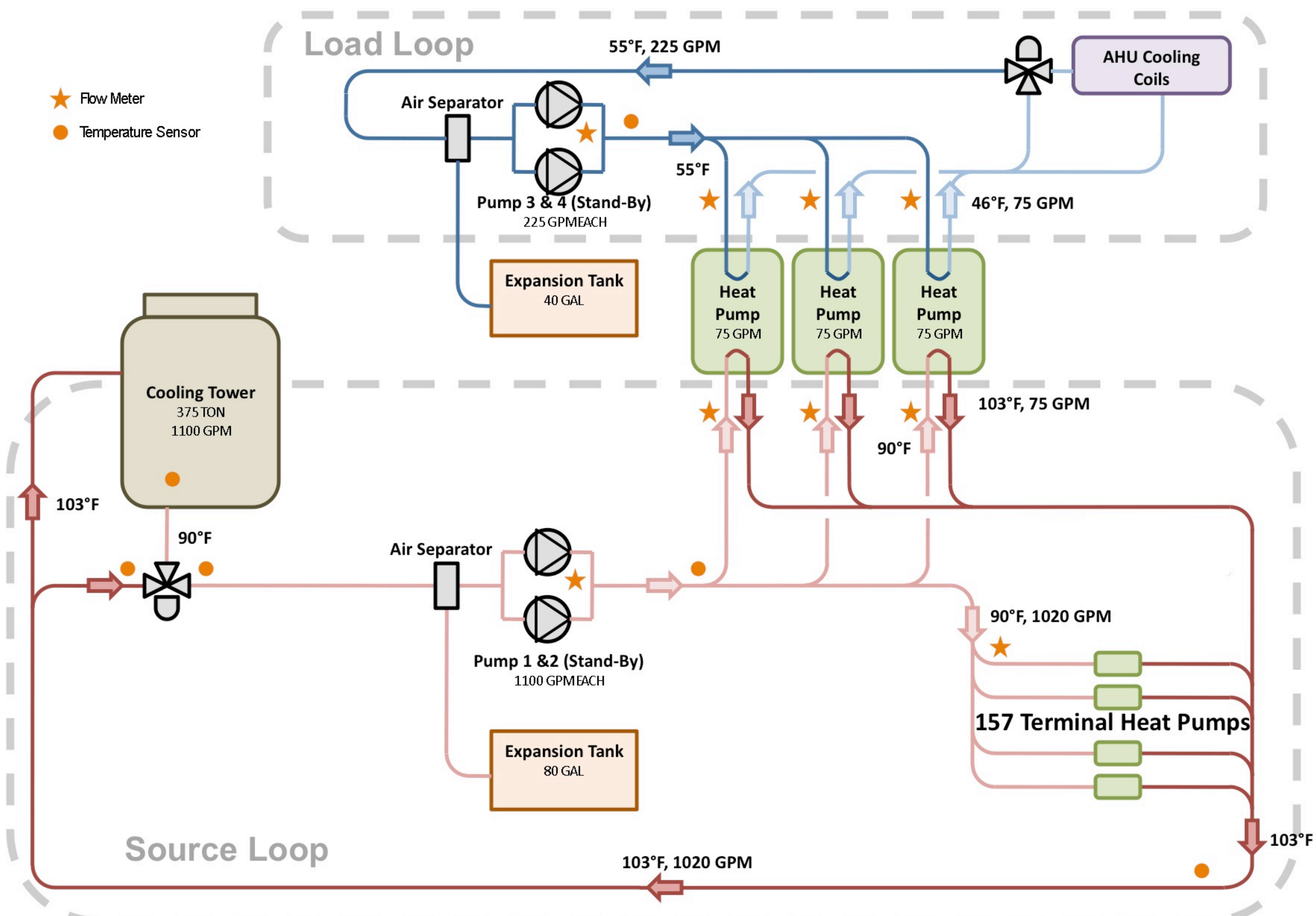

Figure 3 – Heat Pump Cooling Flow Diagram.

SOURCE AND LOAD LOOP HEATING DIAGRAM

When heating occurs, the Load Loop temperature reverses with the Source Loop in cooling. Starting at the Load Loop, the 103F water serves the heating coils in the AHU and returns back to the heat pumps by pumps 3 and 4 at 90F. In order to produce 103F water again, the heat pump absorbs heat from the Source Loop. The Source Loop rejects the incoming water at 70F to the Load Loop, making the leaving water temperature at 60F. This 60F water is then by-passed from the floor loads and directed to the heat exchangers where the water absorbs heat from the steam and raises the temperature back to 70F. This 70F water is then directed to the terminal water-to-air heat pumps serving each floor by pumps 1 and 2. The 70F water provides heat absorption for the refrigerant in the heat pump to provide heating from 70F return air to 104F supply air, returning back again to the heat exchangers at 60F water. **Figure 4** shows the heating flow diagram. Due to the fact that mechanical redesign will not involve the steam system and heat exchanger, no further details will be provided of the steam system. Please refer to *Technical Report Three: Mechanical Systems Existing Conditions Evaluations* for more information about the heating system of the building.

