Technical Report 2

Building & Plant Energy Analysis Report

»Prepared For:
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»Building Name:
Sinai Hospital South Tower Vertical Expansion

»Building Location:
2401 W. Belvedere Ave. | Baltimore, MD 21215

Anly Lor | Mechanical Option
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Executive Summary

The Sinai Hospital South Tower Vertical Expansion was analyzed in order to determine its design cooling load, energy consumption, and operating costs. The results of these evaluations were examined and compared with existing data available from design documents courtesy of the project's mechanical engineering firm.

The result of the design load estimation determined the building's overall cooling load as well as the components which contributed heavily to it. As shown in figure 2 on page 7, the ventilation load, lighting, and solar gain had the greatest impact on that value. Using Trane's Trace software, the computed value of the building's design cooling load was 153.3 tons. 56.5% of that load was due to the three components mentioned earlier. In addition, load and ventilation indices were compared with values obtained from design documents. This analysis showed that the results were comparable to the existing data. A couple of discrepancies were attributed to several factors, including variations in design conditions, occupancy, and equipment loads.

The annual energy consumption and operating costs of the Sinai Hospital South Tower Vertical Expansion were also analyzed using Trane's Trace software. The results demonstrated the energy demand of the building's lighting, which contributed to more than half of the overall energy consumption. Consequently, the annual operating cost of the lighting was $894,900. The overall annual operating cost of the building was $1,652,628. This resulted in an annual operating cost of approximately $2.10 per square foot. Existing energy analyses for this project were unavailable to compare. Since LEED certification was not attempted, it was no longer in the firm's scope of services.

Design Load Estimation

Design Occupancy
From Design Documents
»See Appendix A for occupancy values

OA Ventilation Rates
From Design Documents
(Guidelines for Construction and Equipment of Hospital and Medical Facilities)
»See Appendix A for outdoor air ventilation rates

The following table lists standard spaces on the fourth and sixth floors of the South Tower vertical expansion and the minimum outdoor air changes per hour in these spaces.

Space	***OA Changes Per Hour***
Patient Room	2
Corridor	---
Soiled Utility	---
Janitor	---
Toilet	---
Office	---
Nurse's Station	---
Work Alcove	---
Isolation Room	2
Medication	---
Conference	---
Clean Utility	---
Staff Lounge	---
Ante Room	---
Electrical Closet	---
CR Reader	---
Storage	---
Lobby	---
Nourishment	---
On Call Room	---

Load Sources
From Design Documents
»See Appendix A for load source descriptions

Lights & Equipment Electrical Load
»Assume 2 W/ft^2

Design Indoor & Outdoor Air Conditions
From 2005 ASHRAE Handbook – Fundamentals

Design	***Condition***
Indoor Dry Bulb	70-75°F
Indoor Relative Humidity	50%
Heating, Outdoor Dry Bulb (99.6%)	12.3°F
Cooling, Outdoor Dry Bulb (0.04%)	93.6°F
Cooling, Outdoor Wet Bulb (0.04%)	75°F

»Cooling Schedule: 72°F set point is maintained at all times
»Heating Schedule: 72°F set point is maintained at all times

Construction
From Design Documents

Link & Lobby	***U-Value***
Slab	0.100
Wall	0.200
Window (SC = 0.300)	0.500
Roof	0.065

South Tower	***U-Value***
Wall	0.100
Window (SC = 0.490)	0.540
Roof	0.100

Airflow
From ASHRAE Standard 62.1-2007

Ventilation	***Rate***	***Zone Effectiveness***	***Value***
People	5 cfm/person	Cooling	1.0
Area	0.06 cfm/ft²	Heating	0.8

HVAC Cooling System Overview
•Medium pressure, variable air volume supply and return air systems
•2,000-ton variable speed electric centrifugal water-cooled chiller
•Cooling tower, chilled water and condenser water distribution pumps located in the penthouse

*Trane's Trace Software was used to perform the building and plant energy analysis.

