Technical Report 3

Mechanical Systems Existing Conditions Evaluation

Morton Hospital Expansion

Taunton, MA

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Executive Summary

The purpose of this evaluation is to provide a full summary of Morton Hospital Expansion's mechanical system. Included in the report is a description of the design objectives and requirements, energy sources, existing mechanical equipment descriptions, schematic flow diagrams, and a LEED evaluation.

Ventilation requirements were calculated using ASHRAE Standard 170 – 2013 Ventilation for Healthcare Facilities. A more detailed description of this calculation can be found in Technical Report 1. Heating and cooling loads were calculated using Trane Trace 700, resulting in a total of 1236 MBtu/hr heating and 144.4 ton cooling. Based on the energy use and economic eQuest analysis, the annual operating cost of the addition is $198,353, averaging at $5.20/SF. Technical Report 2 provides a thorough account of these values and how they were obtained.

Heating is primarily supplied by the existing steam plant, in which heat exchangers use low pressure steam to heat the hot water required throughout the addition. Phase 2 cooling is supplied by a new air-cooled chiller, and Phase 1 cooling is provided by an air cooled condensing unit used for direct expansion cooling. Schematic flow diagrams are provided for the building steam and hot water loop, chilled water loop, refrigerant loop, and airside flow diagram.

The mechanical system first cost was estimated at $2,965,365, or $73.95/SF of total building area. The Phase 1 mechanical cost per square foot is significantly higher than the Phase 2 cost, $158.13/SF versus $68.21/SF, respectively. Based on the LEED analysis, it is unlikely that any sort of LEED rating is achievable without major changes to the current design.

Building Overview

Morton Hospital, originally built in 1988, is located in Taunton, MA serving the Greater Taunton Area. In 2010, Steward Healthcare acquired ownership of the hospital and soon after decided to expand its facility. It is currently a 100,000 SF 2-story hospital providing services including emergency and expressMed care, cardiology, orthopedics, maternity, and outpatient surgery. The expansion will be split into two phases totaling 40,000 SF. Phase 1 is a new MRI, while the Phase 2 includes the Emergency Department, Psychiatric Ward, imaging suite, various treatment and triage rooms, and decontamination and isolation rooms. *Figure 1* below shows the key plan with the Phase 1 expansion being the boxed out grey section directly in the middle, Phase 2 expansion in white, and the existing hospital in the remaining grey.

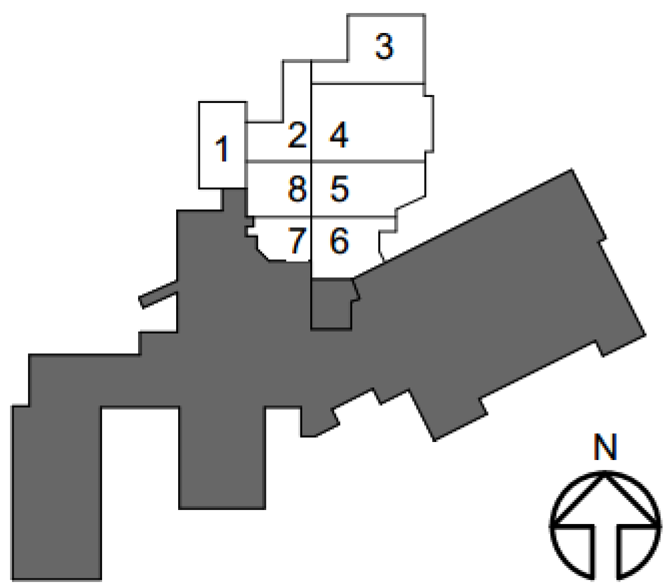

Figure 1: Key plan of existing versus expansion

This expansion will be built around an existing covered parking area that will be fit out for interior space. Both phases will begin construction at the same time, and Phase 1 will be complete and opened while phase 2 remains under construction. The addition will be accessed from the existing building through an additional vestibule, and will also have multiple entryways from the exterior including an ambulance entry vestibule and emergency room vestibule. Because of possible future expansion vertically above this addition, the roof slab was constructed to work as a floor slab.

Design Considerations

Objectives

The objective of the expansion was to satisfy Morton Hospital's growing demands as one of Massachusetts's top hospitals. The mechanical system's main objective was to uphold the health and safety of all patients, physicians, doctors, and staff by maintaining proper indoor air quality within all spaces.

Requirements

Outdoor Design Conditions

Morton Hospital, located in Taunton MA, is classified as Zone 5A according to ASHRAE 90.1. The closest location listed in the ASHRAE Handbook of Fundamentals – 2009 is Providence, RI, and the design conditions given at that location are specified in Table 1 below. Considering that the building is classified as a hospital, it is crucial that it must operate during severe conditions, and therefore was designed using 99.6% heating/winter conditions, and 0.4% cooling/summer conditions.

Table 1: ASHRAE Handbook of Fundamentals - 2009 Providence, RI Design Conditions

Heating DB 99.6% (°F)	Cooling DB 0.4% (°F)	Evaporation (0.4%)		Dehumidification (0.4%)		
		DB (°F)	MCDB (°F)	DP (°F)	HR (grains)	MCDB (°F)
11.9	86.7	74.9	82	72.6	121.2	78.6

DB: Dry Bulb Temperature

Indoor Design Conditions

Dry bulb temperatures were set to 75° F for cooling and 72° F for heating. Relative Humidity was set to 40% RH for Phase 1 and 30% RH for Phase 2, as specified in the HVAC drawing set.

Ventilation Requirements

Ventilation requirements were calculated using ASHRAE Standard 170 – 2013 Ventilation for Healthcare Facilities. Table 7.1 – Design Parameters was used to calculate the required minimum outdoor air changes, total air changes, and exhaust requirements. A more detailed description of this analysis can be found in Technical Report 1. Table 2 summarizes the requirements found in Technical Report 1 and compares it to the current building design. AHU-1 is designed for a total of 27% outdoor air, while AHU-2 is designed for a total of 33% outdoor air. As summarized, both AHUs meet ASHRAE 170 Design Parameters.

