Section 03: Existing Mechanical Conditions

3.01: Mechanical System Location

The Hauptman-Woodward Medical Research Institute is located in the heart of the Buffalo-Niagara Medical campus – an area of the city of Buffalo, NY that is quickly revitalizing itself. Its close proximity to the Roswell Park Cancer Institute, Buffalo General Hospital, as well as the downtown theatre district gave the owners and designers the opportunity to provide an architecturally stunning building in an area that had been in decline over the past few decades. As such, it was necessary to take added precautions to shield the mechanical systems from public view. A mechanical penthouse was built in keeping with the radical design of the building, and as such masks the majority of the equipment. The two rooftop units (RTU-1,2) and the chiller were both hidden from view by means of architectural screening, as shown in Figure V.

Figure V: Street-Level View of Mechanical Penthouse and Equipment Screening.

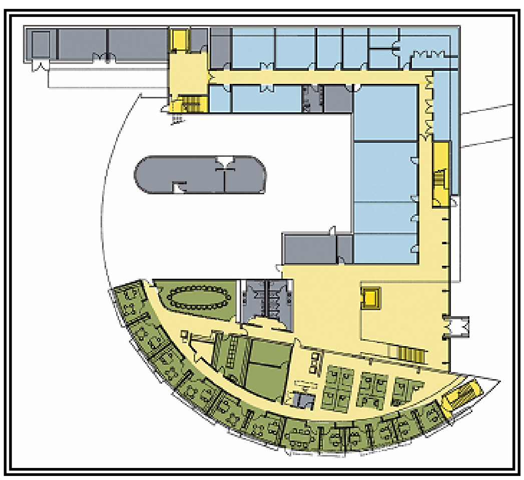

Figure VI: Location of main electrical and Telecom rooms on Ground Floor

One of the primary design considerations at the Hauptman-Woodward Medical Research Institute was the separation of the mechanical systems from the critical laboratory spaces. This was achieved rather simply by placing the majority of the mechanical equipment in the roof penthouse or directly on the roof. The only major lost space within the building was located on the ground floor adjacent to the atrium, where it was necessary to place makeup supply fan for the smoke exhaust system. The main electrical, fire protection and telecommunication rooms are located on the ground level separate from the building itself, adjacent to the covered parking and highlighted in gray in the figure below (Figure VI). All in all, the designers did a spectacular job of isolating the mechanical equipment from the building. Any necessary maintenance to the system can be achieved without setting foot in the laboratory space. This is noted in the breakdown in figure VII, which shows that approximately 55% of the mechanical space allotted was in the penthouse. As a whole, only 12% of the entire building was required for mechanical equipment and shaft space, allowing for the maximum allowable research space.

Space Description	Area (sq.ft.)
First Floor	2405
Second Floor	600
Third Floor	295
Penthouse	4780
Elevator Shafts	630
Total Building Area	73289
Total Lost Rentable Space	8710
Percent Lost Rentable Space	**11.9%**

Figure VII: Breakdown of Lost Rentable Space at HWI.

3.02: Existing Site Energy Sources and Rates

The Hauptman-Woodward Medical Research Institute utilizes two energy sources for operation of its building mechanical systems. These sources include electric power (kWh) and natural gas (therm), and are provided directly to the site. Since monthly utility data was not available from the owner, rates were determined based on site and city data for Buffalo, New York, and are used later in this report to determine approximate annual building costs using Trane TRACE-700 modeling software.

Electricity and Natural Gas were the two most practical energy sources based on site conditions. Due to the specialized nature of the Buffalo Niagara Medical Campus, it would not be practical to have a centralized plant. Therefore, the Hauptman-Woodward Medical Research Institute is self-contained with chiller and boiler plants located within the 4th floor mechanical penthouse. These localized systems provide the necessary heating and cooling required for the building to operate as it was intended.

Electric Service at the Hauptman-Woodward Medical Research Institute is provided by National Grid, a primary electric service provider throughout Western New York. The electric rate is broken down into specific charges, as shown in Figure VIII.

