Technical Report 2

Building and Plant Energy & Emissions Analysis

Morton Hospital Expansion

Taunton, MA

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October 8, 2014

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Executive Summary

The purpose of this analysis is to calculate Morton Hospital Expansion HVAC loads and energy analysis procedures using an energy simulation program. This report uses Trane Trace 700 to calculate building loads and eQuest Quick Energy Simulation Tool 3.65 to calculate annual energy consumption and operating cost.

In order to calculate the load and energy consumption, assumptions had to be made. Because ASHRAE Fundamentals was used for weather data, design conditions for Providence RI were used because it was the nearest location to Taunton MA. Throughout the analysis, this location was used for consistency. Design document data was used for ventilation rates, occupancy, schedules, etc. were available.

After calculating the required loads for both systems within the project, it was found that equipment was oversized. Although all loads are being satisfied by the system, both initial cost and operating cost would decrease if smaller systems could be utilized.

The annual electric consumption came out to 1,115,700 kWh. It was found that most of this came from space cooling during summer months, and Miscellaneous Medical Equipment during the rest of the year. The annual natural gas consumption came out to 3,177.9 MBtu. The majority of this consumption was a result of space heating. Therefore, reducing Morton Expansion's cooling and heating consumption would greatly reduce the overall energy consumption. The total operating cost of the project came out to %198,353, averaging at about $5.20/SF.

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.

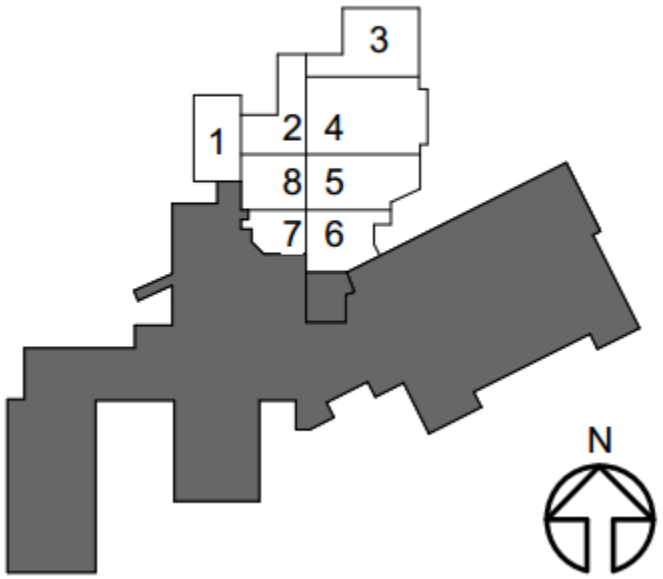

Figure 1: Key plan of existing versus expansion

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.

Mechanical Systems Overview

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

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.

Some spaces will require supplemental cooling provided by a chilled water fan coil unit, including the MRI equipment room, totaling 4 fan coil units within the addition. Chilled water will be provided for direct medical equipment cooling, and any equipment requiring a higher temperature, pressure, or filtration will require a system with an additional heat exchanger and pump.

Design Load Estimation

Design load estimations were calculated using Trane Trace 700 software. Exporting the project's Revit model into a .gbxml file and importing into Trane Trace created separate spaces for each room allowing for a more accurate analysis. The following conditions, assumptions, and equipment were entered into the software.

Design Conditions

Location

Morton hospital is located in Taunton, MA classifies as Zone 5A according to ASHRAE 90.1. Using the ASHRAE Handbook of Fundamentals - 2009, Table 1 summarizes the design conditions at Providence, RI, the nearest location listed in the Handbook.

Table1: Design Conditions as specified in ASHRAE Fundamentals - 2009

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

Construction

Table 2 summarizes the envelope construction used in the building simulation. It can be noted that the floor slab on grade is specified as being exposed to earth, and has crushed stone base below the slab.

Table 2: Envelope Construction as modeled in simulation

Building Envelope Construction				
	Construction	**Finish**	**Exterior/Cavity Insulati**	**Additional Insulation**
Roof	Metal Frame, 24 in. o.c.	Light' Built-up Roof (abs=0.4)	3 in. polyisocyanurate (R-21)	
Above Grade Wall	Metal Frame, 2x4, 16 in. o.c.	Red Brick	2 in. polyisocyanurate (R-14)	R-11 bat insulation
Ground Floor	4 in. Concrete	Vinyl Tile	horizontal internal bed, 2 ft wide, R-5	

Load Assumptions

Outdoor Air Ventilation

Ventilation rates were calculated using ASHRAE 170 – 2013 Table 7.1 Design Parameters, found in Appendix Table 1. OA minimum values are listed in units of air changes per hour per cubic foot. Therefore these values are multiplied by room volume and divided by 60 to reach the required OA CFM for each space. Office ventilation rates were found using ASHRAE 62.1 Table 6-1, which states that offices should have a minimum of 5 CFM of OA per person.

Lighting, Equipment, & Occupancy Loads

Lighting loads were inputted based on the lighting power densities indicated in ASHRAE 90.1 - 2013 Table 9.6.1, found in Appendix Table 2. These values indicate maximum values, and are used to calculate energy consumption caused by the lighting within the building. Treatment rooms, nurse stations, X-ray, and isolation rooms also assumed an additional equipment load of 3 W/SF for required medical equipment. Offices assumed an additional 1.5 W/SF for computers. Occupancy was determined based on design documents.

Schedules

A typical laboratory/medical occupancy schedule was used for the project. Table 3 summarizes the percentage of maximum load for occupancy, lighting, and equipment based on the hour of the day, (hour 1 being 12-1 am, hour 2 between 1-2 am, and so forth). Because it is an emergency department, everything is on 24/7, as indicated.