Table 2: A summary of the design ventilation versus calculated ventilation requirements based on ASHRAE 170

	Design			Required	
	Total System Supply Air (CFM)	**Minimum Outside Air (CFM)**	**Minimum Exhausted Air (CFM)**	**Minimum Outside Air (CFM)**	**Minimum Exhausted Air (CFM)**
AHU-1	2500	850	400	750	-
AHU-2	35000	9450	8600	7890	7100
Total	37500	10300	9000	8640	7100

Heating and Cooling Loads

Heating and cooling loads were calculated using Trane Trace 700. As shown in Table 3, the system design appears to be oversized when compared to the modeled results. Specifically when looking at the total supply CFM, AHU-1 is 46% larger than the modeled results, and AHU-2 is 28% larger. This oversizing could be a result of designing system capacities based on Degree Days, or heating and cooling extremes, both of which rarely occur. It is also a result of safety factors that were taken into account during design.

Table 3: Heating and Cooling Loads, Trane Trace model versus actual design

	System	**Total Supply CFM**	**Total OA CFM**	**Exhaust CFM**	**AHU OA %**	**Heating MBh**	**Cooling Tons**
Model	Phase 1	1709	75	-	4.4%	70	5.8
	Phase 2	27309	7890	7104	28.9%	1166	138.6
	TOTAL	**29018**	**7965**	**7104**	**27.4%**	**1236**	**144.4**

	System	**Total Supply CFM**	**Total OA CFM**	**Exhaust CFM**	**AHU OA %**	**Heating MBh**	**Cooling Tons**
Design	Phase 1	2500	850	400	34.0%	81	10
	Phase 2	35000	9450	8600	27.0%	1700	155
	TOTAL	**37500**	**10300**	**9000**	**27.5%**	**1781**	**165**

Energy Sources

Fuel Types and Rates

Morton Hospital is supplied by the existing steam plant for heating and existing chilled water plant for cooling, as well as an additional air cooled chiller. The chilled water plant is powered by electricity supplied by Taunton Municipal Light and Power (TMLP). Table 4 summarizes the electrical rates provided by TMLP. These rates apply to commercial use in which the load is in excess of 150 KVA and the customer owns the equipment.

Table 4: Electrical rates provided by Taunton Municipal Light and Power

TMLP Electrical Service Rates				
Energy Charges	Distribution Charge	First 300 hours	$0.00810	per kWh
		Excess 300 hours	$0.00270	per kWh
	Transmission Charge		$ -	per kWh
	Transition Charge		$0.01484	per kWh
Demand Charges	Distribution Charge		$ 3.45	per KVA
	Transmission Charge		$ 4.99	per KVA
	Transition Charge		$ 4.51	per KVA
Supplier Sevices	Generation Charge	Under 300 hours	$0.05799	per kWh
		Over 300 hours	$0.05078	per kWh
Total Energy Charge under 300 hours			$0.08093	per kWh
Total Energy Charge over 300 hours			$0.06832	per kWh
Total Demand			$ 12.95	per KVA

Heating is provided by natural gas. In order to estimate steam rates, the district steam rate equation found in LEED was utilized:

Steam Rate ($/MBtu) = 1.81*gas rate ($/MBtu) + 3*electric rate ($/kWh)

Using the Massachusetts averages for gas and electric rates of $3.95/MBtu and $0.1463/kWh, the steam rate is $7.59/MBtu.

Annual Energy Use

Figure 2 below summarizes the annual energy consumption by electricity and natural gas broken up by use. Consumption values were found using eQuest 3.65 for energy simulation. It can be seen that electricity peaks in the summer months, when space cooling predominates. Inversely, gas consumption peaks in the winter months when space heating is predominate. Appendix A includes a cost breakdown by usage for both Electric and natural gas consumption.

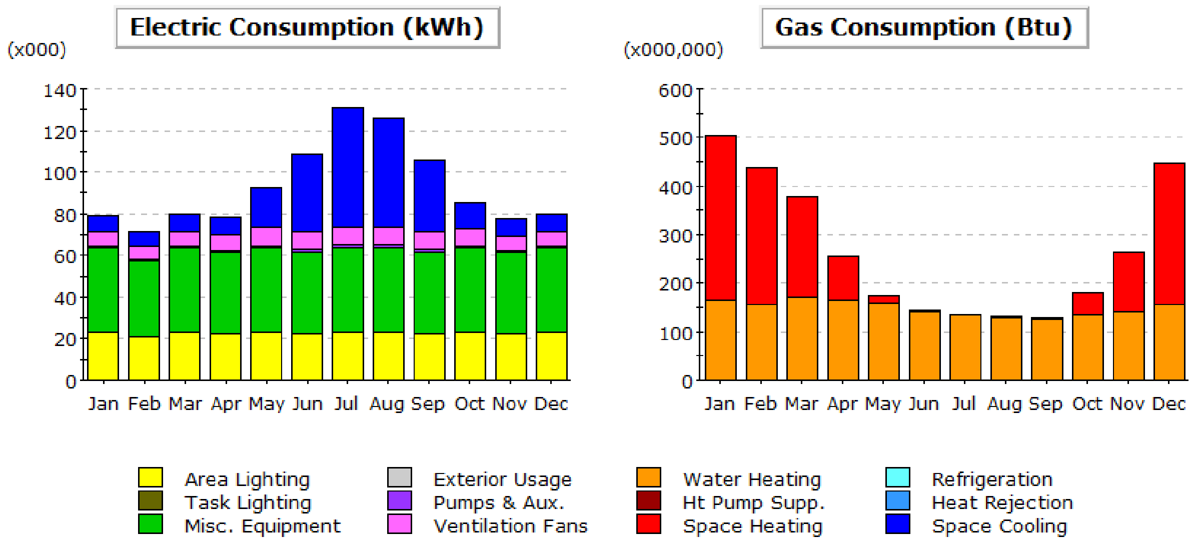

Figure 2: Annual Energy Consumption calculated using eQuest

Figure 3 summarizes the overall annual demands by usage, demonstrating that electricity is dominated by miscellaneous medical equipment and gas is dominated by water heating. However, when looking at peak load usage shown in Figure 4, it can be seen that space cooling and space heating are the predominate factors for electricity usage and natural gas usage, respectively. For a more complete description of annual energy use, please refer to Technical Report 2.

