Mechanical Technical Assignment Three
Mechanical Systems Existing Conditions Evaluation

Geisinger Hospital for Advanced Medicine
Danville, Pennsylvania

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Table of Contents

Executive Summary

The purpose of this report is to evaluate the existing mechanical system conditions of the Geisinger Hospital for Advanced Medicine. This report summarizes the ventilation rates and energy usage calculated in technical assignments one and two. This report also looks at the mechanical equipment for the building and the system operation.

The hospital is found to meet all of the requirements and standards necessary.

Building Design Overview

Geisinger Hospital for Advanced Medicine is a 300,600 square foot building being constructed at Geisinger Main Campus in Danville, PA. The hospital will be nine stories with a lower basement level and a ninth floor penthouse. The building construction has begun and the expected completion is Spring 2010. The estimated construction cost total $108 million.

The building design includes several shell spaces and floor designated for future use as the hospital's needs grow; these shell spaces total about half the square footage of the complete building. No future spaces will be analyzed in this report as little information is known about future intended uses.

The lower level is a partial shell floor but includes the dining room, toilet rooms, and staff areas. The first floor is also a partial shell floor but also includes the non-invasive cardiology areas. The second floor contains four operating rooms and space for an additional four. The third floor is a complete shell floor. The fourth floor contains a large mechanical room and the cardiology clinic. The fifth floor houses the cardiothoracic and vascular clinics, and lab clinics. The sixth floor is also a complete shell floor. The seventh and eighth floors are relatively the same and contain patient rooms.

Mechanical Systems Overview

The mechanical design includes eight air handling units, five to be installed now and three for future use. Other major mechanical work includes a new chiller building and an addition to the existing boiler house.

Air handling units AHU-4-1 and future AHU-4-2 will supply air for the operating rooms. The operating rooms require their own air handling units because the rooms need to be cooled to a lower temperature of 60°F and humidity levels must be more stringently controlled. AHU-4-1 will be installed now and sized to supply a current cfm of 12,000 of mixed outdoor air and return air and a future cfm of 18,000. AHU-4-2 is the future air handling unit and will be installed when the remaining four operating rooms are designed and constructed. Both of these air handling units will be located in the fourth floor mechanical room and both are designed for variable air volume. The mechanical system for the operating rooms also includes a energy recovery unit, which along with a cooling and heating coil pretempers the outside air and provides dehumidification.

Air handling unit AHU-4-3 will be installed now for the surgical pharmacy. AHU-4-3 supplies 2,700 cfm of return air to its spaces only cooling the air, reheat coils will take care of any heating loads. The air handling is located in the fourth floor mechanical room and is a constant volume unit. These areas will receive outdoor air ventilation through transfer air from surrounding spaces supplied by the south air handling units.

Air handling unit HV-4-4 is a future air handling unit for the kitchen hood make-up. This air handling unit will also be located in the fourth floor mechanical room and will be variable air volume.

The remaining areas of the building will be supplied by four air handling units, which includes one future unit. AHU-M-S1 and AHU-M-S2 will supply the south side of the building, both sized for a current cfm of 50,000 and a future cfm of 80,000. AHU-M-N2 and future AHU-M-N1 will supply the north side of the building. AHU-M-N2 will be sized for a current cfm of 80,000 and a future cfm of 77,000. The two south air handling units will be manifolded together and the two north air handling units will also be manifolded together. This provides one supply and return duct riser for the south side of the building and one supply and return duct riser for the north side of the building.

The hospital will use VAV boxes for most of the spaces and variable frequency drives will enable the air handling units to respond to the space loads. In spaces where positive pressure is required, according to AIA guidelines, return air boxes will be used. All supply air will be distributed through ceiling-mounted air devices.

Supplemental heating and cooling for several spaces is provided through fan coil units and radiant heating panels. Several spaces, mainly elevator machine rooms and electrical rooms will be provided with fan coil units to supply cooling and heating. Radiant heating panels will be installed at the perimeter glazing of levels three through eight.

Design Objectives and Requirements

The Geisinger Hospital for Advanced Medicine mechanical system was designed to comply with the following standards and codes:

- Guidelines for Design and Construction of Hospital and Health Care Facilities, 2006
- International Building Code, 2006
- International Mechanical Code, 2006
- International Energy Conservation Code, 2006
- International Fuel Gas Code, 2006
- Life Safety Code, NFPA 101-2000
- Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, NFPA-96
- Installation of Air Conditioning and Ventilating System, NFPA-90A
- Standard for Health Care Facilities, NFPA-99
- ANSI/ASHRAE 15-2004, Safety Standard for Refrigeration Systems
- ANSI/ASHRAE 62-2004, Ventilation for Acceptable Indoor Air Quality
- Handbooks of American Society of Heating, Refrigerating and Air Conditioning Engineers
- LEED-NC Reference Guide for New Construction and Major Renovations, Version 2.2
- USP 797 – Pharmaceutical Compounding – Sterile Preparations

ASHRAE Standard 62-2004 was used to determine ventilation requirements for most public, office, and storage spaces. The remaining spaces including patient rooms, operating rooms, and exam rooms were determined using the Guidelines for Design and Construction of Hospital and Health Care Facilities. These guidelines require a greater amount of ventilation air for spaces. To ensure the safety and health of a hospital's occupants it is vital that sufficient outside air is provided. Other important design requirements include necessary pressurization of rooms, sufficient filtration of return air, and proper exhausting of air. Many of these requirements become increasingly difficult when taking into consideration the LEED Silver Rating the hospital is striving to receive. Much thought must be put into the mechanical design to ensure all standards are meet and done so in an energy efficient manner.

Energy Sources and Rates

The electricity for the Geisinger Main Campus is supplied through a 69kV aerial service from PPL to a Geisinger owned 69kV substation. The rate schedule for the campus is LP-5. The following table shows the rate schedule:

	Per month	First 200 kWh	Second 200 kWh	Additional kWh
Distribution	$ 696	-	-	-
Competitive Transition	-	$ 0.00202	$ 0.00172	$ 0.00150
Intangible Transition	-	$ 0.00810	$ 0.00691	$ 0.00600
Capacity and Energy	-	$ 0.04423	$ 0.03723	$ 0.03199

Natural gas is used to provide heating for the building. The natural gas is supplied by UGI Penn Natural Gas at a cost of $11.11 per Mcf.

Site Factors

The Geisinger Hospital for Advanced Medicine is located in the existing Geisinger main campus. The hospital will connect to the existing hospital on the campus, because of this some demolition and renovation will be done to the existing hospital on the lower level and first through third floors. The site for the hospital is an existing parking lot, a future parking garage adjacent to the building.

Included in this project are major renovations to the existing boiler plant and the construction of a new chiller plant. Several major pieces of mechanical equipment will also be relocated from the existing hospital. These system renovations are a major part of the building receiving LEED certification.