	Charge
Basic Service Charge	$51.60
Delivery Charge for Demand (per kW)	$9.48
Delivery Charge (per kWh)	2.032¢
Delivery Charge Adjustment	0¢
Customer Service Credit (per kWh)***	0.2¢ per KWh
System Benefits Charge (per kWh)	.1619¢
Renewable Portfolio Surcharge (per kWh)	.0491¢
Electricity Supply Charge	0.05585¢

Figure VIII: National Grid Electric Tariffs
(Courtesy of National Grid, Inc. Oct. 2006)

The Natural Gas Service for the Hauptman-Woodward Medical Research Institute is provided by National Fuel, which serves residential buildings and businesses in

Western New York and Northern Pennsylvania. The building falls under the category SC-3: General Sales for buildings of like size and occupancy.

National Fuel Gas Distribution Corporation
New York Division
Rate Summary - March 2007
This Rate Summary Does Not In Any Way Supersede The Tariff

Unbundled Sales Service	Base Delivery Service Rates		Billing Charge	Refund Credit	Delivery Adj. Charge	Monthly Total Transportation	Natural Gas Supply Charge	Total Sales
SC-3 General Sales & Transportation Service (Non-Residential)								
First 1 Mcf	$17.55		$2.00	($5.71)	$0.03	$13.87	$10.19	$24.06
Next 49 Mcf	$2.57806	/Mcf	$0.00	$0.0000	$0.03111	$2.60917	$10.19234	$12.80151
Next 950 Mcf	$1.99656	/Mcf	$0.00	$0.0000	$0.03111	$2.02767	$10.19234	$12.22001
All Over 1,000 Mcf	$1.62309	/Mcf	$0.00	$0.0000	$0.03111	$1.65420	$10.19234	$11.84654
SC-3 Incremental Natural Gas Supply Charge for Transportation Customers above 3,500 Mcf who return to sales service							$10.19234 /Mcf	
Base Cost of Gas (SC-1 & SC-3)	$0.14632	/Mcf	(included in SC 1 & SC 3 Base Delivery Rates)					

Figure IX: National Fuel Natural Gas Tariffs (courtesy of National Fuel, March 2007)

As shown in Figure IX, natural gas is provided on a tier basis, with a base charge of $10.1934/Mcf, which does not include city taxes of 3.0928%.

3.03: Existing System Design and Operation

Rooftop Units (RTU-1,2) w/ VAV Control

The Hauptman-Woodward Medical Research Institute is equipped with two rooftop air handling units to supply conditioned air to the remaining areas of the building with the exception of the laboratory. Although they are significantly different in size, each operate under the same conditions, and are equipped with variable air volume control which are monitored by traverse fan inlet probes and static pressure sensors at supply and return fans. Heating is provided by natural gas and cooling is provided by DX cooling units, which maintain 55^{O}F supply air to each zone. VAV terminal reheat boxes are installed in each zone and space temperature sensors modulate the terminal unit supply air damper in sequence with the reheat coil to maintain space temperature. During occupied periods, the space shall be maintained at 72^{O}F, and when it is unoccupied, the system shall automatically maintain a minimum temperature of 55^{O}F. Each zone is supplied with a manual thermostat to adjust the temperature for comfort.
For a schematic of this system, please consult Appendix A-1.

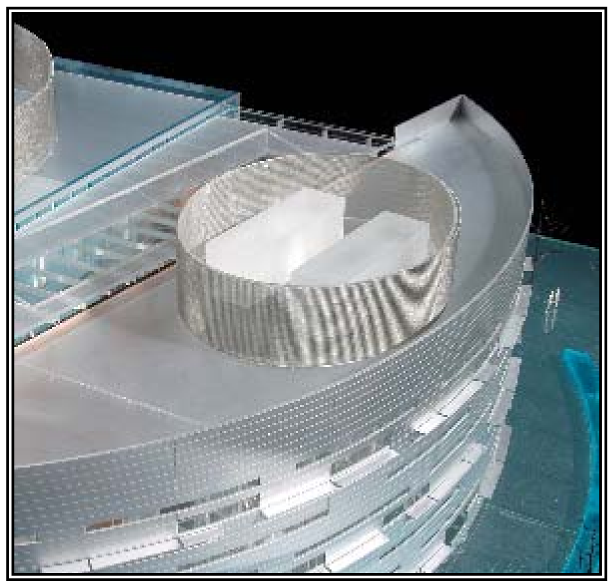

Figure X: Location of Rooftop Units RTU-1 and RTU-2.