Floor Plan Schematic

The floor plan (figure 1, p.6) schematic demonstrates how the patient rooms and the isolation rooms on the fourth and sixth floors of the South Tower are responsible for a majority of the building envelope, and consequently, a majority of the cooling load.

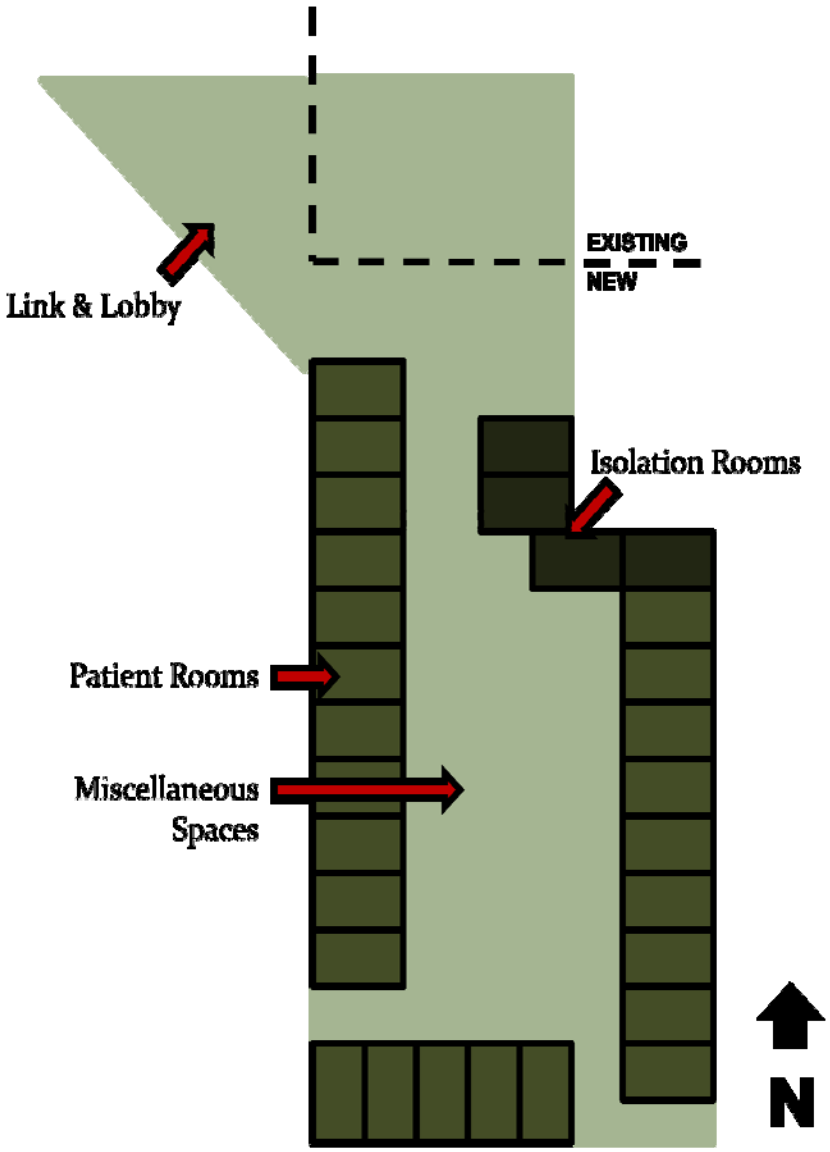


Figure 1

The following table describes the coverage of glazed aluminum framing.