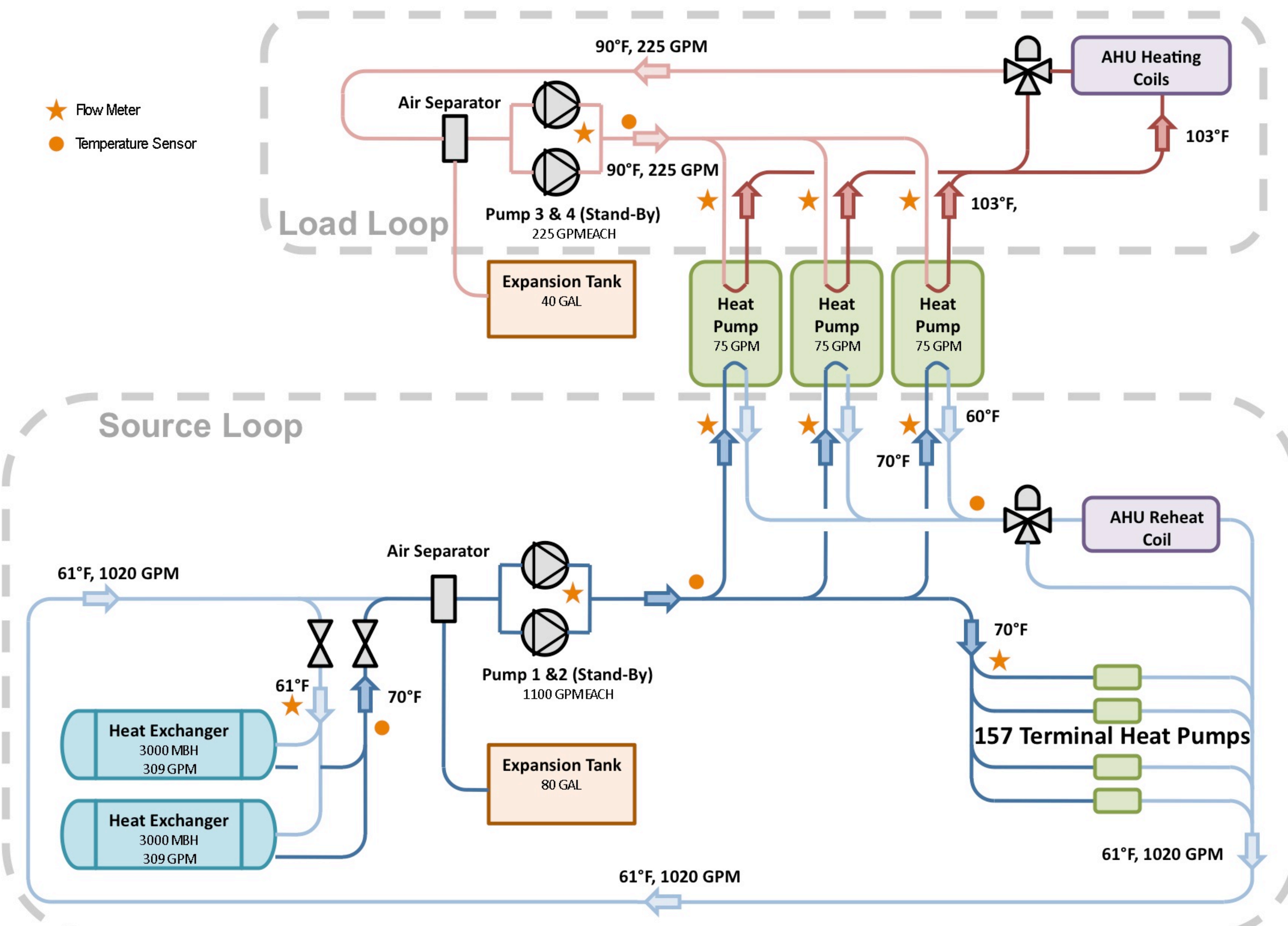

Figure 4 – Heat Pump Heating Flow Diagram.