Outdoor and Indoor Design Conditions

- Outdoor Design Conditions
  - Location: Williamsport, Pennsylvania
    - Latitude: 41.27N
    - Longitude: 77.05W
    - Elevation: 525 ft
  - Summer Conditions (0.4%)
    - 90.1°F DB
    - 72.9°F WB
    - Winds: W 9.8 mph
  - Winter Conditions (99.6%)
    - 3°F DB
    - Winds: WNW 7 mph
  - Obtained from AHRAE 2005 Fundamentals Handbook
- Indoor Design Conditions
  - Operating Rooms
    - Room temperature: 60°F to 70°F (adjustable by room)
    - 50%-55% RH at 60°F
    - 35%-40% RH at 70°F
  - Cath Labs
    - Room temperature: 70°F to 75°F (adjustable by room)
    - 30%-60% RH (adjustable by room)
  - MRI and CTI Rooms
    - Room temperature: 68°F to 75°F (adjustable by room)
    - 30%-60% RH (adjustable by room)
  - Patient Rooms
    - Room temperature: 70°F to 75°F (adjustable by room)
    - 30% RH min (winter)
    - 60% RH max (summer)
  - Exam/Treatment
    - Room temperature: 75°F
    - 30% RH min (winter)
    - 50% RH max (summer)
  - Mechanical and Electrical Rooms
    - Summer: 10°F above outdoor air temperature
    - Winter: 65°F
  - Kitchen
    - Summer: 85°F maximum
    - Winter: 65°F minimum
  - Other spaces:
    - Summer: 75°F, 50% RH maximum
    - Winter: 70°F, 30% RH minimum

Design Ventilation Requirements

An analysis of the ventilation rates of the Geisinger Hospital for Advanced Medicine was completed in Technical Assignment One. The hospital's ventilation rates were compared to those required by ASHRAE Standard 62.1-2007. The following table shows the total airflow rates required for each air handling unit. The table lists the uncorrected outdoor air intake (V_{ou}), the zone primary outdoor air fraction (Z_p), the zone distribution effectiveness (E_v), and the outdoor air intake flow (V_{ot}) calculated using the standard. The table also lists the minimum outdoor air supplied by the air handling unit and its compliance with the standard.

	Service	V_{ou}	Max Z_p	E_v	V_{ot}	Min. OA Supplied	Complies?
AHU-4-1	Operating Rooms	840	0.07	1.0	840	2400	YES
AHU-4-3	Surgical Pharmacy	55.7	0.03	1.0	55.7	0	NO
AHU-M-N2	North Side	6746.04	0.27	0.8	8432.55	19250	YES
AHU-M-S1	South Side	4743.16	0.30	0.8	5928.95	15000	YES
AHU-M-S2	South Side	4743.16	0.30	0.8	5928.95	15000	YES

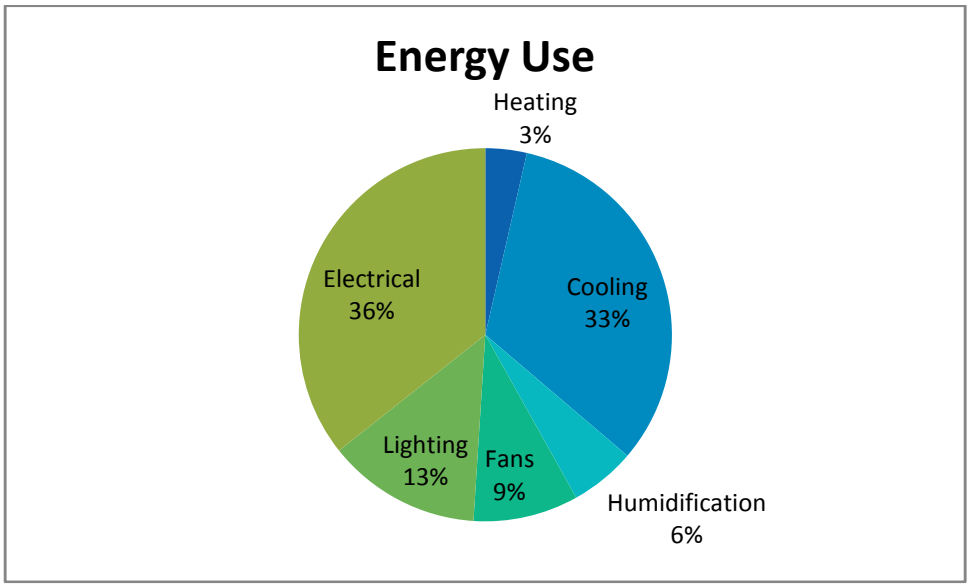
This table shows that air handling units AHU-4-1, AHU-M-N2, AHU-M-S1, and AHU-M-S2 all well exceed the required amount of ventilation air for the spaces. The building was designed using the Guidelines for Design and Construction of Hospitals and Health Care Facilities, 2006 Edition, this standard recommends much higher ventilation rates for spaces in hospitals.

AHU-4-3 appears to not meet the requirements of ASHRAE Standard 62.1 but the spaces actually use transfer air from the south air handling units to supply their outside air. Ducts transfer 1,100 cfm into the space from the surrounding areas. Since the air from the south air handling units is comprised of about 30% outdoor air, this supplies 330 cfm of outdoor air to the surgical pharmacy, well above the 56 cfm required.

Annual Energy Use

An analysis of the annual energy use of the Geisinger Hospital for Advanced Medicine was completed in Technical Assignment Three using the Carrier Hourly Analysis Program (HAP)

According to the HAP system analysis, the Geisinger Hospital for Advanced Medicine consumes 10,435,103 kWh of energy a year. The following pie chart and table show the breakdown of energy use.



	Load (Mbtu)	Load (kWh)
Preheat Coil (kBTU)	747,529	219,024.03
Central Cooling Coil Load (kBTU)	11,582,134	3,393,534.72
Central Heating Coil Load (kBTU)	398,936	116,887.20
Terminal Heating Coil Load (kBTU	127,166	37,259.30
Humidifier Load (kBTU)	2,019,302	591,650.16
Supply Fan (kWh)	2,134,951	625,535
Return Fan (kWh)	1,097,867	321,672
Vent. Reclaim Device (kWh)	122,697	35,950
Lighting (kWh)	4,724,630	1,384,304
Electric Equipment (kWh)	12,659,797	3,709,287
Total	35,615,008	10,435,103

This energy use seems very high for the building, this may be due to the occupancy schedules. The hospital was assumed to have 24-hour occupancy schedules since many of its spaces may be in use at any part of the day. Given the block load that was performed it was difficult to separate spaces which will not have constant occupancy so it was assumed full occupancy at all times. This has greatly increased the amount of energy that would be needed to support the building.

The electricity supply for the hospital is PPL Electric Utilities. The total load minus heating loads, which use natural gas, is 9,470,283 kWh. The cost of this would be $515,156.

The natural gas is supplied to the hospital by UGI Penn Natural Gas. The price is $11.11 per Mcf. The heating and humidification loads are 3,292,933 Mbtu. Using 1020 btu = 1 cf of natural gas, 3,228 Mcf. The cost of this would be $35,867.

The total cost for the building's energy would be $551,023.

Equipment Schedules

Air Handling Units

The following schedule lists the air handling units for the hospital, this does not include future air handling units that are to be installed later. For any air handling unit where two airflows are listed, the first line indicates the future airflow and the second line indicates current airflow.