Table 3: Laboratory/Medical Occupancy Schedule

Hour of Day	Occupancy Percent of Maximum Load	Lighting Percent of Maximum Load	Equipment Percent of Maximum Load	HVAC System
1	5	20	20	On
2	5	20	20	On
3	5	20	20	On
4	5	20	20	On
5	5	20	20	On
6	5	20	20	On
7	5	30	20	On
8	10	50	30	On
9	20	90	40	On
10	90	90	50	On
11	90	90	50	On

Table 3 (cont.): Laboratory/Medical Schedule

Hour of Day	Occupancy Percent of Maximum Load	Lighting Percent of Maximum Load	Equipment Percent of Maximum Load	HVAC System
12	45	90	50	On
13	45	80	40	On
14	90	90	50	On
15	90	90	50	On
16	90	90	50	On
17	90	90	50	On
18	90	90	40	On
19	30	50	30	On
20	10	50	30	On
21	10	30	20	On
22	10	30	20	On
23	5	20	20	On
24	5	20	20	On

Mechanical System Equipment

Air Handling Units

Phase 1, the MRI, is supplied by AHU-1 which uses Direct Expansion coils for cooling, and hot water coils for heating. Zones are supplied by packaged VAV boxes with electric reheat. A 10 ton air-cooled condenser supplies AHU-1. Phase 2 is supplied by AHU-2, using chilled water and hot water coils. Zones within this phase are supplied by standard VAV boxes with hot water reheat. Both systems have a cooling design temperature of 75° F and a heating design temperature of 72° F. A summary of how the systems were modeled can be found in Table 4.

Table 4: A summary of how the air handling units were modeled

		Design		Supply Fan		Return Fan		Humidity Control	
	Service	Supply (CFM)	Distribution	Pressure (in. W.G.)	Fan Type	Pressure (in. W.G.)	Fan Type	Type	High Limit (Btu)
AHU-1	Phase 1	35000	Packaged VV Boxes	4	VFD	1.8	VFD	Steam	36.3
AHU-2	Phase 2	2500	Standard VV Bpxes	6.1	VFD	3.2	VFD	Steam	15.5

	Preheat Coil			Cooling Coil			Reheat Coil	
	Type	Air Pressure Drop (in wg)	Steam Pressure (psig)	Type	Air Pressure Drop (in wg)	Water Pressure Drop (ft wg)	Type	Water Pressure Drop (ft wg)
AHU-1	Steam	0.1	5	Direct Expansion	0.52	N/A	Electric	N/A
AHU-2	Hot Water	0.1	-	Chilled Water	0.5	19.2	Hot Water	10

Primary Heating and Cooling Equipment

Chilled water is supplied by a 155 ton air cooled chiller. This services AHU-2 and Phase 2, which fulfills most of the required cooling. An air cooled condensing unit supplies the required cooling for the direct expansion cooling coil used in AHU-1.

Heating for both phases is provided by the existing steam plant which distributes hot water by use of steam to water heat exchangers. To model this, a typical steam boiler was selected and a steam meter was applied to the hot water loop.

Conclusions

The Trane Trace output data including the System Checksums and Engineering Checksums is included in Appendix Table 3 and 4. A summary of the systems as modeled compared to the systems as designed can be found in Table 5. It can be seen that the design systems have all been oversized as to what is required by the calculated loads. Reducing the equipment sizes will result in reducing the overall energy consumption and is something to further investigate. It should also be noted that results may not be completely accurate considering human error, and making simplifications within the systems.

Table 5: System Modeled Load Calculations versus Design Loads

	System	Total Supply CFM	Total OA CFM	Exhaust CFM	AHU OA %	Heating MBh	Cooling Tons
eQuest Output	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**

Annual Energy Consumption

Energy Consumption was calculated eQuest 3.65 software. The conditions, assumptions, and equipment used in the Trane Trace analysis were also used in the eQuest analysis. Both phases were modeled as a separate zone as seen in Figure 2, and applicable systems were applied to those zones.

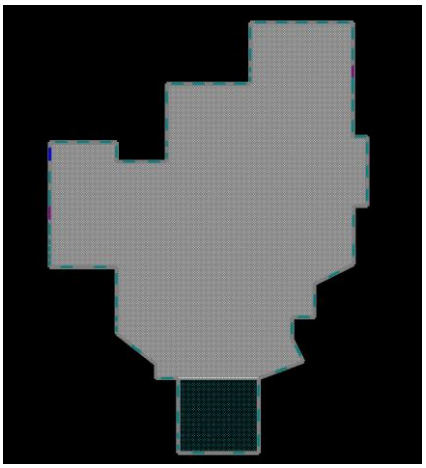

Figure 2: Zones as modeled in eQuest. Phase One: Green and Phase Two: Gray

Fuel Consumption

Figure 3 and Figure 4 demonstrates the output generated by eQuest in terms of monthly natural gas and electric consumption by use. A detailed electric and gas consumption by usage can be found in Appendix Table 5.