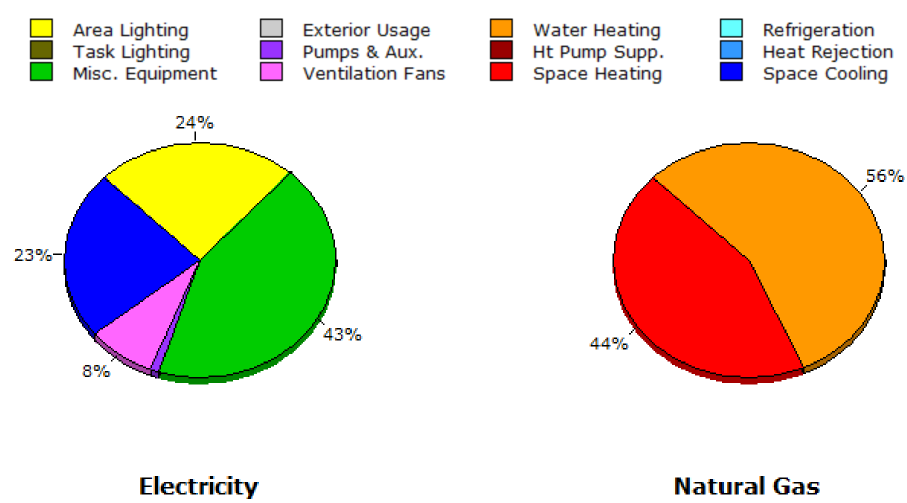

Figure 3: Annual Energy Consumption by End Use

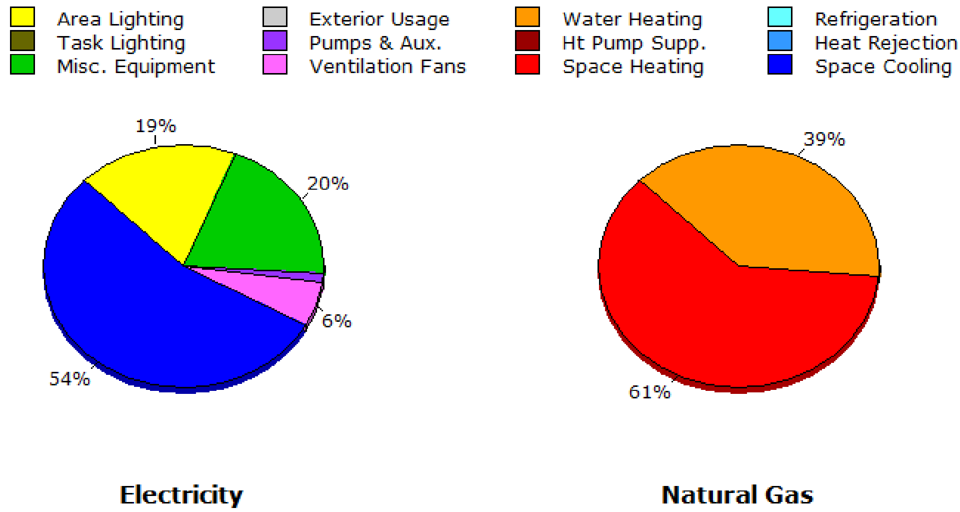

Figure 4: Annual Peak Demands by End-Use

Annual Utility Cost

Based on the eQuest analysis, the annual operating cost of the addition is $198,353, averaging at $5.20/SF. Figure 5 summarizes the monthly utility costs, Utility Rate 1 representing electricity, and Utility Rate 2 representing natural gas. Electricity is predominant, considering that more cooling is needed yearlong to cool equipment, while heating is not needed yearlong. Technical Report 2 includes a detailed description of the utility cost analysis.

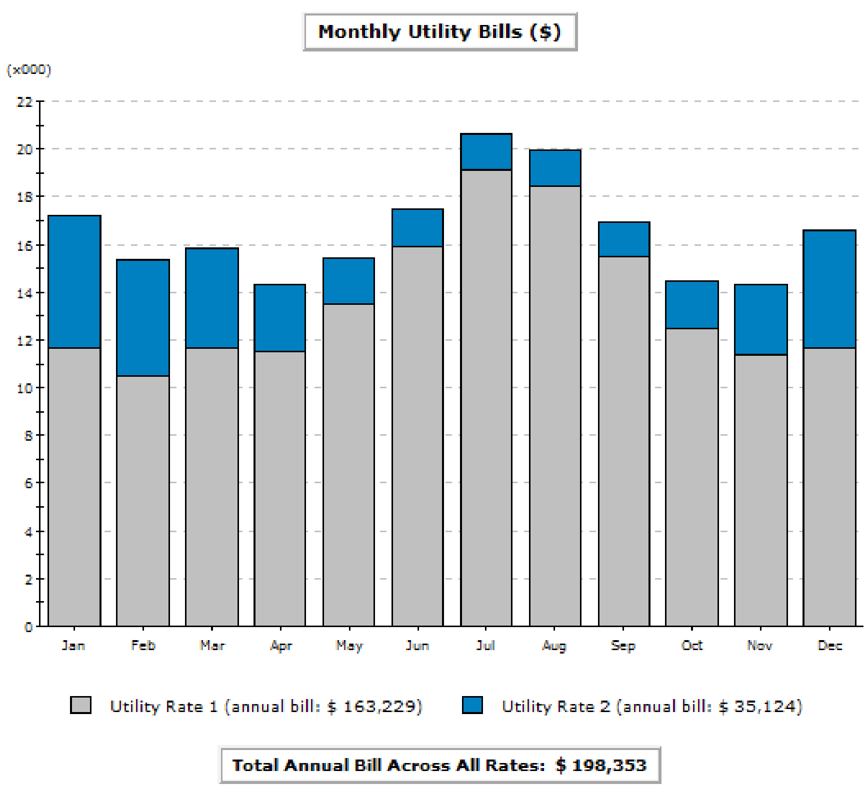

Figure 5: Monthly Utility Rates based on Electrical Demand/Utility Rate 1 and Gas Demand/Utility Rate 2

Tax Relief

Because Morton is a private hospital, no tax relief was granted. Financial incentives for efficient technologies were not applicable for this project.

Existing Mechanical System

The Morton Hospital mechanical system has numerous components, all of which are interconnected and described in the following section. Below is a description of all major equipment, as well as schematic flow diagrams and a description of the system operation. An analysis of the lost usable mechanical space, mechanical first cost, and a LEED analysis are also included.