Section	*% of Exterior Wall Area*
Link & Lobby	80
South Tower	50

Design Load Results

Design Cooling Load Summary

	Computed Value (BTU/hr)	*% of Total*
Solar Gain	309,793	16.8
Glass Transmission	70,462	3.8
Wall Transmission	9,263	0.5
Lighting	357,300	19.4
People	243,900	13.3
Misc. Equipment Loads	211,613	11.5
Ventilation Load	373,207	20.3
Wall Load To Plenum	18,281	1.0
Roof Load To Plenum	179,282	9.7
Lighting Load To Plenum	89,325	4.9
Total Cooling Loads	1,839,309	100.0
	=153.3 tons	

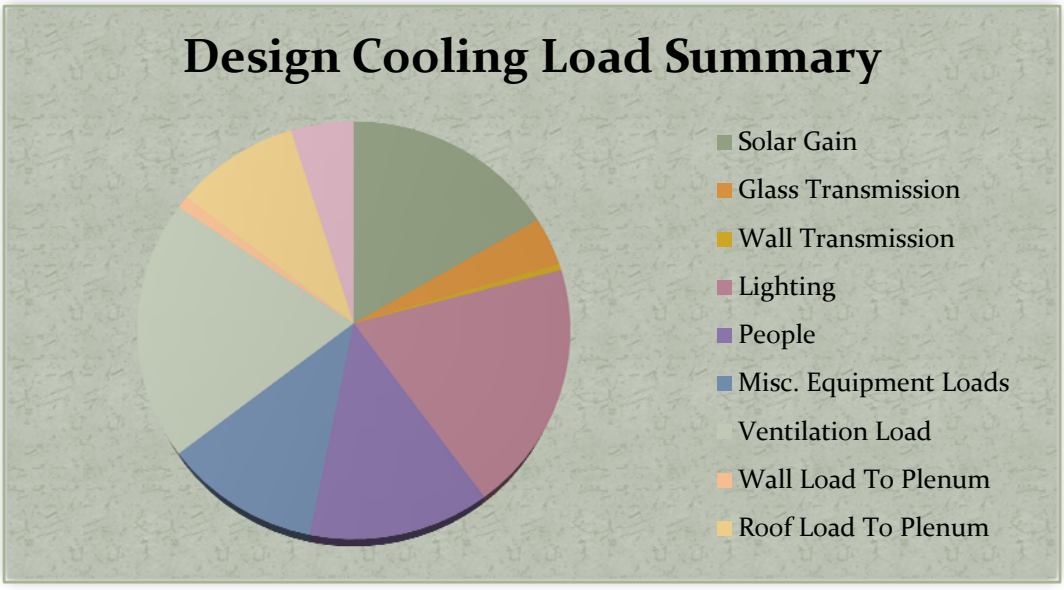


Figure 2

Summary

As depicted in the pie chart (figure 2, p.7), the components contributing most to the design cooling load are the ventilation load, the lighting, and the solar gain.

•For the ventilation load, the required ventilation airflow and the cooling schedule were responsible for the excessive cooling load. Since the dry bulb temperature is maintained at 72°F at all times, this increased the load during the summer months as hot outdoor air needed to be cooled.
•For the lighting, a fairly conservative 2 W/ft^2 was used when performing the analysis. This increased the cooling load in order to achieve the desired "safer" value. However, in a hospital environment, lighting is a priority, which makes the computed value of the lighting load rather reasonable.
•For the solar gain, this is due to the large amount of glazing coverage on the South Tower (50%) and especially on the link (80%).

Load & Ventilation Indices

Cooling Load	***Area***	***Design Document Value***
Fourth Floor	22,957 ft²	148 tons
Sixth Floor	22,931 ft²	148 tons
Link & Lobby	19,140 ft²	31 tons
Total	65,028 ft²	327 tons

	Computed Value	***Design Document Value***
Cooling (ft²/ton)	426.88	198.86
Total supply air (cfm/ft²)	0.98	Fourth Floor: 1.50 Sixth Floor: 0.98 Link & Lobby: 1.60 **Average: 1.36**
Ventilation supply (cfm/ft²)	0.10	Fourth Floor: 0.152 Sixth Floor: 0.133 Link & Lobby: 0.000 **Average: 0.095**