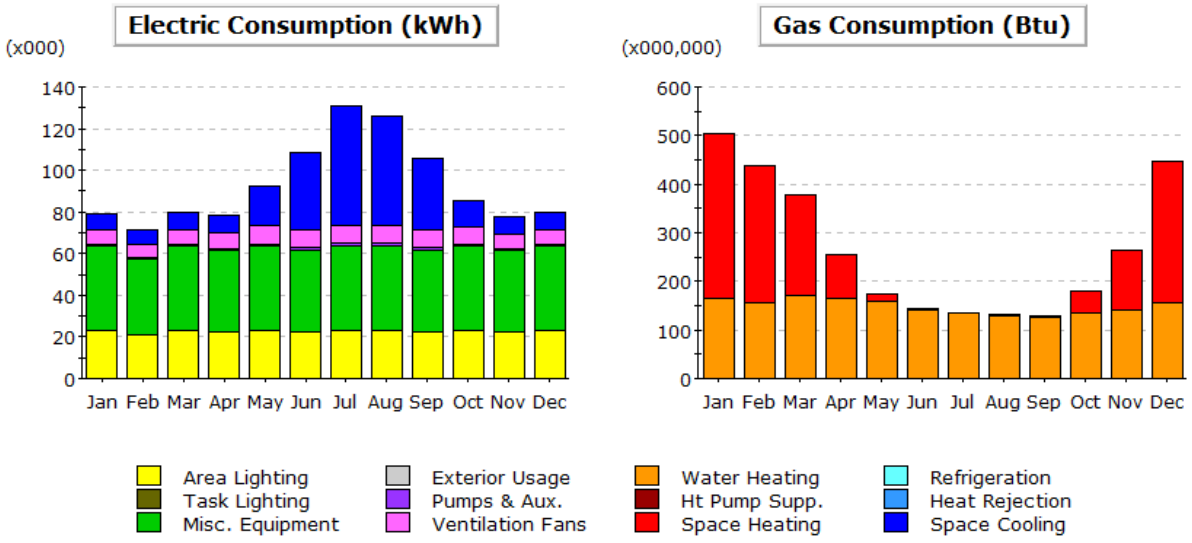

Figure 3: Monthly Electric and Gas Consumption Calculated using eQuest

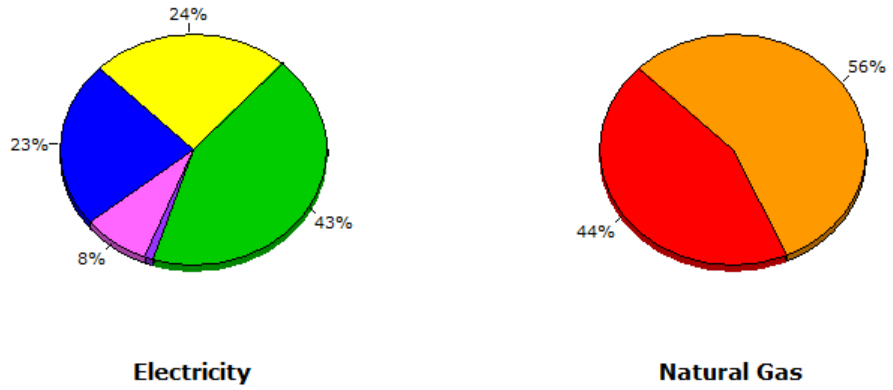

Figure 4: Annual Energy Consumption by End-use

It can be seen in the above figures that most of the electrical consumption is from miscellaneous equipment use. This was expected considering the high use of laboratory and medical equipment within the hospital. During the summer it can be seen that the majority of the electrical usage comes from space cooling. Further investigation into improving this will benefit the overall building energy consumption significantly.

Since Taunton MA is a predominantly a heating climate, natural gas consumption is a significant contribution to the overall energy consumption. Therefore, improving heating methods within the project would also drastically decrease energy consumption.

Figure 5 summarizes peak demands by end use. In July when electrical demand has reached its peak, space cooling accounts for 54% of the overall electrical demand. Natural Gas peak demands are reached in January. During this month, space heating accounts for 61% of the overall gas demand. As stated, these values are noteworthy and further investigation in improving these systems would result in significant decrease in annual and monthly energy consumption.

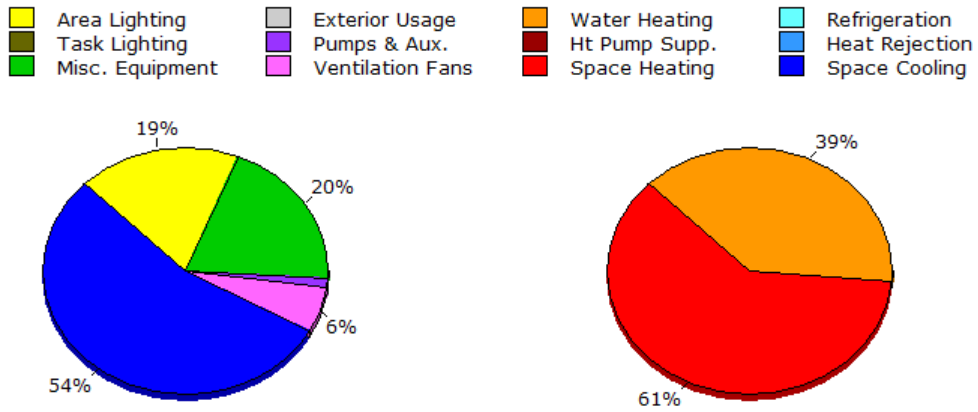

Figure 5:: Annual Peak Demand by End Use

Annual Operating Cost

Overall Cost

Based on the eQuest 3.65 analysis, the annual operating cost of the Morton Hospital Expansion is $198,353. This averages at about $5.20/ SF of area. This is based on a uniform electricity cost estimate of $0.1463/kWh and a uniform natural gas cost of $1.101/therm. These numbers were found using the US Energy Information Administration Fuel Prices averages for the state of Massachusetts. Monthly cost data is summarized in Figure 6. Utility Rate 1 represents the electrical rate and Utility Rate 2 represents the gas rate.

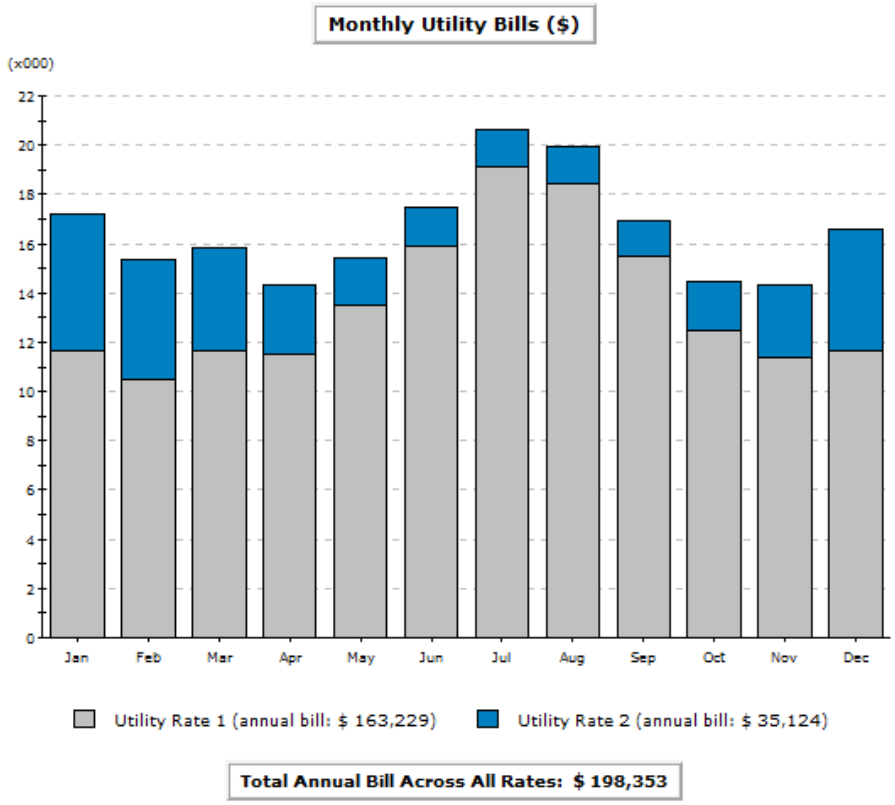

Figure 6: Monthly Utility Rates based on Electrical Demand/Utility Rate 1 and Gas Demand/Utility Rate 2

Equipment Operating Cost

From the eQuest 3.65 analysis, the monthly and annual equipment costs were calculated by end use, categorized as cooling equipment, heating equipment, fans, lighting, and miscellaneous equipment. Table 6 summarizes these energy costs.