AIR HANDLING UNIT SCHEDULE

SYMBOL	TYPE	SERVICE	TOTAL CFM	MIN OA CFM	SUPPLY FAN DATA				COOLING COIL											
					SP/IN.WG.		MAX	MOTOR	EAT °F		LAT °F		MBH		MAX. FACE	APD/	WATER		MIN.	NO.	MAX	ATC
					EXT.	TOT.	BHP	HP	DB	WB	DB	WB	TOT.	SENS.	VEL / FPM	IN. WG	GPM	PD/FT. WG	ROWS	COILS	FINS/IN.	VALVE
AHU-4-1	VAV	OPERATING ROOMS	18,000 12,000	3,600 2,400	3.0	9.2	41.8	50	70.8 54.1	63.1 47.0	47.5 50.0	47.4 45.1	811 81	477 81	493 458	1.4 0.83	161.6 16.1	11.7 1.6	10 8	1 1	12 14	3 WAY 3 WAY
AHU-4-3	CV	SURGICAL PHARMACY	2,700	-	2.5	6.9	6.2	7 1/2	64.7	57.7	49.6	49.4	60	45	393	0.39	12.0	4.0	8	1	8	2 WAY
AHU-M-N2	VAV	NORTH SIDE	80,000 77,000	24,000 19,250	3.0	6.3	132.3	2 @ 75	79.5	65.6	55.1	54	471	363	464	0.47	94.3	7.1	4	6	9	2 WAY
AHU-M-S1	VAV	SOUTH SIDE	80,000 50,000	24,000 15,000	3.0	6.3	132.3	2 @ 75	79.5	65.6	55.1	54	471	363	464	0.47	94.3	7.1	4	6	9	2 WAY
AHU-M-S2	VAV	SOUTH SIDE	80,000 50,000	24,000 15,000	3.0	6.3	132.3	2 @ 75	79.5	65.6	55.1	54	471	363	464	0.47	94.3	7.1	4	6	9	2 WAY

AIR HANDLING UNIT SCHEDULE (con't)

SYMBOL	PREHEAT/ HEATING COIL										FILTERS				
	EAT °F	LAT °F	MBH	FACE VEL. FPM	APD/ IN. WG	PRIM. WATER GPM	CIRC. WATER GPM	PD / FT	NO. COILS	ATC VALVE	LOC	APD/IN WG INIT.	APD/IN WG FINAL	MERV	TYPE
AHU-4-1	0	58.9	1151	735	0.24	115	115	6	1	2 WAY	PF AF	0.28 0.47	0.56 0.94	8 14	CARBON PLEAT RIGID
AHU-4-3	-	-	-	-	-	-	-	-	-	-	PF PF AF	0.12 0.45 1.25	0.24 0.90 2.50	8 13 17	PLEAT RIGID 99.97% HEPA
AHU-M-N2	47.6	65.6	260	454	0.09	7.0	37.6	2.3	6	2 WAY	PF AF	0.15 0.43	0.5 1.0	8 14	CARBON PLEAT RIGID
AHU-M-S1	47.6	65.6	260	454	0.09	7.0	37.6	2.3	6	2 WAY	PF AF	0.15 0.43	0.5 1.0	8 14	CARBON PLEAT RIGID
AHU-M-S2	47.6	65.6	260	454	0.09	7.0	37.6	2.3	6	2 WAY	PF AF	0.15 0.43	0.5 1.0	8 14	CARBON PLEAT RIGID

Boilers

The following schedule lists the boilers for the hospital. Two new gas fired boilers will be installed in an addition to the existing boiler house.

BOILER SCHEDULE

SYMBOL	LOCATION	TYPE	BOILER HP	DESIGN PRESS. PSIG	SQ.FT. OF SURFACE	INPUT MBH	GROSS OUTPUT			RELIEF VALVE SETTING PSIG	GAS BURNER				ELEC. CONSUMPTION KVA	ELEC. SERVICE VOLT
							MBH	STEAM LBS/HR 212 °F	STEAM PRESS. PSIG		CFH	GAS BTU/ CU. FT.	INLET PRESS. IN. WG.	BURNER PRESS. IN. WG.		
B-4	BOILER HOUSE	WATER TUBE	300	170	794	11,824	10,050	10,350	100	135	11,770	1004	5 PSIG	3-5 PSIG	30.4	460
B-5	BOILER HOUSE	ELECTRIC	612	150	-	-	20,273	20,090	100	135	-	-	-	-	6,000	13,200

Chillers

The following schedule list the chiller that will be installed in the new chiller plant, in addition to the chillers that will be relocated there.

WATER CHILLER SCHEDULE

SYMBOL	TYPE	LOCATION	NOM. CAPACITY TONS	EVAPORATOR							CONDENSER					COMPRESSOR	REF.	FULL LOAD	NPLV
				GPM	PD / FT. WG	EWT %%DF	LWT %%DF	NO. OF PASSES	REF.	FOUL FACT	GPM	PD / FT. WG	EWT %%DF	LWT %%DF	NO. OF PASSES	MAX. KW INPUT	WEIGHT (LBS.)	KW/TON (MAX.)	KW/TON (MAX.)
CH-3	CENTRIFUGAL	CHILLER PLANT	900	1800	12.4	42	54	2	R-134a	0.0001	2700	24.7	85	94	2	513	2300	0.592	0.376

Energy Recovery Unit

The energy recovery unit will be used for the operating rooms' air system.

ENERGY RECOVERY UNIT SCHEDULE

SYMBOL	TYPE	SERVICE	LOCATION	OA CFM	EXH CFM	SUPPLY FAN DATA				EXHAUST FAN DATA				ENTHALPY WHEEL	
						SP/IN.WG.		MAX	MOTOR	SP/IN.WG.		MAX	MOTOR	TYPE	
						EXT.	TOT.	BHP	HP	EXT.	TOT.	BHP	HP		HP
ERU-4-1	TEC	O.R. PRE-CONDITIONING	4TH FLOOR MECH. RM.	7,200 2,400	7,200 2,400	1.0	2.8	6.2	7 1/2	0.75	3.8	7.6	10	TEC	1/4

ENERGY RECOVERY UNIT SCHEDULE (con't)

SYMBOL	HEATING COIL										FILTERS			
	EAT °F	LAT °F	MBH	FACE VEL. FPM	APD/ IN. WG	PRIM. WATER GPM	CIRC. WATER GPM	CIRC. WATER PD / FT.	NO. COILS	ATC VALVE	LOC	SIZE THICKNESS	MERV	TYPE
ERU-4-1	0	40	312.3	745	0.17	31.2	31.2	3.9	1	2 WAY	OA	2"	8	CARBON PLEAT
											EA	2"	8	PLEAT

Fans

The following schedule lists all the fans for the hospital including supply fans, return fans, and exhaust fans.