Air Handling Units (AHU-1,2) with Variable Supply and Exhaust

The primary purpose of this 100% OA system is to provide 58,000 cfm of conditioned air to the laboratory space. It consists of 2 air handlers, each with pre and final filters, chilled water cooling coil, glycol preheat coil, glycol heat recovery coil, supply fans, and variable speed VAV control.. The system operates continuously to serve HVAC requirements at each individual zone. Scheduling is programmed on a zone by zone basis. The two units operate in parallel and serve a common supply duct. The units operate together, simultaneously varying temperature and airflow to meet SA requirements. The Supply air temperature is adjustable between 55^{O}F and 60^{O}F, however design dictates that 55^{O}F is the standard for sequence with the VAV terminals.

Low temperature controllers provide freeze protection to the supply air fan when the air temperature drops before 53^{O}F. The SA fan is equipped with variable air volume control, which requires static pressure sensors to keep the flow rate at 1 inch WC. For a schematic of this system, please consult Appendix A-2.

Figure XI: Air-Handling Units AHU-1 and AHU-2 In Mechanical Penthouse

Laboratory Heat Recovery Exhaust System

The laboratory general exhaust system consists of three exhaust fans that share a common intake plenum, and together provide 81,000 cfm removal of exhaust air. Velocity Sensors modulate air dampers in order to maintain 4,000 FPM velocity though the exhaust stack. The heat recovery system recovers heat from the general exhaust to preheat or pre-cool the incoming supply air. The system uses a single pump to circulate a 40% glycol solution between coils located in the exhaust and supply air streams. The pump is controlled via temperature sensor to operate continuously when the outside air is below 55^{O}F or above 80^{O}F. The system is equipped with a bypass in the event that the temperature drops below 10^{O}F to prevent freezing of the system. For a schematic of this system, please consult Appendix A-3.

Figure XII: Laboratory Exhaust Fans

Cooling Chilled Water System

The chilled water system consists of a 300-ton air-cooled water chiller and chilled water pumping system. The system supplies chilled water to the building in addition to serving the cooling coils located in AHU-1 and AHU-2. The system operates when the air outside is above 55°F and is monitored by temperature sensors. The chiller is set to maintain a constant 44°F chilled water supply. The pumping system is staged to run continuously when chilled water is needed. The system consists of 2 pumps, of which only one is needed. They are controlled automatically to alternate to maintain equal run time. For a schematic of this system, please consult Appendix A-4.

Hot Water Boiler Systems

The hot water and glycol heating systems each consist of three hot water boilers with dedicated hot water pumps, and a secondary pumping system, as shown in Figure XII. The system is DDC controlled and utilized electric actuation. Boilers are sequenced to equalize equipment runtime. Selection of the lead boiler will be evaluated on a weekly basis, with the boiler having the least runtime becoming the lead boiler.

Figure XII: Hot Water and Glycol Boiler Systems

For the hot water boiler system, the lead boiler shall start when the outdoor temperature drops below 65°F. The lead boiler is sequenced to maintain the loop temperature at 190°F. Should additional heating be required to maintain this temperature, the lag boilers will come online. Temperature sensors monitor loop temperature and dictate system operation.

The glycol hot water system operates in much the same way. When the outdoor air temperature drops below 55°F, the lead boiler shall start. The lead boiler is sequenced to maintain the loop temperature at 190°F. Again, should additional heating be required to maintain loop temperature, the lag boilers will be automatically enabled. For a schematic of this system, please consult Appendix A-5.