Table 6: Monthly and Annual Equipment Costs

Monthly Equipment Costs by End Use					
	Cooling	**Heating**	**Fans**	**Lighting**	**Misc**
January	$ 1,199.66	$ 3,724.68	$ 950.95	$ 3,364.90	$ 5,969.04
February	$ 1,082.62	$ 3,126.84	$ 863.17	$ 3,028.41	$ 5,398.47
March	$ 1,243.55	$ 2,264.76	$ 965.58	$ 3,364.90	$ 5,969.04
April	$ 1,287.44	$ 994.20	$ 1,053.36	$ 3,247.86	$ 5,778.85
May	$ 2,677.29	$ 189.37	$ 1,331.33	$ 3,364.90	$ 5,969.04
June	$ 5,427.73	$ 12.11	$ 1,272.81	$ 3,247.86	$ 5,778.85
July	$ 8,324.47	$ -	$ 1,243.55	$ 3,364.90	$ 5,969.04
August	$ 7,680.75	$ 6.61	$ 1,258.18	$ 3,364.90	$ 5,969.04
September	$ 5,018.09	$ 48.44	$ 1,272.81	$ 3,247.86	$ 5,778.85
October	$ 1,814.12	$ 511.97	$ 1,214.29	$ 3,364.90	$ 5,969.04
November	$ 1,258.18	$ 1,354.23	$ 980.21	$ 3,247.86	$ 5,778.85
December	$ 1,199.66	$ 3,202.81	$ 965.58	$ 3,364.90	$ 5,969.04
TOTAL	**$ 38,213.56**	**$ 15,436.02**	**$ 13,371.82**	**$ 39,574.15**	**$ 70,297.15**

Emissions

Based on emission factors provided by the National Renewable Energy Laboratory – Source Energy and Emission Factors for Energy Use in Buildings, Table 7 summarizes the amount of pollutant emitted annually.

Table 7: Pollutant Emissions caused by the delivered Electrical Demand

Emmissions for Delivered Electricity			
Pollutant	Eastern US Emission Factor (lb pollutant/kWh electricity)	Electricity Usage (kWh)	Amount of Pollutant (lb)
CO2	1.64E+00	1,115,700.00	1,829,748.00
NOX	3.00E-03	1,115,700.00	3,347.10
SOX	8.57E-03	1,115,700.00	9,561.55

In order to maintain occupant comfort, the electrical demand must be maintained, and therefore these greenhouse gases are emitted as a result. To reduce this impact, a study on the refrigerants used in the chiller plant would be beneficial.

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.

Deru, Michael P., and P. Torcellini. Source Energy and Emission Factors for Energy Use in Buildings. Golden, CO: National Renewable Energy Laboratory, 2007.

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." EIA. N.p., n.d. Web. 06 Oct. 2014.

"U.S. Natural Gas Prices." U.S. Natural Gas Prices. N.p., n.d. Web. 07 Oct. 2014.

Appendix

TABLE 7.1 Design Parameters

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
SURGERY AND CRITICAL CARE							
Operating room (Class B and C) (m), (n), (o)	Positive	4	20	NR	No	20–60	68–75/20–24
Operating/surgical cystoscopic rooms, (m), (n) (o)	Positive	4	20	NR	No	20–60	68–75/20–24
Delivery room (Caesarean) (m), (n), (o)	Positive	4	20	NR	No	20–60	68–75/20–24
Substerile service area	NR	2	6	NR	No	NR	NR
Recovery room	NR	2	6	NR	No	20–60	70–75/21–24
Critical and intensive care	NR	2	6	NR	No	30–60	70–75/21–24
Intermediate care (s)	NR	2	6	NR	NR	max 60	70–75/21–24
Wound intensive care (burn unit)	NR	2	6	NR	No	40–60	70–75/21–24
Newborn intensive care	Positive	2	6	NR	No	30–60	72–78/22–26
Treatment room (p)	NR	2	6	NR	NR	20–60	70–75/21–24
Trauma room (crisis or shock) (c)	Positive	3	15	NR	No	20–60	70–75/21–24
Medical/anesthesia gas storage (r)	Negative	NR	8	Yes	NR	NR	NR
Laser eye room	Positive	3	15	NR	No	20–60	70–75/21–24
ER waiting rooms	Negative	2	12	Yes (q)	NR	max 65	70–75/21–24
Triage	Negative	2	12	Yes (q)	NR	max 60	70–75/21–24
ER decontamination	Negative	2	12	Yes	No	NR	NR
Radiology waiting rooms	Negative	2	12	Yes (q), (w)	NR	max 60	70–75/21–24
Procedure room (Class A surgery) (o), (d)	Positive	3	15	NR	No	20–60	70–75/21–24
Emergency department exam/treatment room (p)	NR	2	6	NR	NR	max 60	70–75/21–24
INPATIENT NURSING							
Patient room	NR	2	4 (y)	NR	NR	max 60	70–75/21–24
Nourishment area or room	NR	NR	2	NR	NR	NR	NR
Toilet room	Negative	NR	10	Yes	No	NR	NR
Newborn nursery suite	NR	2	6	NR	No	30–60	72–78/22–26
Protective environment room (t)	Positive	2	12	NR	No	max 60	70–75/21–24
AII room (u)	Negative	2	12	Yes	No	max 60	70–75/21–24
Combination AII/PE room	Positive	2	12	Yes	No	Max 60	70-75/21-24
AII anteroom (u)	(e)	NR	10	Yes	No	NR	NR
PE anteroom (t)	(e)	NR	10	NR	No	NR	NR