FAN SCHEDULE

SYMBOL	TYPE	LOCATION	SERVICE	CFM	SP/ IN. WG	RPM	MOTOR MAX. BHP	MOTOR HP	VFD
SF-B-1	INLINE	BOILER PLANT ADDITION	BOILER PLANT VENTILATION	5,000	0.5	555	0.86	1 1/2	NO
EF-B-2	PRV	BOILER PLANT ROOF	ELECTRICAL SUBSTATION VENT.	1,000	0.5	1250	0.16	1/4	NO
EF-CH-1	PRV	CHILLER PLANT ROOF	CHILLER PLANT EMERGENCY VENT.	5,250	0.5	560	0.94	1 1/2	NO
EF-CH-2	PRV	CHILLER PLANT ROOF	CHILLER PLANT VENTILATION	2,500	0.5	880	0.46	3/4	NO
EF-CH-3	PRV	CHILLER PLANT ROOF	ELECTRICAL SUBSTATION	15,000	0.5	307	2.6	3	NO
EF-CH-4	PRV	CHILLER PLANT ROOF	EMERGENCY ELECTRICAL ROOM	2,000	0.5	782	0.33	1/2	NO
EF-LL-1	PROP	PASSAGE 0L050	AGP MECH. ROOM VENT	25,000	0.63	1105	6.9	7 1/2	YES
EF-LL-2	PROP	PASSAGE 0L050	AGP MECH. ROOM VENT	25,000	0.63	1105	6.9	7 1/2	YES
EF-LL-3	PROP	PASSAGE 0L050	AGP MECH. ROOM VENT	25,000	0.63	1105	6.9	7 1/2	YES
EF-LL-4	PROP	SUBSTATION 0L024	SUBSTATION VENTILATION	8,000	0.5	810	1.3	1 1/2	NO
EF-LL-5	PROP	SUBSTATION 0L024	SUBSTATION VENTILATION	8,000	0.5	810	1.3	1 1/2	NO
EF-LL-6	INLINE	EMERGENCY ELEC. RM. 0L038	EMERGENCY ELEC. RM. VENT.	3,000	0.5	632	0.5	3/4	NO
EF-LL-7	CEIL	ELECTRICAL ROOM 0L039	ELECTRICAL ROOM EXHAUST	600	0.5	804	0.12	1/2	NO
EF-1-1	INLINE	SHELL 01066	AGP DINING 01190	510	0.5	1343	251 W	1/4	NO
EF-1-2	INLINE	SHELL 01066	AGP SOIL. UTIL. 01203	450	0.75	1469	244 W	1/4	NO
EF-1-3	INLINE	SHELL 01066	AGP PROCEDURE 01195 & 01207	1,200	0.75	1222	0.5	3/4	NO
RF-4-1	MIXED FLOW	4TH FLOOR MECH. ROOM	AHU-4-1 RETURN AIR	18,000 11,200	2.0	1074	8.5	10	YES
EF-4-3	INLINE	4TH FLOOR MECH. ROOM	MECHANICAL ROOM VENTILATION	6,000	0.5	608	1.1	1 1/2	NO
SPF-4-4	UTIL	3RD FLOOR ROOF	STAIR PRESSURIZATION	10,700	1.0	441	2.3	3	NO
SPF-4-5	UTIL	3RD FLOOR ROOF	STAIR PRESSURIZATION	4,800	0.75	597	0.9	1 1/2	NO
RF-M-N2	MIXED FLOW	PENTHOUSE	AHU-N-2 RETURN AIR	56,000 54,500	2.5	507	32.6	40	YES
RF-M-S1	MIXED FLOW	PENTHOUSE	AHU-S-1 RETURN AIR	56,000 33,300	2.5	507	32.6	40	YES
RF-M-S2	MIXED FLOW	PENTHOUSE	AHU-S-2 RETURN AIR	56,000 33,300	2.5	507	32.6	40	YES
EF-M-6	PRV	MECHANICAL LEVEL ROOF	SOUTH PATIENT TOILET ROOM EXHAUST	3,300 1,650	1.0	1195	1.1	1 1/2	YES
EF-M-7	PRV	MECHANICAL LEVEL ROOF	NORTH PATIENT TOILET ROOM EXHAUST	4,500 2,250	1.0	1018	1.4	2	YES
EF-M-8	UTIL	MECHANICAL LEVEL ROOF	ISOLATION EXHAUST	6,250 5,000	1.5	815	2.1	3	YES
SPF-R-1	UTIL	ROOF	STAIR PRESSURIZATION	10,000	1.0	507	2.2	3	NO
EF-R-4	UTIL	ROOF	NORTH GENERAL EXHAUST	8,000 7,500	1.5	745	2.8	5	YES
EF-R-5	UTIL	ROOF	NORTH GENERAL EXHAUST	8,000 7,500	1.5	745	2.8	5	YES
EF-R-6	UTIL	ROOF	SOUTH GENERAL EXHAUST	11,000 7,700	1.5	599	3.6	5	YES
EF-R-7	UTIL	ROOF	SOUTH GENERAL EXHAUST	11,000 7,700	1.5	599	3.6	5	YES
EF-R-10	UTIL	ROOF	PHARMACY HOOD EXHAUST	900	1.25	1623	0.3	1/2	NO
EF-R-11	UTIL	ROOF	SURG. PATH LAB EXHAUST	2,870	1.25	1024	0.8	1	NO
EF-R-12	PROP	PENTHOUSE	PENTHOUSE VENTILATION	7,500	0.5	842	-	2	NO
EF-R-13	PROP	PENTHOUSE	PENTHOUSE VENTILATION	7,500	0.5	842	-	2	NO
ER-R-14	UTIL	ROOF	LIGHTBOX VENTILATION	5,000	0.5	446	0.6	3/4	NO

Fan Coil Units

The following schedule list the fan coil units for the hospital. Fan coil units will be used for most mechanical, electrical, and information technology rooms.

FAN COIL UNIT SCHEDULE (SEE HPE SCHEDULE FOR ELECTRICAL SERVICE)