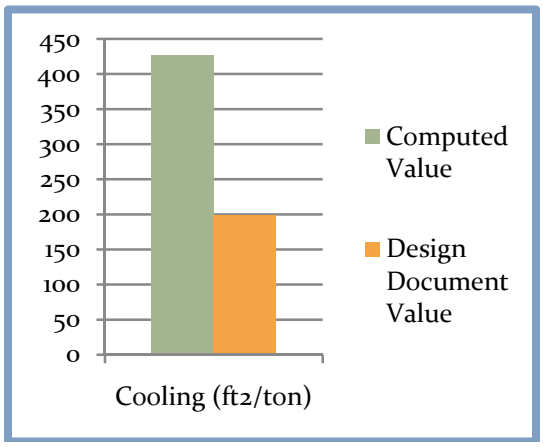


Figure 3a

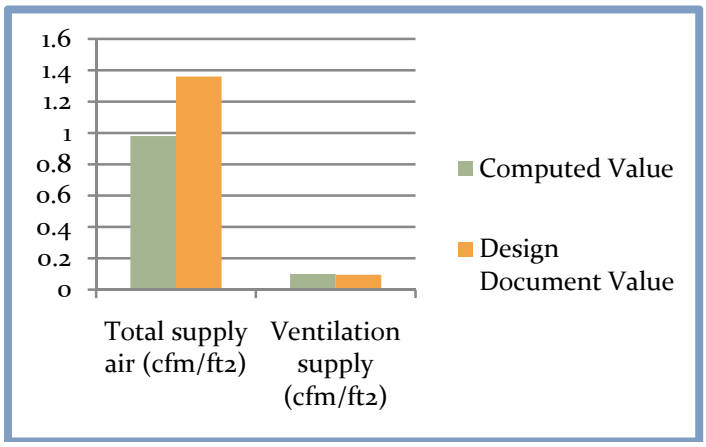


Figure 3b

Summary

Overall, the load and ventilation indices from the analysis and the design documents are quite comparable. The main discrepancy is the cooling ft²/ton, where the difference is 228.02, or the computed value being 115% greater than the design document value. Several factors may have contributed to this inconsistency:

1. The mechanical engineering firm used higher outdoor cooling design conditions (95°F/78°F).
2. The indoor dry bulb design temperature may have been 70°F instead of 72°F.
3. The schedules utilized in this analysis may not correspond to the design document schedules.
4. The loads may have been overcompensated for in the design documents.
5. Final occupancy and equipment load alterations may not have been accounted for.

Energy Consumption Results

Cooling Coil

Parameters	***Energy Consumption (kWh)***
Entering Air (DB/WB)	76.8/62.9°F
Entering Humidity Ratio	64.04 gr/lb
Leaving Air (DB/WB)	55.5/53°F
Leaving Humidity Ratio	55.47 gr/lb
Sensible Load	1,493.85 MBh
Total Load	1,839.31 MBh
Supply Air Temperature	55.47°F
Total Airflow	63,239.07 cfm

Equipment Energy Consumption

Equipment	***Total Building Energy (kBTU/yr)***	***Total Source Energy (kBTU/yr)***
Lights	3,912,432	11,738,469
Miscellaneous Loads	1,853,729	5,561,744
Chiller	1,012,194	3,036,886
Cooling Tower, Condenser Fans	276,446	829,442
Miscellaneous Accessory Equipment	29,898	89,703

