Mechanical Technical Assignment Two
Building and Plant Energy Analysis Report

Geisinger Hospital for Advanced Medicine
Danville, Pennsylvania

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Executive Summary

The purpose of this report is to evaluate the building energy use for the Geisinger Hospital for Advanced Medicine. A design load estimation and an annual energy consumption and operating costs analysis were performed using Carrier's Hourly Analysis Program (HAP). The calculations were performed using data from the construction documents and assumed conditions.

The design load estimation was found to be fairly consistent with the design. There were a few differences but they can be contributed to the less accurate block load used.

The annual energy consumption results were fairly high. This is most likely due to the full, 24-hour occupancy schedule that was used.

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.

Building Load Analysis

The design loads for Geisinger Hospital for Advanced Medicine were estimated using Carrier's Hourly Analysis Program (HAP). The following assumptions were used in the calculations:

- Room areas, wall types and orientation, window types and placement were calculated using the architectural drawings.
- Occupancy was calculated using furniture layouts or other design conditions, all occupant load were estimated for office work activity level, 245 Btu/hr sensible heat and 205 Btu/hr latent heat load.
- Lighting loads were estimated on a per floor average W/sf with the exception of the second floor which was calculated per space.
- Electrical loads were estimated at 3 W/sf with the exception of the operating rooms which were estimated at 6 W/sf.
- Outdoor ventilation rates were determined from mechanical drawings and schedules.
- Outdoor Design Conditions
  - Location: Williamsport, Pennsylvania
  - 90.1°F DB/72.9°F WB summer, 3°F DB winter (ASHRAE 2005 Fundamentals Handbook)
- Indoor Design Conditions
  - North Spaces
    - Room temperature setpoint: 75°F
    - Supply temperature: 58°F
  - South Spaces
    - Room temperature setpoint: 75°F
    - Supply temperature: 58°F
  - Operating Rooms
    - Room temperature setpoint: 60°F
    - Supply Temperature: 50°F
  - Surgical Pharmacy
    - Room temperature setpoint: 68°F
    - Supply Temperature: 55°F

The following table shows the areas, lighting and equipment loads, and occupancies were used for each block of the building:

	Area (SF)	Occupancy	Lighting (W/SF)	Equipment (W/SF)
Lower Level North	5008	210	0.39	3
Lower Level South	7062	210	0.39	3
First Floor North	7134	5	1.25	3
First Floor South	15013	133	1.25	3
Second Floor OR	3890	42	3.56	6
Second Floor Pharmacy	595	4	1.04	3
Second Floor South	10754	31	0.69	3
Fourth Floor North	10618	102	0.93	3
Fourth Floor South	15720	118	0.93	3
Fifth Floor North	10648	79	1.1	3
Fifth Floor South	9950	137	1.1	3
Seventh Floor North	10087	45	1.38	3
Seventh Floor South	10320	72	1.38	3
Eighth Floor North	10136	45	1.39	3
Eighth Floor South	10320	72	1.39	3

In comparing the HAP analysis with the actual design, the design exceeds almost all the requirements. The following table compares the design to the HAP calculations:

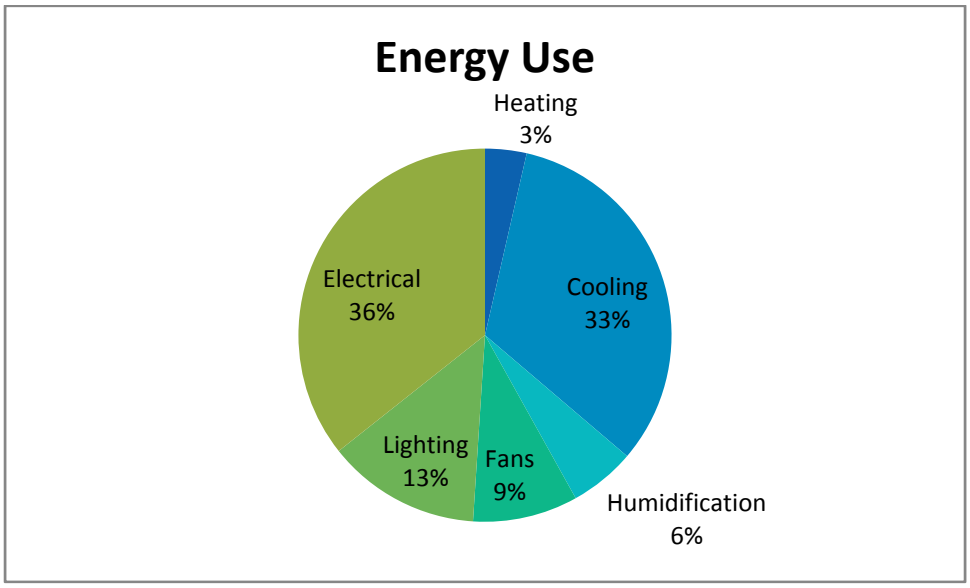
	Design Supply Air	HAP Supply Air	Design % Outdoor Air	HAP % Outdoor Air	Design Outdoor Air	HAP Outdoor Air	Design Cooling Load (MBh)	HAP Cooling Load (MBh)
AHU-4-1	12000	13627	0.20	0.18	2400	2400	811	409.1
AHU-4-3	2700	1879	0.00	0.00	0	0	60	34.2
AHU-M-N2	77000	66121	0.25	0.24	19250	15883	2826	2069.7
AHU-M-S1	50000	47358	0.30	0.29	15000	13576	2826	1531.1
AHU-M-S2	50000	47358	0.30	0.29	15000	13576	2826	1531.1

The values for AHU-4-3, AHU-M-N2, AHU-M-S1, and AHU-M-S2 are all higher than the calculated HAP values. These difference are most likely due to the simplified block load that was use, providing less accuracy for exterior and interior loads.

Several of the values for AHU-4-1, the operating room air-handling unit are slightly lower than what was calculated with HAP. This may be due to the inaccuracies due to the increased lighting and electrical loads. It may also be due to the probability of all operating loads being at full load at the same time.

Annual Energy Consumption and Operating Costs

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 following chart show prices:

	$/kWh
First 200 kWh	0.0657
next 600 kWh	0.0586
over 800 kWh	0.0544

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.

References

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