Heating

Steam Plant

The existing hospital steam plant will provide low pressure steam to the addition. Unfortunately, the existing hospital drawings could not be obtained for further investigation. Because the building has been built over time with numerous additions, documentation is missing.

Heat Exchangers

There are two 4-pass shell and tube heat exchangers employed in the project, one being on standby. Steam from the existing steam plant enters the shell side at a temperature of 375 °F and a pressure of 150 psi. Return water enters the tube at a flow rate of 80 GPM with a temperature of 140 °F. The exiting water leaves at 180 °F and supplies the hot water preheat coil in AHU-2, as well as the radiant panels throughout the project, and the reheat coils located on the terminal boxes within each zone.

Radiant Panel Heating

Few spaces within the addition require additional heating below exterior windows or storefronts. Hot water supplied by the steam-to-water heat exchangers flows through the panel at an average temperature of 160 °F. Panels vary in active length and total 69 linear feet. Each panel has three passes and a minimum of 260 Btu/hr per linear foot. The maximum temperature difference between the entering and leaving water is 40 °F.

Steam and Hot Water Schematic

Figure 6, below, is a schematic drawing of the steam and hot water flow diagram of the hospital addition. Low pressure steam is supplied from the existing campus steam plant. Both air handling units use steam humidifiers, and steam is supplied at 5 psig, 50 lb/hr for AHU-1 and 5 psig, 400 lb/hr for AHU-2. AHU-1 utilizes a steam preheat coil in which steam is supplied at a pressure of 5 psig and a flow rate of 150 lb/hr. Steam also enters one of the heat exchangers, described above, and converts to hot water. This water enters one of the hot water pumps and is supplied to the hot water preheat coil within AHU-2 at a flow rate of 86 gpm at 180 °F water. Water returns from the coil at 140 °F, enters the heat exchanger, and again leaves at a temperature of 180 °F. After the heat transfer process occurs within the heat exchanger, steam is returned to the existing condensate pump, with a 210 °F suction temperature. Additionally, hot water is supplied and returned to radiant panels, discussed above, and terminal box reheat coils, discussed below.

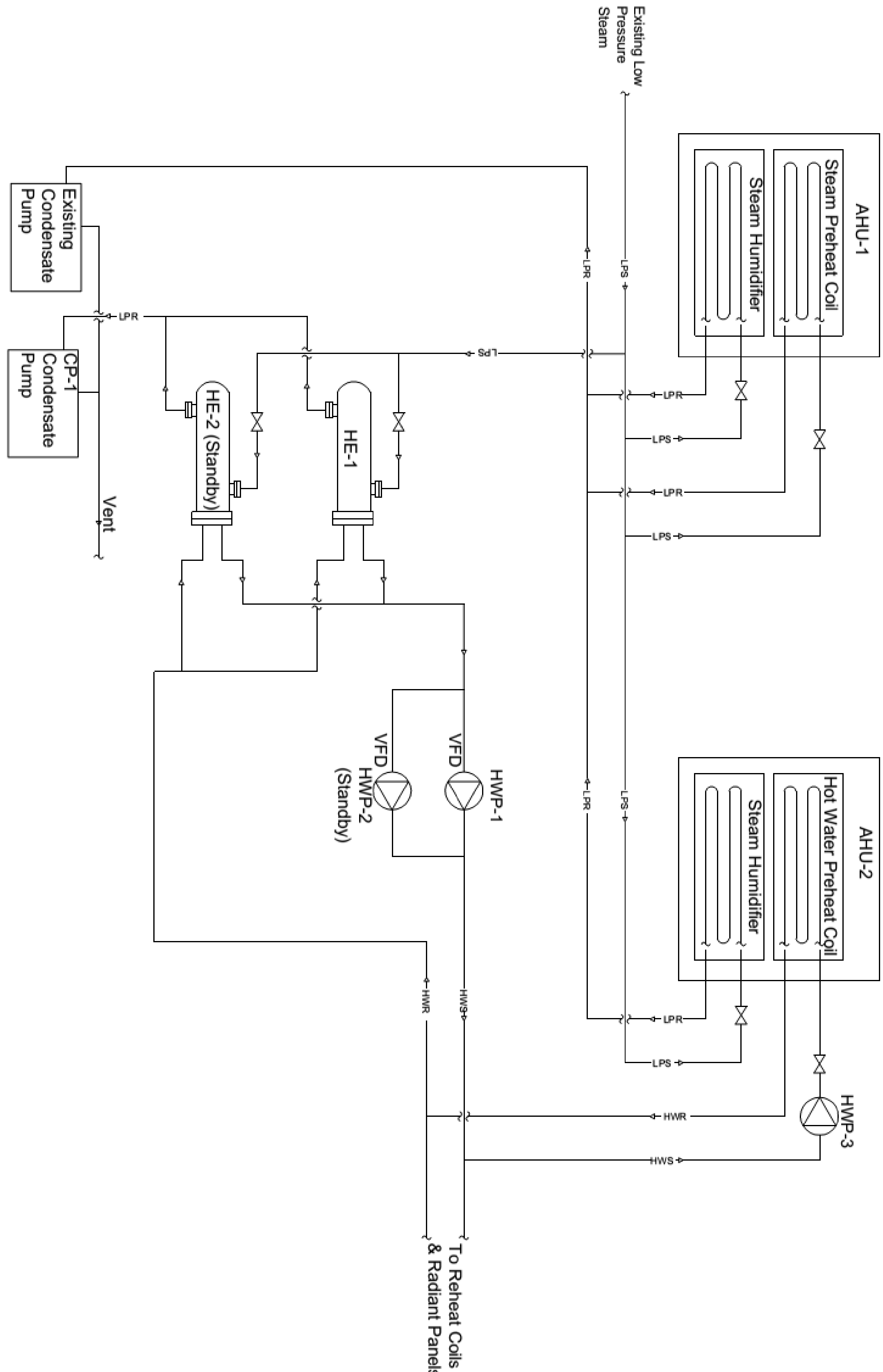

Figure 6: Building Steam and Hot Water Flow Diagram

Cooling

Air Cooled Chiller

The primary source of cooling for Phase 2 of the Morton Hospital addition is the 155 ton air cooled chiller. Basis of the design of the packaged chiller is Trane Model RTAC, Helical Rotary Chiller. Within the chiller is an evaporator, condenser, and compressor. The fluid used in the evaporator is water, which enters at 323 gpm and 55 °F, and exits the evaporator at 43 °F. The condenser has 13 fans and an ambient temperature of 95 °F. There are two direct drive compressors rated at 158.2 kW. The chiller manufacturer must also provide a prefabricated pump room including chilled water pumps, air separator, expansion tank, and flywheel tank.