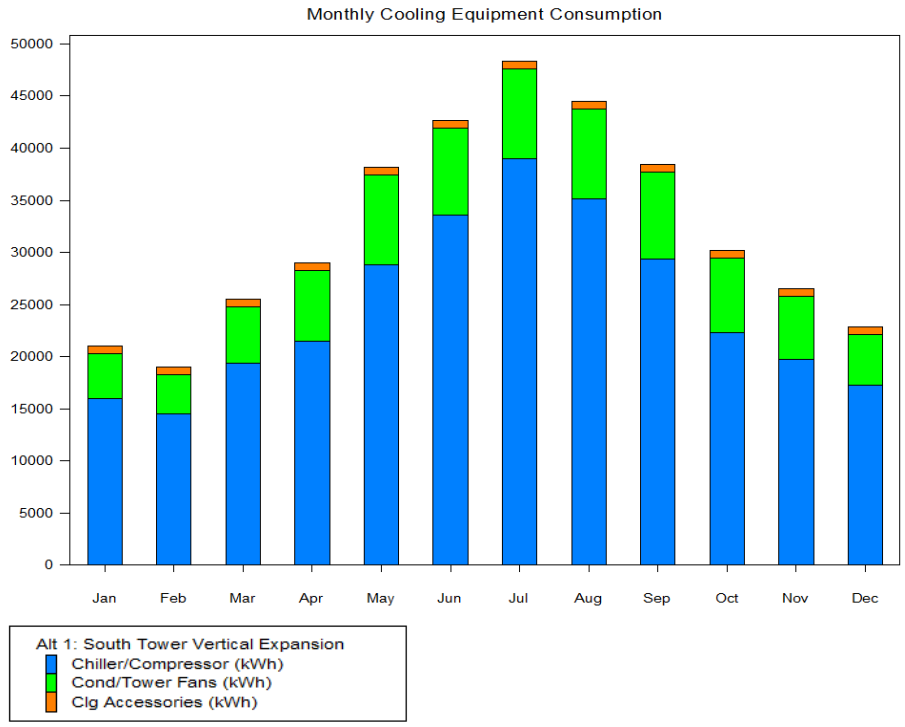
Equipment Electric Consumption

Equipment	***Energy Consumption (kWh)***
Lights	1,146,332
Miscellaneous Loads	543,137
Chiller	296,570
Cooling Tower, Condenser Fans	80,998
Miscellaneous Accessory Equipment	8,760
Total	2,075,797

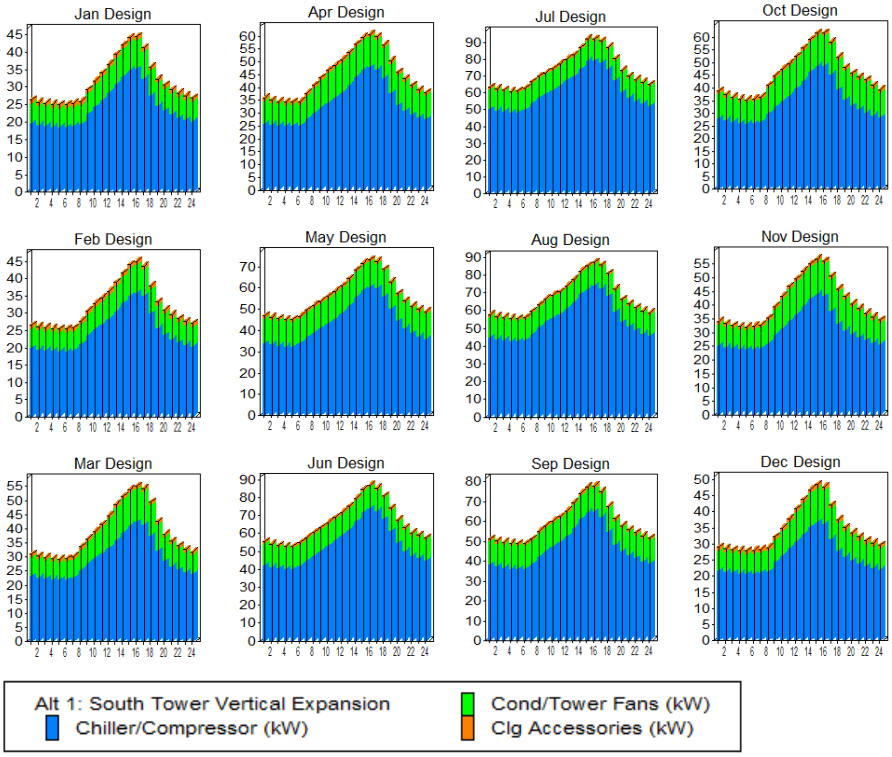
Remarks

•The lights were responsible for more than half of the total energy consumption.
•Source energy consumption was approximately three times greater than building energy consumption.