Note: NR = no requirement

TABLE 7.1 Design Parameters *(Continued)*

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
Combination AII/PE anteroom	(e)	NR	10	Yes	No	NR	NR
Labor/delivery/recovery/postpartum (LDRP) (s)	NR	2	6	NR	NR	max 60	70–75/21–24
Labor/delivery/recovery (LDR) (s)	NR	2	6	NR	NR	max 60	70–75/21–24
Patient Corridor	NR	NR	2	NR	NR	NR	NR
NURSING FACILITY							
Resident room	NR	2	2	NR	NR	NR	70–75/21–24
Resident gathering/activity/dining	NR	4	4	NR	NR	NR	70–75/21–24
Resident unit corridor	NR	NR	4	NR	NR	NR	NR
Physical therapy	Negative	2	6	NR	NR	NR	70–75/21–24
Occupational therapy	NR	2	6	NR	NR	NR	70–75/21–24
Bathing room	Negative	NR	10	Yes	No	NR	70–75/21–24
RADIOLOGY (v)							
X-ray (diagnostic and treatment)	NR	2	6	NR	NR	max 60	72–78/22–26
X-ray (surgery/critical care and catheterization)	Positive	3	15	NR	No	max 60	70–75/21–24
Darkroom (g)	Negative	2	10	Yes	No	NR	NR
DIAGNOSTIC AND TREATMENT							
Bronchoscopy, sputum collection, and pentamidine administration (n)	Negative	2	12	Yes	No	NR	68–73/20–23
Laboratory, general (v)	Negative	2	6	NR	NR	NR	70–75/21–24
Laboratory, bacteriology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, biochemistry (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, cytology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, glasswashing	Negative	2	10	Yes	NR	NR	NR
Laboratory, histology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, microbiology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, nuclear medicine (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, pathology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, serology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, sterilizing	Negative	2	10	Yes	NR	NR	70–75/21–24
Laboratory, media transfer (v)	Positive	2	4	NR	NR	NR	70–75/21–24
Nonrefrigerated body-holding room (h)	Negative	NR	10	Yes	No	NR	70–75/21–24

Note: NR = no requirement

TABLE 7.1 Design Parameters *(Continued)*

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
Autopsy room (n)	Negative	2	12	Yes	No	NR	68–75/20–24
Pharmacy (b)	Positive	2	4	NR	NR	NR	NR
Examination room	NR	2	6	NR	NR	max 60	70–75/21–24
Medication room	NR	2	4	NR	NR	max 60	70–75/21–24
Gastrointestinal endoscopy procedure room (x)	NR	2	6	NR	No	20–60	68–73/20–23
Endoscope cleaning	Negative	2	10	Yes	No	NR	NR
Treatment room (x)	NR	2	6	NR	NR	max 60	70–75/21–24
Hydrotherapy	Negative	2	6	NR	NR	NR	72–80/22–27
Physical therapy	Negative	2	6	NR	NR	Max 65	72–80/22–27
STERILIZING							
Sterilizer equipment room	Negative	NR	10	Yes	No	NR	NR
CENTRAL MEDICAL AND SURGICAL SUPPLY							
Soiled or decontamination room	Negative	2	6	Yes	No	NR	72–78/22–26
Clean workroom	Positive	2	4	NR	No	max 60	72–78/22–26
Sterile storage	Positive	2	4	NR	NR	max 60	72–78/22–26
SERVICE							
Food preparation center (i)	NR	2	10	NR	No	NR	72–78/22–26
Warewashing	Negative	NR	10	Yes	No	NR	NR
Dietary storage	NR	NR	2	NR	No	NR	72–78/22–26
Laundry, general	Negative	2	10	Yes	No	NR	NR
Soiled linen sorting and storage	Negative	NR	10	Yes	No	NR	NR
Clean linen storage	Positive	NR	2	NR	NR	NR	72–78/22–26
Linen and trash chute room	Negative	NR	10	Yes	No	NR	NR
Bedpan room	Negative	NR	10	Yes	No	NR	NR
Bathroom	Negative	NR	10	Yes	No	NR	72–78/22–26
Janitor's closet	Negative	NR	10	Yes	No	NR	NR
SUPPORT SPACE							
Soiled workroom or soiled holding	Negative	2	10	Yes	No	NR	NR
Clean workroom or clean holding	Positive	2	4	NR	NR	NR	NR
Hazardous material storage	Negative	2	10	Yes	No	NR	NR

Note: NR = no requirement

Notes for Table 7.1:

a. Except where indicated by a "No" in this column, recirculating room HVAC units (with heating or cooling coils) are acceptable for providing that portion of the minimum total air changes per hour that is permitted by Section 7.1 (subparagraph [a][5]). Because of the cleaning difficulty and potential for buildup of contamination, recirculating room units shall not be used in areas marked "No." Recirculating devices with HEPA filters shall be permitted in existing facilities as interim, supplemental environmental controls to meet requirements for the control of airborne infectious agents. The design of either portable or fixed systems should prevent stagnation and short circuiting of airflow. The design of such systems shall also allow for easy access for scheduled preventative maintenance and cleaning.
b. Pharmacy compounding areas may have additional air change, differential pressure, and filtering requirements beyond the minimum of this table depending on the type of pharmacy, the regulatory requirements which may include adoption of USP 797), the associated level of risk of the work (see USP [2013] in Informative Appendix B), and the equipment utilized in the spaces.
c. The term *trauma room* as used herein is a first-aid room and/or emergency room used for general initial treatment of accident victims. The operating room within the trauma center that is routinely used for emergency surgery is considered to be an operating room by this standard.
d. Pressure relationships need not be maintained when the room is unoccupied.
e. See Section 7.2 and its subsections for pressure-relationship requirements.
f. This letter is not used in this table.
g. All air need not be exhausted if darkroom equipment has a scavenging exhaust duct attached and meets ventilation standards regarding NIOSH, OSHA, and local employee exposure limits.[2, 3]
h. A nonrefrigerated body-holding room is applicable only to facilities that do not perform autopsies on-site and use the space for short periods while waiting for the body to be transferred.
i. Minimum total air changes per hour (ach) shall be that required to provide proper makeup air to kitchen exhaust systems as specified in ANSI/ASHRAE Standard 154.[4] In some cases, excess exfiltration or infiltration to or from exit corridors compromises the exit corridor restrictions of NFPA 90A,[5] the pressure requirements of NFPA 96,[6] or the maximum defined in the table. During operation, a reduction to the number of air changes to any extent required for odor control shall be permitted when the space is not in use. (See FGI [2010] in Informative Appendix B.)
j. In some areas with potential contamination and/or odor problems, exhaust air shall be discharged directly to the outdoors and not recirculated to other areas. Individual circumstances may require special consideration for air exhausted to the outdoors. To satisfy exhaust needs, constant replacement air from the outdoors is necessary when the system is in operation.
k. The RH ranges listed are the minimum and/or maximum allowable at any point within the design temperature range required for that space.
l. Systems shall be capable of maintaining the rooms within the range during normal operation. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those conditions.
m. National Institute for Occupational Safety and Health (NIOSH) criteria documents regarding occupational exposure to waste anesthetic gases and vapors, and control of occupational exposure to nitrous oxide[7] indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized. Refer to NFPA 99 for other requirements.[8]
n. If pressure-monitoring device alarms are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube, or flutterstrip shall be permitted for verification of airflow direction.
o. Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and/or air distribution methods that exceed the minimum indicated ranges.
p. Treatment rooms used for bronchoscopy shall be treated as bronchoscopy rooms. Treatment rooms used for procedures with nitrous oxide shall contain provisions for exhausting anesthetic waste gases.
q. In a recirculating ventilation system, HEPA filters shall be permitted instead of exhausting the air from these spaces to the outdoors provided that the return air passes through the HEPA filters before it is introduced into any other spaces. The entire minimum total air changes per hour of recirculating airflow shall pass through HEPA filters. When these areas are open to larger, nonwaiting spaces, the exhaust air volume shall be calculated based on the seating area of the waiting area. (***Note:*** The intent here is to not require the volume calculation to include a very large space [e.g., an atrium] just because a waiting area opens onto it.)
r. See NFPA 99 for further requirements.[8]
s. For intermediate care, labor/delivery/recovery rooms, and labor/delivery/recovery/postpartum rooms, four total ach shall be permitted when supplemental heating and/or cooling systems (radiant heating and cooling, baseboard heating, etc.) are used.
t. The protective environment airflow design specifications protect the patient from common environmental airborne infectious microbes (i.e., *Aspergillus* spores). Recirculation HEPA filters shall be permitted to increase the equivalent room air exchanges; however, the outdoor air changes are still required. Constant-volume airflow is required for consistent ventilation for the protected environment. The pressure relationship to adjacent areas shall remain unchanged if the PE room is utilized as a normal patient room. Rooms with reversible airflow provisions for the purpose of switching between protective environment and AII functions shall not be permitted.
u. The AII room described in this standard shall be used for isolating the airborne spread of infectious diseases, such as measles, varicella, or tuberculosis. Supplemental recirculating devices using HEPA filters shall be permitted in the AII room to increase the equivalent room air exchanges; however, the minimum outdoor air changes of Table 7.1 are still required. AII rooms that are retrofitted from standard patient rooms from which it is impractical to exhaust directly outdoors may be recirculated with air from the AII room, provided that air first passes through a HEPA filter. When the AII room is not utilized for airborne infection isolation, the pressure relationship to adjacent areas, when measured with the door closed, shall remain unchanged and the minimum total air change rate shall be 6 ach. Switching controls for reversible airflow provisions shall not be permitted.
v. When required, appropriate hoods and exhaust devices for the removal of noxious gases or chemical vapors shall be provided in accordance with NFPA 99.[8]
w. The requirement that all room air is exhausted directly to outdoors applies only to radiology waiting rooms programmed to hold patients who are waiting for chest x-rays for diagnosis of respiratory disease.
x. If the planned space is designated in the organization's operational plan to be utilized for both bronchoscopy and gastrointestinal endoscopy, the design parameters for "bronchoscopy, sputum collection, and pentamidine administration" shall be used.
y. For single-bed patient rooms using Group D diffusers, a minimum of six total ach shall be provided and calculated based on the volume from finished floor to 6 ft (1.83 m) above the floor.

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method *(Continued)*

Informative Note: This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft^2	RCR Threshold	a Local Control (See Section 9.4.1.1[a])	b Restricted to Manual ON (See Section 9.4.1.1[b])	c Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	d Bilevel Lighting Control (See Section 9.4.1.1[d])	e Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	f Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	g Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	h Automatic Full OFF (See Section 9.4.1.1[h])	i Scheduled Shutoff (See Section 9.4.1.1[i])
Office											
… enclosed and ≤250 ft^2	1.11	8	REQ	ADD1	ADD1	REQ	REQ	REQ	—	REQ	—
… enclosed and >250 ft^2	1.11	8	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
… open plan	0.98	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Parking Area, Interior	0.19	4	See Section 9.4.1.2.								
Pharmacy Area	1.68	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Restroom											
… in a facility for the visually impaired (and not used primarily by the staff)[3]	1.21	8	REQ	—	—	—	REQ	REQ	—	REQ	—
… all other restrooms	0.98	8	REQ	—	—	—	REQ	REQ	—	REQ	—
Sales Area[4]	1.44	6	REQ	ADD1	ADD1	REQ	—	REQ	—	ADD2	ADD2
Seating Area, General	0.54	4	REQ	ADD1	ADD1	—	REQ	REQ	—	ADD2	ADD2
Stairway			The space containing the stairway shall determine the LPD and control requirements for the stairway.								
Stairwell	0.69	10	REQ	—	—	REQ	REQ	REQ	REQ	ADD2	ADD2
Storage Room											
… <50 ft^2	1.24	6	REQ	—	—	—	—	—	—	ADD2	ADD2
… ≥50 ft^2 and ≤ 1000 ft^2	0.63	6	REQ	ADD1	ADD1	—	REQ	REQ	—	REQ	—
… all other storage rooms	0.63	6	REQ	ADD1	ADD1	—	REQ	REQ	REQ	ADD2	ADD2
Vehicular Maintenance Area	0.67	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Workshop	1.59	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2

1. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply
2. In corridors, the extra lighting power density allowance is permitted when the width of the corridor is less than 8 ft and is not based on the RCR.
3. A "Facility for the Visually Impaired" is a facility that can be documented as being designed to comply with the light levels in ANSI/IES RP-28 and is licensed or will be licensed by local/state authorities for either senior long-term care, adult daycare, senior support and/or people with special visual needs.
4. For accent lighting, see Section 9.6.2(b).
5. Sometimes referred to as a "Picking Area."
6. Automatic daylight responsive controls are mandatory only if the requirements of the specified sections are present.
7. An additional 0.53 w/ft^2 shall be allowed, provided that the additional lighting is controlled separately from the base allowance of 0.42 W/ft^2. The additional 0.53 w/ft^2 allowance shall not be used for any other purpose.