Chilled Water Schematic

Figure 7, below, describes the flow of hot water through Phase 2 of the addition. Chilled water is supplied by the air cooled chiller, as described above, and enters the prefabricated pump package provided by the manufacturer. Supply chilled water enters the cooling coil within AHU-2 at a flow rate of 276 gpm and temperature of 43 °F. Water is then returned at 55 °F to the pump package and then back to the air cooled chiller. The chilled water loop has a variable primary flow configuration. This means that variable flow enters the chiller from the chiller pump, which is controlled by a variable frequency drive (VFD), rather than a primary-secondary flow configuration.

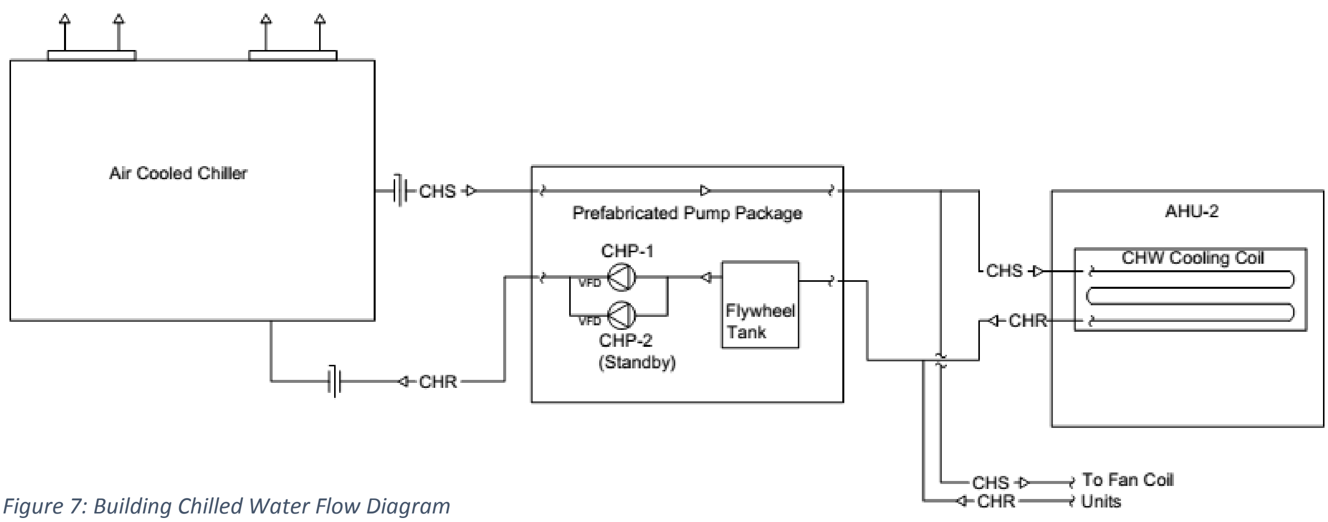

Figure 7: Building Chilled Water Flow Diagram

Airside

Air Handling Units

Two air handling units supply the necessary air to the Morton Hospital expansion, both being located on the roof. AHU-1 supplies a total of 2500 CFM to Phase 1, and a minimum of 850 CFM of outside air to the spaces. It includes a pre-filter before the coils, with an efficiency rating of MERV 8, and a final filter after the coils and supply fan with a rating of MERV 14. There is one supply fan and one return fan within this air handling unit, both being double width, double inlet (DWDI) type, and having an airflow measurement station at each fan inlet. AHU-2 supplies 35000 CFM of total air to Phase 2, and has a minimum of 9450 CFM outside air. There is a pre-filter and after filter located before the coils, with efficiency ratings of MERV 8 and MERV 11 respectively. The final filter has a rating of MERV 14. There are four supply fans and four return fans, all being centrifugal type, with an airflow measurement station at each fan inlet. The leaving air temperature of both AHUs is 55 °F.

Air Cooled Condensing Units

Phase 1 of the addition uses direct expansion cooling coils to cool the spaces. Two air cooled condensing units are used to supply refrigerant to AHU-1 and the computer room air conditioning unit (CRAC-1) located in the MRI control room. The first air cooled condensing unit, ACCU-1, corresponds to AHU-1, and contains two 10-ton semi-hermetic compressors using refrigerant R410A. The composition of R410A is 50% HFC-32 and 50% HFC-125. ACCU-2 corresponds to the computer room air conditioning unit, CRAC-1, and contains one 3 ton scroll compressors using refrigerant R407C. The composition of R407C is 23% HFC-32, 25% HFC-125, and 52% HFC-34A. Both refrigerants are offered by DuPont Suva, and are alternatives to R-22, which is currently being phased out.

Refrigerant Schematic

Figure 8, below, demonstrates the refrigerant flow within phase 1 of the project. Refrigerant liquid, RL, enters both the direct expansion cooling coils and refrigerant suction, RS, exits the coils to return to the condensing units, as described above.