Cooling Equipment Consumption



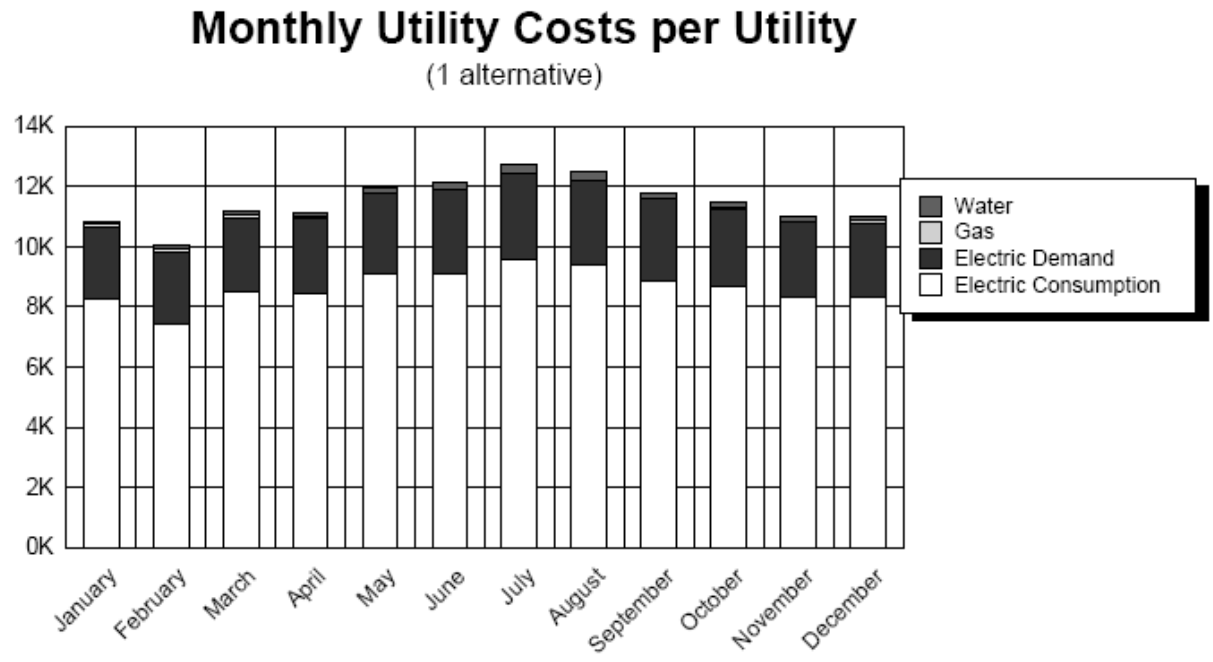
Cooling Equipment Demand



Operating Cost Results

»Assume 20-year life cycle

Equipment	*Monthly Cost*	*Annual Cost*
Electric	$135,042	$1,620,504
»Lighting	$74,575	$894,900
»Chiller	$35,334	$424,008
»Cooling Tower/Condenser Fans	$5,269	$63,228
»Miscellaneous Equipment	$569	$6,828
Water	$2,121	$25,452
Gas	$556	$6,672
Total	$137,719	$1,652,628



Annual Operating Costs
$1,652,628
$2.10 per square foot

Energy Analysis Comparison

•An energy analysis by the mechanical engineer was not performed for this project.

•In early stages of the design process, LEED certification for the building was discussed. However, when a decision was made not to follow through with the accreditation, the energy analysis, typically performed using DOE-2 and Trane's Trace Software, was no longer in the firm's scope of services.

Source: Jim Gleba, Project Manager, Leach Wallace Associates, Inc.