Penthouse Air Handling Unit (AHU-3)

The boiler make-up air unit is set up to run continuously and provide fresh air to the mechanical penthouse. The unit provides 3000 cfm of outside air to the space and a space temperature sensor modulates outdoor air dampers to maintain space conditions at 70^{O}F. Controls will override space sensor and open outdoor air dampers when boilers are started, allowing for additional make-up air to the penthouse and removal of excess boiler exhaust gases. For a schematic of this system, please consult Appendix A-6.

Atrium Smoke Control Ventilation System

The atrium smoke control system consists of four exhaust fans (E/F-6,7,8,9), make-up air from RTU-2, and two supply fans (SF-1,2). The system is designed to exhaust smoke from the atrium in order to keep smoke above an interface level of 42ft. Upon signal from the fire alarm, the system will open exhaust fan dampers and OA dampers from the air handling units, in addition to automatically opening all atrium entry doors. The rooftop unit return fan shall shut down and associated smoke dampers will close. Once these procedures have been initiated, the four exhaust fans shall exhaust the required 160,000 cfm of air until deactivated at the firefighter control center (FCC). For a schematic of this system, please consult Appendix A-7.

3.04: Existing System Analysis: ASHRAE Standard 62.1-2004 Compliance

ASHRAE Standard 62.1-2004 describes the procedure to verify the required amount of outdoor air that must be supplied to the building. At the Hauptman-Woodward Medical Research Institute, the Ventilation Rate procedure was used to complete this task. This procedure has a very straightforward approach in that it consists of a series of equations for find the rate of outside air intake to the building when all floor areas, occupancies, and space uses are known. Table 6-1 of Standard 62.1-2004 describes general contaminant concentrations in various space designations, and provides design values based on floor areas and occupancy levels.

According to the ventilation rate procedure, the required amounts of outdoor air are summarized in Table XIII.

System	Max Zp	Ev	Vou (cfm)	ΣVoz (cfm)	Required OA (Vot)	Design OA (cfm)	Total SA (cfm)	Complies to Standard 62.1-2004
RTU-1	0.77	0.95	2,003	2,504	**2,635**	3,500	14,175	Yes
RTU-2	0.31	0.6	2,823	3,530	**5,885**	7,075	28,300	Yes
AHU-1&2			4,713	5,892	**5,892**	58,000		Yes

Table XIII: Required Outdoor Air Summary for Existing Air Handling Units

It was found that for each rooftop unit, the sum of the zone outdoor airflow (ΣV_{OZ}) was less than the design outdoor air intake airflow (V_{OT}). According to the design schedules, the minimum outdoor air was sufficient to comply with Standard 62.1. In addition, the air-handling units that supply the laboratory spaces provide 100% outdoor air, thus provide a significantly greater amount of required outside air than is required to the laboratory. It is therefore in compliance with Standard 62.1. These required values of outdoor air will be necessary in the next portion of the report, which will deal with the incorporation of Dedicated Outdoor Air Systems at HWI.

3.05: Existing System Design: ASHRAE 90.1-2004 Compliance

The purpose of ASHRAE Standard 90.1-2004 is to provide minimum requirements for the energy-efficient design of buildings. The Standard is broken down into sections that analyze aspects such as building envelope, heating, power, lighting and electric motors. For our purposes, we will concentrate on the building lighting systems at the Hauptman-Woodward Medical Research Institute, and will be further discussed in the breadth section of this report.

The existing lighting power density was analyzed using the Space-by-Space method, as prescribed in Section 9 of ASHRAE Std. 90.1-2004. Building area types were taken from Table 9.6.1 of the standard. After completing the power density calculations for each space, it was determined that many of the spaces did not comply with Standard 90.1-2004. There could be many reasons for this to be the case. First and foremost, the Standard has changed since the last revision in 1999, and could account for some discrepancies. In addition, many of the spaces within the Hauptman Woodward Institute have redundant lighting systems that provide architectural merit to the building. Upon inspection, each lighting system is switched independently, which allows for the building occupants to monitor the light output at any one time.

For a complete summary of the existing lighting power densities of each space at the Hauptman Woodward Institute, consult Appendix B.