SYMBOL	SERVICE	TYPE	FAN				COOLING									HEATING				
			CFM	ESP IN. WG	HP	RPM	EAT DB °F	EAT WB °F	LAT DB °F	LAT WB °F	EWT °F	GPM	SENS. MBH	TOTAL MBH	PD/ FT. WG	EAT °F	MBH	WATER EWT °F	WATER GPM	WATER PD/FT. WG
FCU-LL-1	ELEV. MACH. 0L068	EH-2P	1,200	0.5	1/2	1117	85.0	70.8	58.8	58.2	47	10.1	34.8	50.7	6.8	-	-	-	-	-
FCU-LL-2	MDF 0L049	EH-2P	870	-	1/8 & 1/16	1090	75.0	62.5	53.4	52.7	47	4.6	18.6	22.4	6.9	-	-	-	-	-
FCU-LL-3	COMM 0L048	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-1-1	ELEV. MACH. 01002	EH-4P	1,600	0.5	1	861	85.0	70.8	59.3	58.8	47	13.0	45.5	65.0	4.7	60	10.0	180	1.0	0.1
FCU-1-2	ELEC. 01017	EH-2P	1,000	0.5	3/4	1448	95.0	69.0	54.5	54.1	47	9.3	44.5	46.5	6.1	-	-	-	-	-
FCU-1-3	I/T 01018	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-1-4	EXIT PASSAGE 01021	HCABR-4P	250	-	1/20	1090	75.0	62.5	61.3	57.5	47	0.8	3.7	3.8	4.4	75	17.0	180	1.7	12.4
FCU-1-5	CORRIDOR 01003	VCABR-4P	190	-	1/20	856	75.0	62.5	59.9	56.9	47	0.7	3.0	3.1	3.0	75	13.6	180	1.4	8.3
FCU-2-1	ELEC. 02035	EH-2P	1,300	0.5	1/2	1126	95.0	69.0	56.9	55.7	47	11.0	54.5	54.8	7.8	-	-	-	-	-
FCU-2-2	I/T 02036	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-2-3	EQUIP/SYS 02050	EH-2P	870	-	1/8 & 1/16	1090	75.0	62.5	53.4	52.7	47	4.6	18.6	22.4	6.9	-	-	-	-	-
FCU-3-2	I/T 03061	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-4-1	ELEC. 04077	EH-2P	910	-	1/8 & 1/16	1080	95.0	69.0	58.2	55.9	47	7.3	34.0	35.5	15.4	-	-	-	-	-
FCU-4-2	I/T 04078	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-4-3	STAIR #2 ST04002	VCAB-4P	465	-	1/8	848	85.0	70.8	58.3	57.3	47	3.8	12.1	18.9	6.8	60	15.0	180	1.5	9.0
FCU-5-1	ELEC. 05063	EH-2P	910	-	1/8 & 1/16	1080	95.0	69.0	58.2	55.9	47	7.3	34.0	35.5	15.4	-	-	-	-	-
FCU-5-2	I/T 05064	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-6-2	I/T 06004	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-6-3	STAIR #2 ST06002	VCAB-4P	465	-	1/8	848	85.0	70.8	58.3	57.3	47	3.8	12.1	18.9	6.8	60	15.0	180	1.5	9.0
FCU-7-1	ELEC. 07047	EH-2P	1,000	0.5	3/4	1448	95.0	69.0	54.5	54.1	47	9.3	44.5	46.5	6.1	-	-	-	-	-
FCU-7-2	I/T 07048	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-8-1	ELEC. 08047	EH-2P	1,000	0.5	3/4	1448	95.0	69.0	54.5	54.1	47	9.3	44.5	46.5	6.1	-	-	-	-	-
FCU-8-2	I/T 08048	EH-2P	475	-	1/8	840	75.0	62.5	55.0	54.2	47	2.2	9.7	10.9	3.1	-	-	-	-	-
FCU-8-3	STAIR #2 ST08002	VCAB-4P	465	-	1/8	848	85.0	70.8	58.3	57.3	47	3.8	12.1	18.9	6.8	60	15.0	180	1.5	9.0
FCU-M-1	ELEV. MACH. EMPH001	EH-4P	1,800	0.5	1	992	85.0	70.8	57.3	57.2	47	16.3	55.2	81.4	2.0	60	16.9	180	0.5	0.1
FCU-M-2	ELEV. MACH. EMPH002	EH-4P	2,200	0.5	1 1/2	993	85.0	70.8	55.9	55.8	47	21.6	70.8	108	3.7	60	18.7	180	0.5	0.1
FCU-M-3	STAIR #2 STPH002	VCAB-4P	465	-	1/8	848	85.0	70.8	58.3	57.3	47	3.8	12.1	18.9	6.8	60	15.0	180	1.5	9.0

Finned Tube Radiation

The following schedule lists all the finned tube radiators that will be used in the hospital.

FINNED TUBE RADIATION SCHEDULE

SYMBOL	TYPE	ELEMENT						WATER		BTUH/ FT.	EAT °F
		ROWS	FIN SIZE IN. x IN.	FINS/ FT.	TUBE SIZE IN.	MATERIAL TUBE	MATERIAL FINS	EWT °F	LWT °F		
FTR-A	PEDESTAL	1	4-1/4x3-5/8	40	3/4	CU	AL	180	160	798	70
FTR-B	PEDESTAL	2 WIDE	4-1/4x3-5/8	40	3/4	CU	AL	180	160	1226	70
FTR-C	WALL MOUNT	1	3-1/4x3-1/4	40	3/4	CU	AL	180	160	570	70
FTR-D	PEDESTAL	2 WIDE	4-1/4x3-5/8	50	1 1/4	CU	AL	180	160	1368	70
FTR-E	BARE	1	3-1/4x3-1/4	40	3/4	CU	AL	180	160	740	65
FTR-F	BARE	2 WIDE	4-1/4x3-5/8	50	3/4	CU	AL	180	160	1525	70
FTR-G	BARE	2 WIDE	4-1/4x3-5/8	50	1 1/4	CU	AL	180	160	1368	70
FTR-H	WALL MOUNT	1	3-1/4x3-1/4	40	3/4	CU	AL	180	160	540	70

Heat Exchanger

The following schedule lists the heat exchangers for the hospital. The heat exchangers will be used to provide hot water to the hospital.

CONVERTOR/HEAT EXCHANGER SCHEDULE

SYMBOL	LOCATION	SERVICE	MBH	TUBE SIDE						SHELL SIDE		
				GPM	EWT °F	LWT °F	PD/ FT.WG.	NO. OF PASSES	CONN. SIZE	STEAM PSIG	STEAM LBS/HR	PD/ FT.WG.
HX-LL-1	AGP LL1 MECH. ROOM	HEATING WATER	12,000	1,228	160	180	2.7	2	8"	2	12,422	0
HX-LL-2	AGP LL1 MECH. ROOM	HEATING WATER	12,000	1,228	160	180	2.7	2	8"	2	12,422	0

Humidifier

The following schedule lists the humidifiers for the hospital.

HUMIDIFIER SCHEDULE

SYMBOL	SERVICE	DESIGN CONDITIONS						DISCHARGE LBS. STM/ HR.	STEAM SUPPLY PSIG	TUBES/MAINFOLD		MAX. ABSORPT. DIST. (IN.)
		AIRFLOW (CFM)	OUTSIDE TEMP °F	OUTSIDE HUM %RH	MIX AIR TEMP °F	INDOOR TEMP °F	INDOOR HUM %RH			SPACING IN.	APD IN. W.C.	
H-2-1	O.R. 02051 BOOSTER	3,000	-	-	58	73	45	40	10	6	0.04	18
H-2-2	O.R. 02043 BOOSTER	3,000	-	-	58	73	45	40	10	6	0.04	18
H-2-3	O.R. 02047 BOOSTER	3,000	-	-	58	73	45	40	10	6	0.04	18
H-2-4	O.R. 02055 BOOSTER	3,000	-	-	58	73	45	40	10	6	0.04	18
H-4-1	AHU-4-1 PRIMARY	18,000	0	40	46	60	45	227	10	3	0.17	12
H-M-N2	AHU-M-N2 PRIMARY	80,000	0	40	55	75	30	712	10	6	0.04	12
H-M-S1	AHU-M-S1 PRIMARY	80,000	0	40	55	75	30	712	10	6	0.04	12
H-M-S2	AHU-M-S2 PRIMARY	80,000	0	40	55	75	30	712	10	6	0.04	12

Pumps

The following schedules list the pumps for the hospital. The schedules list condensate pumps, infrastructure pumps, and all other pumps for the building.