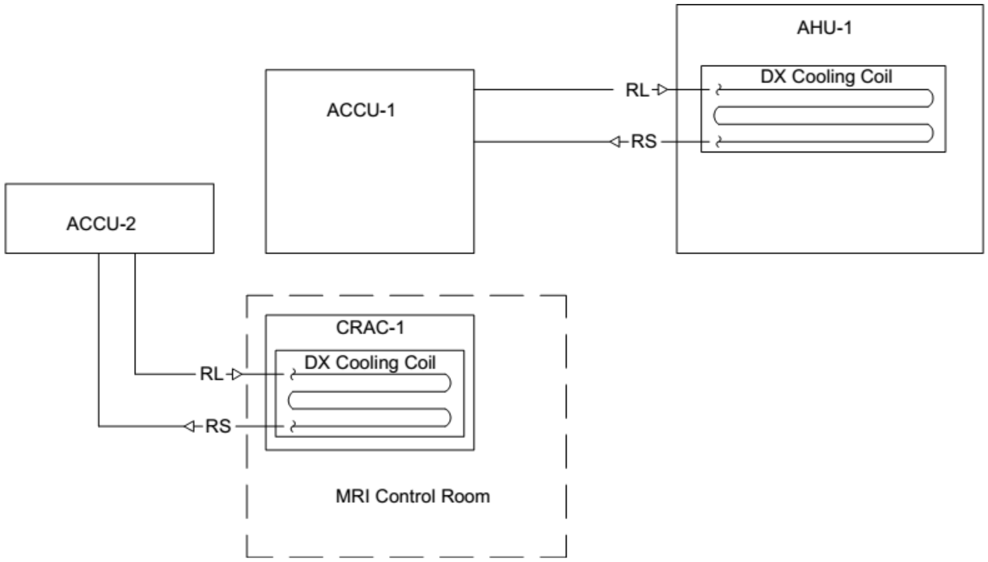

Figure 8: Building Refrigerant Flow Diagram

Electric Heating Coil

Phase 1 employs electric heating coils at each zone, each coil being 3 phase 480 Volts. Coils range from 3-15 kW in terms of electricity, and 8.1-38.9 MBtu/hr in terms of capacity. Each coil has an entering air temperature of 55 °F and leaving air temperature of 85 °F.

Terminal Boxes

Phase 2 of the project utilizes a total of 58 supply air terminal boxes with a hot water reheat coil at each zone. Each terminal box will include a unit controller to control airflow and temperature within that zone. Areas in which a positive or negative pressure relationship is required utilize a constant volume box. These critical areas include isolation rooms, trauma rooms, and the emergency department waiting room. Non-critical areas utilize a variable volume box with a minimum turn down volumetric flow rate. Each terminal box also has an attached in-duct sound attenuator to minimize unwanted noise within each zone.

Hot Water Reheat Coils

Terminal boxes in Phase 2 also have an attached hot water reheat coil, provided by hot water converted using the heat exchangers, as described above. Water enters at 180 °F and exits at 140 °F, heating the air from 55 °F to 85 °F.

Fan Coil Units

Some areas within the hospital require separate horizontal fan coil units because of excessive/unexpected loads, including all entry vestibules and electrical and Tel/Data rooms. Fan coils located in entry vestibules have both a hot water and chilled water coil to ensure that extreme outdoor air does not affect the indoor air temperature. The electrical rooms and Tel/Data rooms only include a chilled water coil to cool the equipment within these spaces, which give off excessive heat year round. All FCUs have a single phase 115 Volt motor at 60 Hz.

Airflow Schematic

Figure 9 demonstrates the airflow throughout the building expansion. Air enters both AHUs from a ducted return, since it is a hospital and plenum return is not practical, and reaches the return fan(s), which are described above. This return air mixes with the required outdoor air within the mixing plenum and then is filtered through a pre-filter and an after filter (only in AHU-2). Following the filters, air enters the preheat coil, humidifier, cooling coil, and supply fans, all of which are described above. Air leaves both AHUs at 55 °F, and enters the respected zones. As seen in the schematic, air going to a temperature control zone in Phase 1 enters an electric reheat coil before being distributed to the zone. Air being supplied to a temperature control zone in Phase 2 is modulated by a constant or variable volume terminal box with hot water reheat coil before entering the zone. It should also be noted that there are four separate ducted exhaust schemes that discharge 10 feet above the roof. This includes the general exhaust, isolation exhaust, decontamination exhaust, and ED waiting room exhaust, all of which must be separated from each other. The latter three are 100% exhausted.