Appendix A

Fourth Floor

			From Design Documents:		
Room	***Quantity***	***Area (ft²)***	***Occupancy***	***OA Ventilation Rate (cfm)***	***Load Sources***
Ante Room 1	1	65	1	0	computers
Ante Room 2	1	65	1	0	computers
Clean Utility 1	1	87	0	0	none
Clean Utility 2	1	168	0	0	none
Clean Utility 3	1	128	0	0	none
Clinical Leaders	1	253	3	0	computers
CR Reader	1	80	0	0	none
Director's Office 1	1	148	3	0	computers
Director's Office 2	1	147	3	0	computers
Electrical Closet 1	1	50	0	0	elec. equip.
Electrical Closet 2	1	128	0	0	elec. equip.
Elevator Lobby	1	378	11	0	none
Equipment Storage	1	363	0	0	none
Family Consultant	1	108	2	0	computers
Housekeeping	1	50	0	0	none
ICU Patient Room 01	1	419	5	130	med. equip.
ICU Patient Room 02	1	399	5	120	med. equip.
ICU Patient Room 03	1	399	5	120	med. equip.
ICU Patient Room 04	1	399	5	120	med. equip.
ICU Patient Room 05	1	399	5	120	med. equip.
ICU Patient Room 06	1	399	5	120	med. equip.
ICU Patient Room 07	1	399	5	120	med. equip.
ICU Patient Room 08	1	399	5	120	med. equip.
ICU Patient Room 09	1	399	5	120	med. equip.
ICU Patient Room 10	1	400	5	120	med. equip.
ICU Patient Room 11	1	399	5	120	med. equip.
ICU Patient Room 12	1	379	5	115	med. equip.
ICU Patient Room 13	1	339	5	105	med. equip.
ICU Patient Room 14	1	411	5	125	med. equip.
ICU Patient Room 15	1	366	5	110	med. equip.
ICU Patient Room 16	1	363	5	110	med. equip.
ICU Patient Room 17	1	366	5	110	med. equip.
ICU Patient Room 18	1	434	5	135	med. equip.
ICU Patient Room 19	1	399	5	120	med. equip.
ICU Patient Room 20	1	399	5	120	med. equip.
ICU Patient Room 21	1	399	5	120	med. equip.
ICU Patient Room 22	1	399	5	120	med. equip.

ICU Patient Room 23	1	399	5	120	med. equip.
ICU Patient Room 24	1	399	5	120	med. equip.
ICU Patient Room 25	1	399	5	120	med. equip.
Isolation Room 1	1	398	5	120	med. equip.
Isolation Room 2	1	369	5	115	med. equip.
Isolation Room 3	1	454	5	140	med. equip.
Isolation Room 4	1	454	5	140	med. equip.
Medication 1	1	88	0	0	computers
Medication 2	1	81	0	0	computers
Meds Room	1	77	0	0	computers
Mid Level Providers	1	150	2	0	computers
Nourishment 1	1	131	0	0	none
Nourishment 2	1	74	0	0	none
Nurse Manager	1	110	4	0	computers
Nurse Station 1	1	198	4	0	computers
Nurse Station 2	1	202	4	0	computers
Nurse Station 3	1	202	4	0	computers
Nurse Station 4	1	150	4	0	computers
On Call Room 1	1	62	1	0	computers
On Call Room 2	1	63	1	0	computers
On Call Room 3	1	68	1	0	computers
On Call Room 4	1	65	1	0	computers
Patient Corridor	1	4400	0	0	none
Public Toilet	1	59	0	0	none
Reception	1	119	1	0	computers
Security	1	104	1	0	computers
Social Worker	1	75	2	0	computers
Soiled Utility	1	100	0	0	none
Staff Conference Room	1	292	10	0	TV
Staff Lockers	1	271	1	0	none
Staff Lounge	1	290	12	0	TV, refrigerator
Staff Toilet 1	1	66	0	0	none
Staff Toilet 2	1	42	0	0	none
Staff Toilet 3	1	62	0	0	none
Storage 1	1	365	0	0	none
Storage 2	1	45	0	0	none
Viewing	1	222	9	0	TV, computers
Waiting Room	1	930	26	0	TV
Work Alcove	13	40	1	0	computers