CONDENSATE PUMP UNIT SCHEDULE

SYMBOL	TYPE	LOCATION	SERVICE	NO. OF PUMPS	GPM EA.	TOTAL HEAD PSI	OPER. TEMP. °F	SIZE IN.		RPM EA.	HP EA.	RECEIVER GAL.
								SUCT.	DISCH.			
CP-B-1	DUPLEX	BOILER PLANT	UH-B-1, B-2, B-3	2	9	20	212	2	1 1/2	3500	1/3	23
CP-LL-1	SIMPLEX	AGP MECH. RM.	CONDENSATE RECOVERY	1	22	40	55	2	1 1/2	3500	1 1/2	22
CP-LL-2	DUPLEX	AGP LL1 MECH. RM.	STEAM CONDENSATE	2	90	30	212	4	2	3500	3	120
CP-LL-3	DUPLEX	AGP LL1 MECH. RM.	DHWG CONDENSATE	2	90	30	212	4	2	3500	3	120
CP-LL-4	DUPLEX	ZONE MAINT. 0L056	L.P. CONDENSATE	2	9	30	212	2	1 1/2	3500	3/4	23
CP-4-1	DUPLEX	MECH. 04112	STEAM CONDENSATE	2	9	30	212	2	1 1/2	3500	3/4	23
CP-4-2	SIMPLEX	MECH. 04112	CONDENSATE RECOVERY	1	12	40	55	2	3/4	3500	1	14
CP-M-1	DUPLEX	PENTHOUSE	HUMIDIFIER CONDENSATE	2	9	30	212	2	1 1/2	3500	3/4	23
CP-M-2	SIMPLEX	PENTHOUSE	CONDENSATE RECOVERY	1	12	40	55	2	3/4	3500	1	14
CP-M-3	SIMPLEX	PENTHOUSE	CONDENSATE RECOVERY	1	12	40	55	2	3/4	3500	1	14

PUMP SCHEDULE (INFRASTRUCTURE)													
SYMBOL	TYPE	SERVICE	GPM	TOTAL HEAD FT. WG	MAX. NPSH FT. WG	OPER. TEMP. %%DF	SIZE IN.		EFF. %	RPM	BHP	HP	VFD
							SUCT.	DISCH.					
P-PCHW1	HORIZ. SPLIT CASE	PRIMARY CHILLED WATER	1,800	55	-	54	10	8	86.2	1187	29	40	NO
P-PCHW2	HORIZ. SPLIT CASE	PRIMARY CHILLED WATER	1,800	55	-	54	10	8	86.2	1187	29	40	NO
P-PCHW3	HORIZ. SPLIT CASE	PRIMARY CHILLED WATER	1,800	55	-	54	10	8	86.2	1187	29	40	NO
P-SCHW1	HORIZ. SPLIT CASE	SECONDARY CHILLED WATER	3,700	140	-	54	10	8	90.1	1780	145	200	YES
P-SCHW2	HORIZ. SPLIT CASE	SECONDARY CHILLED WATER	3,700	140	-	54	10	8	90.1	1780	145	200	YES
P-SCHW3	HORIZ. SPLIT CASE	SECONDARY CHILLED WATER	3,700	140	-	54	10	8	90.1	1780	145	200	YES
P-TCHW1	END SUCTION	THERMAL TANK CHILLED WATER	1,350	140	-	54	8	6	75.9	1750	63	100	YES
P-TCHW2	END SUCTION	THERMAL TANK CHILLED WATER	1,350	140	-	54	8	6	75.9	1750	63	100	YES
P-CW1	HORIZ. SPLIT CASE	CONDENSER WATER	2,700	80	10.1	95	10	8	87.3	1780	62	75	NO
P-CW2	HORIZ. SPLIT CASE	CONDENSER WATER	2,700	80	10.1	95	10	8	87.3	1780	62	75	NO
P-CW3	HORIZ. SPLIT CASE	CONDENSER WATER	2,700	80	10.1	95	10	8	87.3	1780	62	75	NO
P-CW4	HORIZ. SPLIT CASE	CONDENSER WATER	2,700	80	10.1	95	10	8	87.3	1780	62	75	NO
P-SCW1	INLINE	SECONDARY CONDENSER WATER	75	20	-	95	2	2	59.9	1167	0.6	3/4	NO
P-SCW2	INLINE	SECONDARY CONDENSER WATER	75	20	-	95	2	2	59.9	1167	0.6	3/4	NO
P-FW1	CENTRIFUGAL	BOILER FEEDWATER	110	360	8.0	250	2	2	72.5	3450	-	20	YES
P-FW2	CENTRIFUGAL	BOILER FEEDWATER	110	360	8.0	250	2	2	72.5	3450	-	20	YES
P-FW3	CENTRIFUGAL	BOILER FEEDWATER	110	360	8.0	250	2	2	72.5	3450	-	20	YES
P-XFER1	CENTRIFUGAL	SURGE TANK TRANSFER	200	60	2.9	250	3	2 1/2	75.9	1750	4	7 1/2	NO
P-XFER2	CENTRIFUGAL	SURGE TANK TRANSFER	200	60	2.9	250	3	2 1/2	75.9	1750	4	7 1/2	NO
FOP-CH-1	DUPLEX ROTARY	GENERATOR FUEL TRANSFER	4.7	50 PSI	-	-	1/2	1/2	-	-	-	2 @ 3/4	NO

PUMP SCHEDULE												
SYMBOL	TYPE	SERVICE	GPM	TOTAL HEAD FT. WG	MAX. NPSH FT. WG	OPER. TEMP. °F	SIZE IN.		EFF. %	RPM	HP	VFD
							SUCT.	DISCH.				
P-LL-HW1	END SUCTION	HEATING WATER	1,230	80	-	180	8	6	80.4	1750	40	YES
P-LL-HW2	END SUCTION	HEATING WATER	1,230	80	-	180	8	6	80.4	1750	40	YES
P-4-1	INLINE	AHU-4-1 HW BLEND	115	20	-	180	3	3	66.7	1167	1 1/2	NO
P-4-3	INLINE	ERU-4-1 HW BLEND	31	20	-	180	1 1/4	1 1/4	52.7	1750	1/2	NO
P-M-N2A	END SUCTION	AHU-M-N2 HW BLEND	226	20	-	130	4	3	75.5	1167	2	NO
P-M-N2B	END SUCTION	AHU-M-N2 HW BLEND	226	20	-	130	4	3	75.5	1167	2	NO
P-M-S1A	END SUCTION	AHU-M-S1 HW BLEND	226	20	-	130	4	3	75.5	1167	2	NO
P-M-S1B	END SUCTION	AHU-M-S1 HW BLEND	226	20	-	130	4	3	75.5	1167	2	NO
P-M-S2A	END SUCTION	AHU-M-S2 HW BLEND	226	20	-	130	4	3	75.5	1167	2	NO
P-M-S2B	END SUCTION	AHU-M-S2 HW BLEND	226	20	-	130	4	3	75.5	1167	2	NO
FOP-UPS-1	DUPLEX ROTARY	GENERATOR FUEL TRANSFER	4.7	50 PSI	-	-	1/2	1/2	-	-	2 @ 3/4	NO

Radiant Heating Panels

The following schedule lists the radiant heating panels for the hospital. Radiant heating panels will be used for perimeter heating in the patient rooms.

RADIANT HEATING PANEL (HYDRONIC) SCHEDULE						
SYMBOL	SERVICE	BTUH	WATER			WPD FT. WG
			GPM	EWT %%DF	LWT %%DF	
RHP-A	PERIMETER HEATING	7,780	0.8	180	160	2
RHP-B	PERIMETER HEATING	1,200	0.5	180	175	0.1

Split System Air Conditioning System Schedule

The following schedule lists the split system air conditioning system that will be used in the elevator machine room of the hospital.