System Checksums

By ACADEMIC

Phase 1

System 5 - Packaged RTU VAV Reheat, DX & Hot Water

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 72 / 96

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	0	0	0	0
Glass/Door Cond	0	0	0	0
Wall Cond	0	0	0	0
Partition/Door	0		0	0
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	23,991		23,991	40
Sub Total ==>	23,991	0	23,991	40
Internal Loads				
Lights	2,568	642	3,210	5
People	2,040	0	2,040	3
Misc	22,099	0	22,099	37
Sub Total ==>	26,707	642	27,349	45
Ceiling Load	147	-147	0	0
Ventilation Load	0	0	2,539	4
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	1,312		1,312	2
Exhaust Heat		-1,003	-1,003	-2
Sup. Fan Heat			3,832	6
Ret. Fan Heat		2,480	2,480	4
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	52,156	1,973	60,500	100.00

CLG SPACE PEAK

Mo/Hr: 7 / 18
OADB: 83

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	0	0
Glass/Door Cond	0	0
Wall Cond	0	0
Partition/Door	0	0
Floor	0	0
Adjacent Floor	0	0
Infiltration	6,154	16
Sub Total ==>	6,154	16
Internal Loads		
Lights	8,987	24
People	1,188	3
Misc	20,552	54
Sub Total ==>	30,727	81
Ceiling Load	499	1
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing	667	2
Exhaust Heat		
OA Preheat Diff.		
RA Preheat Diff.		
Additional Reheat		
Underflr Sup Ht Pkup		
Supply Air Leakage		
Grand Total ==>	38,046	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	0	0	0.00
Wall Cond	0	0	0.00
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-48,129	-48,129	129.61
Sub Total ==>	-48,129	-48,129	129.61
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	-5,093	13.72
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	33,927	33,927	-91.37
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		-14,787	39.82
Additional Reheat		-3,051	8.22
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-14,202	-37,132	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	82.6
Ra Plenum	75.2	70.0
Return	76.2	70.0
Ret/OA	76.6	65.5
Fn MtrTD	0.2	0.0
Fn BldTD	0.5	0.0
Fn Frict	1.4	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	1,709	1,011
Terminal	1,709	1,011
Main Fan	1,709	1,011
Sec Fan	0	0
Nom Vent	75	75
AHU Vent	75	75
Infil	709	709
MinStop/Rh	1,011	1,011
Return	2,418	1,719
Exhaust	784	784
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	4.4	7.4
cfm/ft²	0.70	0.42
cfm/ton	295.59	
ft²/ton	419.44	
Btu/hr·ft²	28.61	-28.64
No. People	6	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	5.8	69.4	42.7	1,617	76.6	63.4	66.5	52.9	48.3	43.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	5.8	69.4								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	2,425		
Part	0		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	0	0	0
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-41.8	1,011	52.9	82.6
Aux Htg	0.0	0	0.0	0.0
Preheat	-4.6	75	9.0	52.9
Reheat	-24.1	1,011	52.9	70.0
Humidif	-23.0	784	1.8	43.7
Opt Vent	0.0	0	0.0	0.0
Total	-69.5			

System Checksums

By ACADEMIC

Phase 2

System 7 - Packaged RTU VAV Reheat Chill Water & Hot Water

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 86 / 72 / 96

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	0	0	0
Glass Solar	26,134	0	26,134	2
Glass/Door Cond	4,253	0	4,253	0
Wall Cond	14,543	4,660	19,202	1
Partition/Door	291,147		291,147	20
Floor	0		0	0
Adjacent Floor	0	0	0	0
Infiltration	174,691		174,691	12
Sub Total ==>	510,769	4,660	515,428	35
Internal Loads				
Lights	34,943	8,736	43,679	3
People	164,469	0	164,469	11
Misc	185,960	0	185,960	13
Sub Total ==>	385,373	8,736	394,109	27
Ceiling Load	3,722	-3,722	0	0
Ventilation Load	0	0	343,892	24
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	74,245		74,245	5
Exhaust Heat		-20,836	-20,836	-1
Sup. Fan Heat			96,174	7
Ret. Fan Heat		52,615	52,615	4
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	974,109	41,453	1,455,628	100.00

CLG SPACE PEAK

Mo/Hr: 7 / 18
OADB: 83

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	35,279	4
Glass/Door Cond	3,855	0
Wall Cond	14,497	2
Partition/Door	291,147	37
Floor	0	0
Adjacent Floor	0	0
Infiltration	34,802	4
Sub Total ==>	379,580	48
Internal Loads		
Lights	87,410	11
People	87,473	11
Misc	175,934	22
Sub Total ==>	350,816	44
Ceiling Load	7,206	1
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing	58,252	7
Grand Total ==>	795,855	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	-28,487	-28,487	3.05
Wall Cond	-28,611	-37,845	4.06
Partition/Door	-291,147	-291,147	31.21
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-272,173	-272,173	29.18
Sub Total ==>	-620,418	-629,652	67.50
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	-3,227	0	0.00
Ventilation Load	0	-437,650	46.92
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	432,254	432,254	-46.34
Exhaust Heat		2,798	-0.30
OA Preheat Diff.		-58,843	6.31
RA Preheat Diff.		-61,126	6.55
Additional Reheat		-180,548	19.36
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-191,391	-932,767	100.00

TEMPERATURES

	Cooling	Heating
SADB	48.8	81.1
Ra Plenum	75.4	69.7
Return	77.1	69.7
Ret/OA	79.7	44.4
Fn MtrTD	0.3	0.0
Fn BldTD	0.7	0.0
Fn Frict	2.2	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	27,309	15,451
Terminal	27,309	15,451
Main Fan	27,309	15,451
Sec Fan	0	0
Nom Vent	7,890	6,445
AHU Vent	7,890	6,445
Infil	4,008	4,008
MinStop/Rh	15,451	15,451
Return	28,449	16,859
Exhaust	9,031	7,854
Rm Exh	2,867	2,600
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	28.9	41.7
cfm/ft²	0.86	0.49
cfm/ton	197.08	
ft²/ton	229.66	
Btu/hr·ft²	52.25	-36.64
No. People	466	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	138.6	1,662.8	1,009.6	26,605	79.7	64.0	64.4	45.6	40.6	29.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	138.6	1,662.8								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	31,823		
Part	125,078		
Int Door	0		
ExFlr	0		
Roof	0	0	0
Wall	5,982	421	7
Ext Door	148	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-764.4	15,451	45.6	81.1
Aux Htg	0.0	0	0.0	0.0
Preheat	-401.6	7,890	9.0	45.6
Reheat	-525.2	15,451	45.6	70.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1,166.0			