Sixth Floor

			From Design Documents:		
Room	***Quantity***	***Area (ft^2)***	***Occupancy***	***OA Ventilation Rate (cfm)***	***Load Sources***
Ante Room 1	1	69	1	0	computers
Ante Room 2	1	139	1	0	computers
Charting	1	46	1	0	computers
Clean Utility 1	1	120	0	0	none
Clean Utility 2	1	120	0	0	none
Clean Utility 3	1	147	0	0	none
Clinical Coach	1	86	2	0	computers
Clinical Leaders	1	310	4	0	computers
Conference	1	240	8	0	computers
Consulting	1	133	4	0	computers
Corridor 1	1	2275	0	0	none
Corridor 2	1	1533	0	0	none
Corridor 3	1	303	0	0	none
Corridor 4	1	220	0	0	none
Corridor 5	1	355	0	0	none
Corridor 5A	1	200	0	0	none
E Patient Room	11	300	5	85	med. equip.
E Patient Room Toilet	11	35	0	0	none
Electrical Room	1	156	0	0	elec. equip.
Elevator Lobby	2	80	5	0	none
Equipment	1	242	0	0	none
Family Waiting	1	138	7	0	none
Isolation Room 1	1	331	5	94	med. equip.
Isolation Room 2	1	373	5	106	med. equip.
Isolation Room 3	1	50	5	15	med. equip.
Isolation Room 4	1	50	5	15	med. equip.
Isolation Room 5	1	347	5	99	med. equip.
Isolation Room 6	1	343	5	98	med. equip.
Janitor 1	1	51	0	0	none
Janitor 2	1	63	0	0	none
Locker	1	207	1	0	none
Managerial Assistant	1	88	3	0	computers
Medication	1	120	0	0	computers
Nourishment 1	1	81	0	0	none
Nourishment 2	1	81	0	0	none
Nurse Manager	1	145	6	0	computers

Nurse's Station 1	1	641	6	0	computers
Nurse's Station 2	1	534	6	0	computers
Office	1	123	3	0	computers
Patient Room	1	336	5	96	med. equip.
Patient Support	1	115	1	0	computers
Repertory Storage	1	395	0	0	none
Repertory Therapy	1	360	6	0	computers
S Patient Room	5	290	5	83	med. equip.
S Patient Room Toilet	5	35	0	0	none
S Patient Room Toilet 1	1	35	0	0	none
S Patient Room Toilet 2	1	35	0	0	none
S Patient Room Toilet 3	1	35	0	0	none
Soiled Utility	1	147	0	0	none
Soiled Holding	1	70	0	0	none
Staff Lounge	1	318	12	0	refrigerator
Staff Toilet	1	78	0	0	none
Storage	1	170	0	0	none
SW Case Management	1	148	2	0	computers
Trash Room	1	80	0	0	none
Vending	1	64	3	0	none
W Patient Room	13	320	5	91	med. equip.
W Patient Room Toilet	13	35	0	0	none

Link & Lobby

			From Design Documents:		
Room	***Quantity***	***Area (ft²)***	***Occupancy***	***OA Ventilation Rate (cfm)***	***Load Sources***
First Floor Walkway & Lobby	1	7580	0	0	none
Second Floor Walkway	1	2100	0	0	none
Third Floor Walkway	1	2100	0	0	none
Fourth Floor Walkway	1	2100	0	0	none
Fifth Floor Walkway	1	2100	0	0	none
Sixth Floor Walkway	1	2100	0	0	none
Women's Toilet	1	400	0	0	none
Men's Toilet	1	420	0	0	none
Corridor	1	240	0	0	none