SPLIT SYSTEM AIR CONDITIONING SYSTEM SCHEDULE

SYMBOL	TYPE	SERVICE	TOTAL CFM	FAN DATA ESP/ IN. WG	FAN DATA NOM. HP	COOLING CAPACITY EAT °F DB	COOLING CAPACITY EAT °F WB	COOLING CAPACITY MBH TOT.	COOLING CAPACITY MBH SENS.	COOLING CAPACITY NOMINAL TONS	COOLING CAPACITY REF	HEATING CAPACITY H/P MBH	HEATING CAPACITY ELECTRIC KW	CONDENSER AIR (TEMP %%DF) SUM.	CONDENSER AIR (TEMP %%DF) WINT.	COMPRESSOR MIN. STAGES OF COOLING
SS-R-1	DUCTLESS SPLIT HEAT PUMP	ELEV. MACH. EMHW001	740	-	1/6	85.0	70.8	34.8	18.7	3	R-410A	17.5	3	105	-20	1

Unit Heater

The following schedule lists the unit heaters for the hospital. The first schedule lists those supplied by hot water and the second schedule lists those supplied by steam.

UNIT HEATER SCHEDULE (HOT WATER)

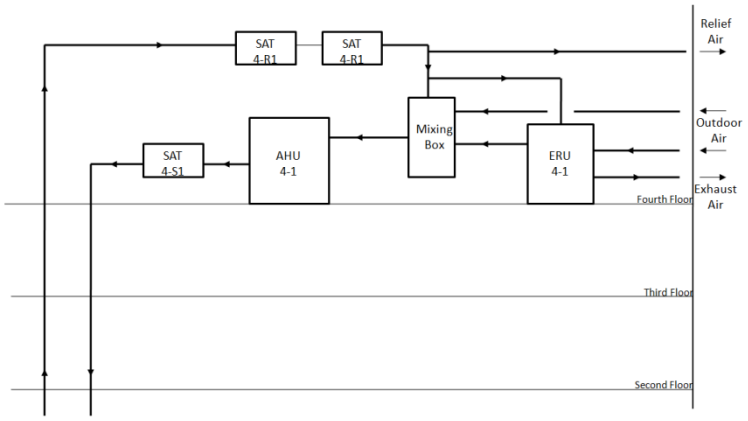
SYMBOL	TYPE	FAN CFM	FAN HP	FAN RPM	HEATING CAPACITY MBH	HEATING CAPACITY EAT %%DF	HEATING CAPACITY STEAM PSIG	HEATING CAPACITY STEAM LB/HR	HEATING CAPACITY ELEC. KW	HEATING CAPACITY ELEC. STAGES
UH-B-1	PROP	2,400	1/6	1070	152.0	60	2	157	-	-
UH-B-2	PROP	2,400	1/6	1070	152.0	60	2	157	-	-
UH-B-3	PROP	280	1/50	1050	17.4	60	2	18	-	-
UH-CH-1	PROP	910	1/20	1530	51.2	60	-	-	15.0	2
UH-CH-2	PROP	650	1/30	1600	25.6	60	-	-	7.5	2
UH-CH-3	PROP	350	1/100	1600	10.2	60	-	-	3.0	1
UH-CH-4	PROP	650	1/30	1600	25.6	60	-	-	7.5	2
UH-CH-5	PROP	2,100	1/4	1600	85.2	60	-	-	25.0	2

UNIT HEATER SCHEDULE (STEAM)

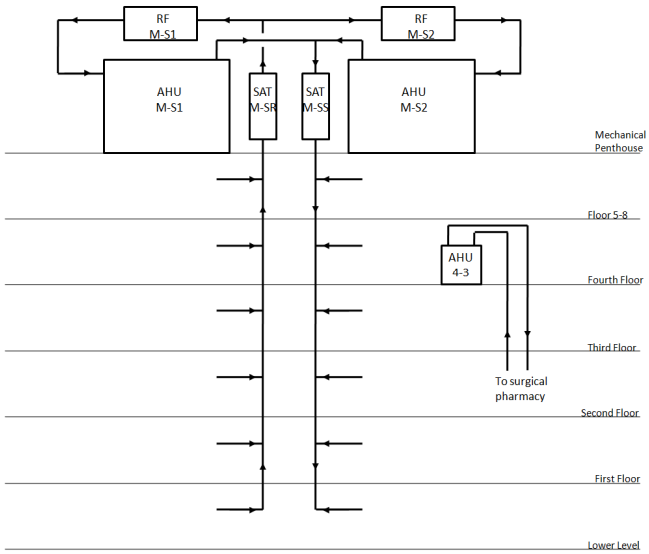
SYMBOL	TYPE	FAN CFM	FAN HP	FAN RPM	HEATING CAPACITY MBH	HEATING CAPACITY EAT %%DF	HEATING CAPACITY WATER GPM	HEATING CAPACITY WATER PD/FT WG	HEATING CAPACITY WATER EWT %%DF	HEATING CAPACITY ELECTRIC KW	HEATING CAPACITY ELECTRIC STAGES
UH-UPS-1	ELEC	350	1/100	1600	10.2	60	-	-	-	3	1
UH-LL-1	PROP	545	1/20	1550	14.3	60	1.5	0.1	180	-	-
UH-LL-2	PROP	545	1/20	1550	14.3	60	1.5	0.1	180	-	-
UH-LL-3	PROP	815	1/20	1550	27.4	60	2.8	0.2	180	-	-
UH-LL-4	PROP	545	1/20	1550	14.3	60	1.5	0.1	180	-	-
CUH-LL-5	VCAB-EX	390	1/8	837	39.3	60	3.9	5.8	180	-	-
CUH-1-1	HCAB	750	1/4	1283	55.0	60	5.5	10.0	180	-	-
CUH-1-2	VCAB-EX	290	1/8	630	29.8	60	3.0	3.4	180	-	-
UH-1-3	PROP	545	1/20	1550	14.3	60	1.5	0.1	180	-	-
UH-1-4	PROP	545	1/20	1550	14.3	60	1.5	0.1	180	-	-
UH-1-5	PROP	815	1/20	1550	27.4	60	2.8	0.2	180	-	-
UH-2-1	PROP	545	1/20	1550	14.3	60	1.5	0.1	180	-	-
UH-4-1	PROP	815	1/20	1550	27.4	60	2.8	0.2	180	-	-
UH-4-2	PROP	815	1/20	1550	27.4	60	2.8	0.2	180	-	-
UH-M-1	PROP	2380	1/6	1100	95.5	60	9.8	3.0	180	-	-
UH-M-2	PROP	2380	1/6	1100	95.5	60	9.8	3.0	180	-	-
UH-M-3	PROP	2380	1/6	1100	95.5	60	9.8	3.0	180	-	-
UH-M-4	PROP	2380	1/6	1100	95.5	60	9.8	3.0	180	-	-
UH-M-5	PROP	2380	1/6	1100	95.5	60	9.8	3.0	180	-	-

Schematics

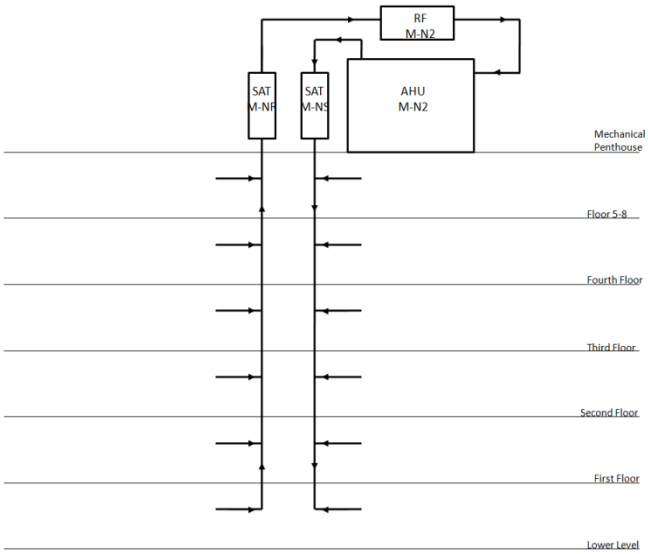
Airflow diagrams



Operating Room Air Handling Unit Flow Diagram



South Air Handling Units Flow Diagram



North Air Handling Unit Flow Diagram

System Operation

The system will be controlled by a DDC system, which will be connected to the existing Johnson Metasys Control System. All communication will be done over ethernet connections. The DDC system will provide alarming for all controlled devices.