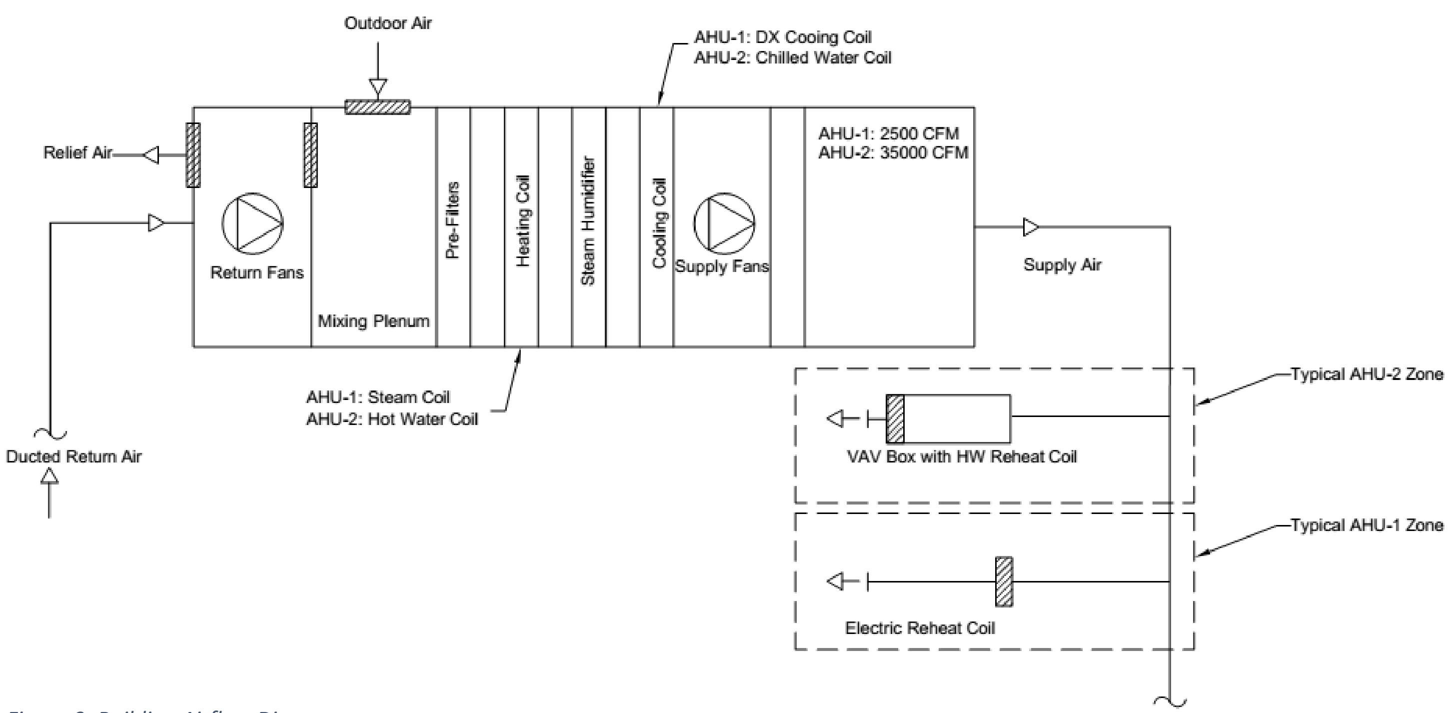

Figure 9: Building Airflow Diagram

Pumps

Hot water is pumped to the reheat coils, radiant panels, and AHU-2 heating coil by pumps HWP-1 and HWP-2. Both pumps are sized for 100% of the building total load, one being active and one being on standby. Both these pumps are end-suction type and have a variable frequency drive (VFD) that controls the flow through the pumps. AHU-2 also requires an in-line pump, HWP-3, to pump hot water to the preheat coil within it. This pump does not have a variable frequency drive, and the flow through this pipe is determined by how much flows through the pumps before it.

Chilled water is pumped to the chiller on the return side of the chilled water loop by pumps CHP-1 and CHP-2. Each pump is sized for 100% load, one pump on standby and one being active. Both pumps are end suction type and flow is controlled by a VFD.

Pump efficiency is equal to the hydraulic power (whp) divided by the brake power (bhp), where whp = Flow Rate (gpm) * Head (ft)/3960. Table 5 summarizes the five pumps located in the building addition.

Table 5: Building Water Pump Data

Water Pumps						
Unit Number	Location	Service	Capacity (GPM)	Head (ft H_20)	Efficiency (%)	VFD
CHP-1	AHU-2	AHU-2 CHWR	323	76	71%	Yes
CHP-2	AHU-2	AHU-2 CHWR	323	76	71%	Yes
HWP-1	Mechanical Room	Hot Water Loop	80	45	65%	Yes
HWP-2	Mechanical Room	Hot Water Loop	80	45	65%	Yes
HWP-3	AHU-2	AHU-2 HWS	86	20	58%	No

Lost Usable Space

All major components of the mechanical system are either located in the basement or on the roof. Because the addition is only one floor, no mechanical shafts are found within the space besides a small insignificant piping shaft. The basement mechanical area totals 1400 SF, taking up about 4% of the total usable space.

Mechanical System First Cost

As indicated in the bidding documents, the total cost of the HVAC system is $2,965,365. This comes to $73.95/SF of total building area, and accounts for 20.43% of the total estimated construction cost. Phase 1 mechanical cost totals $404,328 or $158.13/SF, and the Phase 2 mechanical cost comes to

$2,561,037 or $68.21/SF. The Phase 1 mechanical cost per square foot is significantly higher than the Phase 2 cost, and is something that should be investigated further.

LEED Evaluation

The original design of the hospital expansion did not aim to achieve a LEED rating. However, an analysis of the Energy and Atmosphere (EA) Credits and the Indoor Environmental Quality (EQ) Credits point breakdown is given below. This analysis used USGBC LEED Volume 4 for Building Design and Construction for New Construction.

Energy and Atmosphere Credits (EA)

✔ ***EA Prerequisite 1: Fundamental Commissioning and Verification***

A detailed commissioning plan will be provided, as stated in the specifications. A commission authority also fulfills the stated requirements. This prerequisite is met.

✖ ***EA Prerequisite 2: Minimum Energy Performance***

There are three options given to reduce environmental harms, only two of which apply to healthcare. Either option 1 or option 2 must be satisfied to meet this prerequisite.

Option 1: Whole-Building Simulation: An improvement of 3% for major renovations compared to the base building must be demonstrated. The baseline performance is based on ASHRAE Standard 90.1. As discussed in Technical Report 1, the addition does not completely comply with this standard because no heat recovery system is utilized.

Option 2: Prescriptive Compliance: ASHRAE 50% Advanced Energy Design Guide. Because the addition does not comply with ASHRAE 90.1, this option does not apply either. Therefore, the addition does not reach this prerequisite.

✔ ***EA Prerequisite 3: Building-Level Energy Metering***

Energy meters are provided in the project to provide energy consumption data, as described in the building specifications.

✔ ***EA Prerequisite 4: Fundamental Refrigerant Management***

The use of chlorofluorocarbon-based refrigerants, CFCs, is not prohibited because of its high global warming potential (GWP). The refrigerants used in the project are R410A and R407C, satisfying this prerequisite.

Indoor Environmental Quality Credits (EQ)

✓ *EQ Prerequisite 1: Minimum Indoor Air Quality Performance Required*

Because it is a healthcare facility, the ventilation must comply with ASHRAE 170 Section 7. As already discussed in technical report 1, Morton meets this prerequisite. Spaces also have an outdoor airflow measurement device.

✓ *EQ Prerequisite 2: Environmental Tobacco Smoke Control*

Smoking is prohibited inside the building, and therefore this prerequisite is met.

✓ *EQ Credit 1: Enhanced Indoor Air Quality Strategies (1 out of 2)*

There are two options, both with separate requirements, to achieving two possible credits. Option 1: Enhanced IAQ Strategies. Since all spaces are mechanically ventilated, there are three requirements:

A. Entryway Systems
B. Interior Cross-contamination prevention
C. Filtration

There are entryway systems at least 10 feet wide at all exterior entryways, sufficient exhaust in hazardous contaminated areas maintaining a minimum of 0.5 CFM/SF, and final filters within both AHUs are MERV 14, meeting the minimum requirement of MERV 13 specified by LEED. All three of these requirements are met for Option 1, and 1 credit is awarded.

Option 2: Additional Enhanced IAQ Strategies. Select one of the following:

A. Exterior contamination prevention
B. Increase ventilation
C. Carbon dioxide monitoring
D. Additional source control monitoring

The first selection must ensure that the project minimizes pollutants entry with a computational fluid model. This has not been done, and therefore does not comply with this option. Secondly, increasing the outdoor air rates by 30% has not been done. Thirdly, CO_2 monitors are not provided for all occupied spaces. And lastly, other contaminant monitoring is not provided. Only 1 of the 2 available credits are awards.

✖ ***EQ Credit 2: Low-Emitting Materials (0 out of 3)***

The intent of this credit is to reduce contaminant concentrations, and is measured by threshold percentages of materials. These threshold values have not been provided, and therefore credits are not awarded.