System operation information is incomplete, waiting for additional information from designer

Lost Rentable Space

The following table lists the areas of the mechanical and electrical spaces of the building, this does not include the ninth floor penthouse which is all mechanical space.

	SF	%
Fourth Floor Mechanical Room	4350	3%
Other Mechanical and Electrical Rooms	2284	2%
Total Mechanical	6634	5%
Total Building	135951	

Mechanical System First Cost

The construction manager for the Geisinger Hospital for Advanced Medicine is Torcon. They performed a cost estimation for the project. The project is divided into several parts, site work, infrastructure, utility relocation, core and shell, and interior fit-outs. The square footage used for the interior fit-outs was 118,600 sf, all other parts of the project used 322,400 sf. The following table shows the estimated costs of plumbing, HVAC, and electrical for all parts of the project and the total cost of the project. The total HVAC cost is $23,484,600 which is 21.6% of the total cost of the project.

	Site Work		Infrastructure		Utility Relocation		Core & Shell		Interior Fit-outs		Total Project	
	Cost	Cost/SF	Cost	Cost/SF	Cost	Cost/SF	Cost	Cost/SF	Cost	Cost/SF	Cost	Cost/SF
Plumbing	-	-	-	-	-	-	$ 1,954,200	$ 6.06	$ 3,564,300	$ 30.05	$ 5,518,500.00	$ 17.12
HVAC	-	-	$ 6,478,900	$ 20.10	$ 1,302,600	$ 4.04	$ 10,663,900	$ 33.08	$ 5,039,200	$ 42.49	$ 23,484,600	$ 72.84
Electrical	-	-	$ 4,133,900	$ 12.82	$ 360,700	$ 1.12	$ 4,346,200	$ 13.48	$ 2,674,900	$ 22.55	$ 11,515,700	$ 35.72
Total	$ 2,422,900	$ 7.52	$ 15,086,200	$ 46.79	$ 2,635,300	$ 8.17	$ 61,156,200	$ 189.69	$ 27,057,700	$ 228.14	$ 108,358,300	$ 336.10

System Evaluation

The mechanical system for the Geisinger Hospital for Advanced Medicine seems to be appropriate for the building's use. The most important considerations in a hospital are the safety and well being of its occupants. One of the ways the system is able to address this issues is with sufficient ventilation air, the design meets AIA Hospital Guidelines which more ventilation air than does ASHRAE. The system includes exhaust in all necessary rooms, pressurizes all required rooms, and follows all precautions to keep the indoor air quality high. The only way to further improve the indoor air quality would be the use of an 100% outdoor air system.

Another important consideration is energy use. While the building is aiming to obtain LEED silver, there are several ways the design could incorporate more energy savings. An energy recovery device is used in the operation rooms air handling system. The building could have tried to use similar devices in other systems and perhaps incorporated exhaust air heat recovery.

Overall the mechanical system is well designed and able to meet all requirements set by the owners and various standards. Some improvements could be made if the owner was willing to pay the additionally first costs.

References

EwingCole. 2008, Mechanical Construction Documents. EwingCole, Philadelphia, PA. 2008.

Appendix A: LEED-NC

LEED for New Construction v2.2
Registered Project Checklist

Project Name:
Project Address:

Yes	?	No			
6	5	3	**Sustainable Sites**		14 Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
1			Credit 1	**Site Selection**	1
1			Credit 2	**Development Density & Community Connectivity**	1
	1		Credit 3	**Brownfield Redevelopment**	1
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
	1		Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel-Efficient Vehicles	1
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Site Development,** Protect or Restore Habitat	1
		1	Credit 5.2	**Site Development,** Maximize Open Space	1
1			Credit 6.1	**Stormwater Design,** Quantity Control	1
	1		Credit 6.2	**Stormwater Design,** Quality Control	1
	1		Credit 7.1	**Heat Island Effect,** Non-Roof	1
1			Credit 7.2	**Heat Island Effect,** Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
3	1	1	**Water Efficiency**		5 Points
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	1		Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere — 17 Points

Yes	?	No			
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required

***Note for EAc1**: All LEED for New Construction projects registered after June 26th, 2007 are required to achieve at least two (2) points under EAc1.

4	4	2	Credit 1	**Optimize Energy Performance**	1 to 10
				10.5% New Buildings or 3.5% Existing Building Renovations	1
				14% New Buildings or 7% Existing Building Renovations	2
				17.5% New Buildings or 10.5% Existing Building Renovations	3
				4 21% New Buildings or 14% Existing Building Renovations	4
				24.5% New Buildings or 17.5% Existing Building Renovations	5
				28% New Buildings or 21% Existing Building Renovations	6
				31.5% New Buildings or 24.5% Existing Building Renovations	7
				35% New Buildings or 28% Existing Building Renovations	8
				38.5% New Buildings or 31.5% Existing Building Renovations	9
				42% New Buildings or 35% Existing Building Renovations	10
		3	Credit 2	**On-Site Renewable Energy**	1 to 3
				2.5% Renewable Energy	1
				7.5% Renewable Energy	2
				12.5% Renewable Energy	3
1			Credit 3	**Enhanced Commissioning**	1
1			Credit 4	**Enhanced Refrigerant Management**	1
	1		Credit 5	**Measurement & Verification**	1
	1		Credit 6	**Green Power**	1

continued…

Materials & Resources — 13 Points

Yes	?	No			
3	4	6			
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
		1	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
1			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
	1		Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
		1	Credit 3.1	**Materials Reuse**, 5%	1
		1	Credit 3.2	**Materials Reuse**,10%	1
1			Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
	1		Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
1			Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regior	1
	1		Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regior	1
		1	Credit 6	**Rapidly Renewable Materials**	1
	1		Credit 7	**Certified Wood**	1

Yes	?	No			
7	4	**4**	**Indoor Environmental Quality**		**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
	1		Credit 1	**Outdoor Air Delivery Monitoring**	1
		1	Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
	1		Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	1		Credit 6.1	**Controllability of Systems**, Lighting	1
		1	Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
1			Credit 7.1	**Thermal Comfort**, Design	1
		1	Credit 7.2	**Thermal Comfort**, Verification	1
	1		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
3	2		**Innovation & Design Process**		**5** Points
1			Credit 1.1	**Innovation in Design**: Provide Specific Title	1
1			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
	1		Credit 1.3	**Innovation in Design**: Provide Specific Title	1
	1		Credit 1.4	**Innovation in Design**: Provide Specific Title	1
1			Credit 2	**LEED® Accredited Professional**	1
28	22	**19**	**Project Totals** (pre-certification estimates)		**69** Points