✖ ***EQ Credit 3: Construction Indoor Air Quality Management Plan (0 out of 1)***

There are seven components of this credit that must be met for healthcare facilities. Six of the seven components are met, and consequently no credit is given.

A. Moisture control plan: this is being utilized during construction of the addition.
B. Particulate control: A MERV of at least 8 is being used in all operating AHUs.
C. Minimize VOC emissions: Exposure to VOCs is minimized during construction processes by having specified limitations on material VOCs.
D. Minimize Outdoor emissions: Outdoor activities monitor emission rates to avoid infiltrating spaces.
E. Tobacco: Construction areas do not permit smoking within 25 feet of the site.
F. Noise and Vibration: No mention of complying with British Standard BS 5228 to reduce noise is mentioned, therefore it does not meet all requirements.
G. Infection control: As stated in building specifications, construction follows FGI 2010 Guidelines for Design and Construction of Healthcare Facilities.

✖ ***EQ Credit 4: Indoor Air Quality Assessment (0 out of 2)***

There are two options in achieving either 1 or 2 credits.

Option 1: Flush-Out, 1 point: A flush out before or during occupancy was not completed, and no point is awarded.

Option 2: Air Testing, 2 points: Only a CRI (Carpet & Rug Institute) IAQ Testing Procedure is stated in the specifications. LEED lists ASTM, EPA, or ISO methods as acceptable, all of which have not been discussed.

✖ ***EQ Credit 5: Thermal Comfort (0 out of 1)***

Specifications state that ASHRAE Standard 55 – 2004 Thermal Comfort Conditions for Human Occupancy is met. LEED states that the 2010 version must be met, so the credit is not awarded.

✖ ***EQ Credit 6: Interior Lighting (0 out of 1)***

All patient stations are provided with build in lighting control. However, staff areas do not specify any form of lighting control.

✖ ***EQ Credit 7: Daylight (0 out of 2)***

There is no discussion on daylight provided in the building specifications or other documents. It is assumed that this credit has not been met.

✖ ***EQ Credit 8: Quality Views (0 out of 2)***

Requirements for healthcare facilities is to have a direct line of sight for 75% of all inpatient units. However, all inpatient units within the Morton Expansion are psychiatric rooms, which have no windows. No points are awarded.

✓ ***EQ Credit 9: Acoustic Performance (1 out of 2)***

There are two options and two possible points to be awarded for acoustic performance.

Option 1: Speech Privacy, Sound Isolation, and Background Noise, 1 point: There is no mention within the provided building documentation of following the required Sound and Vibration Design Guidelines for Healthcare Facilities (2010 SV Guidelines). This option is not met.

Option 2: Acoustical Finishes and Site Exterior Noise, 1 point: Finishes within the project all meet FGI Table 1.2-1, Design Room Sound Absorption Coefficients, as provided in the specifications. One point is awarded.

LEED Summary

It is unlikely that any sort of LEED rating is attainable based on the analysis completed above. No points were awarded in the Energy and Atmosphere section, and only two points were awarded in the Indoor Environmental Quality section.

Overall Mechanical System Summary

The primary source for the building addition heating is provided by the existing hospital steam system. The low pressure steam system will employ heat exchangers to provide building reheat, preheat, perimeter heating, and domestic water heating. The steam connection will originate from the existing basement below the proposed MRI space. The primary cooling source will be a new 155 ton air cooled chiller. The chilled water system is a variable primary flow type.

The central air handling system will be served by two modular air handling units. Phase 1 will be provided by a rooftop packaged DX unit containing a steam preheat coil and direct expansion cooling coil, provided by existing steam plant and air cooled condensing unit respectfully. Phase 2 will employ a roof mounted chilled water air handling unit containing a hot water preheat coil and chilled water cooling coil, supplied by a steam-to-water heat exchanger and air cooled chiller respectfully. Both will be variable air volume, supply return type, controlled by minimum outside air monitoring and airside economizer control. Humidifiers are included within the units, and supply and return fans are driven by variable frequency drives. Phase 1 will have electric reheat coils at each zone, while Phase 2 will utilize terminal supply boxes with hot water reheat coils.

Lost usable space associated with the mechanical system is a minimum, taking up about 4% of the total area at about 1400 SF. The mechanical system first cost was estimated at $2,965,365, or $73.95/SF of total building area. The Phase 1 mechanical cost per square foot is significantly higher than the Phase 2 cost, $158.13/SF versus $68.21/SF, respectfully.

Based on the LEED analysis, it is unlikely that any sort of LEED rating is achievable. No points were awarded in the Energy and Atmosphere section, and only two points were awarded in the Indoor Environmental Quality section.

References

ANSI/ASHRAE/IES Standard 90.1 – 2013, Energy Standard for Buildings Except Low-Rise Residential Buildings. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

ANSI/ASHRAE/IES Standard 170 – 2013, Ventilation of Healthcare Facilities. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

ASHRAE Handbook – 2009, Fundamentals. Altanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.

"Rate 31." *Taunton Municipal Lighting Plant Home Page*. N.p., n.d. Web. 09 Nov. 2014.

Appendix

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	8.2	7.4	8.5	8.8	18.3	37.1	56.9	52.5	34.3	12.4	8.6	8.2	261.2
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	6.5	5.9	6.6	7.2	9.1	8.7	8.5	8.6	8.7	8.3	6.7	6.6	91.3
Pumps & Aux.	0.9	0.8	0.9	0.8	0.9	1.1	1.4	1.3	1.1	0.9	0.8	0.9	11.9
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	40.8	36.9	40.8	39.5	40.8	39.5	40.8	40.8	39.5	40.8	39.5	40.8	481.0
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	23.0	20.7	23.0	22.2	23.0	22.2	23.0	23.0	22.2	23.0	22.2	23.0	270.3
Total	79.4	71.7	79.8	78.7	92.1	108.6	130.6	126.2	105.8	85.4	78.0	79.5	1,115.7

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	338.4	284.0	205.7	90.3	17.2	1.1	-	0.6	4.4	46.5	123.0	290.9	1,402.1
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	165.4	154.9	171.9	163.6	157.6	141.4	136.3	130.0	125.3	134.6	139.6	155.3	1,775.8
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	503.9	438.9	377.6	253.9	174.8	142.5	136.3	130.6	129.7	181.0	262.5	446.2	3,177.9