Project Name: Morton Hospital
Dataset Name: MORTON ED1.TRC

ENGINEERING CHECKS

By ACADEMIC

System	Zone	Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²
Alternative 1												
	Corridor 1		Zone	400	0.00	0.40	363.8	909.6	13.19	0.00	0.40	-9.53
	MRI Phase 1		Zone	2,025	3.53	1.05	396.4	377.5	31.79	8.82	0.42	-32.41
Phase 1			**System - System 5 - Packaged RTU VAV Reheat, DX & Hot Water**	**2,425**	**4.39**	**0.70**	**295.6**	**419.4**	**28.61**	**7.42**	**0.42**	**-28.64**
	A01 TREATMENT		Zone	137	42.50	1.28	165.9	129.1	92.94	100.00	0.51	-55.97
	A02 TREATMENT		Zone	137	42.50	1.28	165.9	129.1	92.94	100.00	0.51	-55.97
	A03 TREATMENT		Zone	137	42.48	1.28	165.9	129.2	92.91	100.00	0.51	-55.95
	A04 TREATMENT		Zone	145	41.45	1.25	166.6	133.4	89.98	100.00	0.50	-53.76
	A05 TREATMENT		Zone	143	41.86	1.26	166.2	132.3	90.69	100.00	0.50	-54.32
	A06 TREATMENT		Zone	143	40.38	1.30	168.0	129.5	92.63	100.00	0.52	-55.12
	A07 TREATMENT		Zone	138	42.44	1.28	165.9	129.3	92.79	100.00	0.51	-55.87
	A08 TREATMENT		Zone	138	42.44	1.28	165.9	129.3	92.79	100.00	0.51	-55.87
	ADMIN ASSIST		Zone	184	19.20	0.73	249.3	342.4	35.05	48.01	0.29	-23.10
	AMBULANCE ENTRY VESTIBULE		Zone	316	0.00	0.60	271.9	449.4	26.70	0.00	0.40	-21.94
	ANTE		Zone	47	79.86	1.99	133.0	66.8	179.60	100.00	0.80	-124.62
	ANTE		Zone	59	71.21	1.78	139.2	78.2	153.45	100.00	0.71	-103.58
	B09 TREATMENT		Zone	148	40.84	1.24	167.2	134.8	89.02	100.00	0.50	-53.00
	B10 TREATMENT		Zone	144	41.65	1.25	166.4	132.8	90.34	100.00	0.50	-54.04
	B11 TREATMENT		Zone	138	42.44	1.28	165.9	129.3	92.79	100.00	0.51	-55.87
	B12 TREATMENT		Zone	138	42.44	1.28	165.9	129.3	92.79	100.00	0.51	-55.87
	B13 TREATMENT		Zone	144	41.65	1.25	166.4	132.8	90.34	100.00	0.50	-54.04
	B14 TREATMENT		Zone	144	39.87	1.31	169.6	129.8	92.43	99.68	0.52	-55.18
	B15 TREATMENT		Zone	139	42.26	1.28	166.1	129.8	92.49	100.00	0.51	-55.62
	B16 PATIENT TOILET		Zone	56	50.79	1.75	191.9	109.7	109.41	100.00	0.70	-83.64
	B16 TREATMENT		Zone	139	42.26	1.28	166.1	129.8	92.49	100.00	0.51	-55.62
	B17 BARIATRIC TREATMENT		Zone	201	32.71	1.14	176.1	154.5	77.65	81.76	0.46	-43.97
	B17 HOLDING		Zone	228	0.00	0.60	274.3	457.7	26.22	0.00	0.40	-21.94
	B18 BARIATRIC TREATMENT		Zone	201	32.91	1.13	175.7	154.9	77.45	82.27	0.45	-43.87
	B19 TREATMENT		Zone	169	27.38	1.62	207.8	128.4	93.46	68.44	0.65	-58.06
	B20 TREATMENT		Zone	168	27.46	1.63	207.8	127.8	93.92	68.64	0.65	-58.43
	BEREAVEMENT		Zone	269	21.69	0.64	243.7	378.0	31.74	54.23	0.26	-21.27
	C00 CHARTING		Zone	34	0.00	2.39	268.1	112.1	107.04	0.00	0.40	-21.94
	C01 FAST TRACK TREATMENT		Zone	125	45.27	1.32	163.0	123.4	97.24	100.00	0.53	-59.42
	C02 FAST TRACK TREATMENT		Zone	123	51.82	1.18	153.6	130.2	92.20	100.00	0.47	-57.01
	C03 FAST TRACK TREATMENT		Zone	125	48.60	1.23	157.7	128.0	93.74	100.00	0.49	-57.51
	C04 FAST TRACK TREATMENT		Zone	132	43.66	1.30	164.7	126.3	94.98	100.00	0.52	-57.58
	C05 FAST TRACK TREATMENT		Zone	132	43.66	1.30	164.7	126.3	94.98	100.00	0.52	-57.58
	C06 FAST TRACK TREATMENT		Zone	132	43.66	1.30	164.7	126.3	94.98	100.00	0.52	-57.58
	C07 FAST TRACK TREATMENT		Zone	132	43.66	1.30	164.7	126.3	94.98	100.00	0.52	-57.58

System	Zone Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²
	C08 FAST TRACK TREATMENT	Zone	138	42.80	1.27	165.3	130.1	92.22	100.00	0.51	-55.53
	C63 STAFF LOUNGE	Zone	397	0.00	1.58	289.1	182.6	65.73	0.00	0.40	-21.94
	C67 SECURITY/ NURSE SATION	Zone	153	0.00	0.67	287.0	427.6	28.06	0.00	0.40	-18.53
	C68 ELEC	Zone	28	0.00	2.62	256.4	98.1	122.39	0.00	0.40	-21.94
	C77 REG STAFF WORK	Zone	138	18.06	0.77	248.8	321.3	37.35	45.15	0.31	-24.11
	CHARTING	Zone	65	0.00	1.40	275.2	196.2	61.17	0.00	0.40	-21.94
	CHARTING	Zone	65	0.00	1.40	275.2	196.2	61.17	0.00	0.40	-21.94
	CHARTING	Zone	34	0.00	1.85	260.5	140.6	85.33	0.00	0.40	-21.94
	CLEAN	Zone	110	38.95	1.75	200.0	114.3	104.99	97.38	0.70	-73.10
	CLEAN	Zone	73	59.01	1.75	163.3	93.3	128.62	100.00	0.70	-90.96
	CLEAN	Zone	154	27.80	1.75	236.7	135.3	88.72	69.50	0.70	-63.16
	CLEAN	Zone	60	70.89	1.76	139.4	79.0	151.81	100.00	0.71	-102.31
	CONFERENCE	Zone	311	22.43	0.62	236.3	378.9	31.67	56.07	0.25	-20.80
	Corridor 2	Zone	10,000	0.00	0.40	306.7	766.8	15.65	0.00	0.40	-13.72
	CT	Zone	496	14.41	1.05	224.2	213.5	56.21	36.03	0.42	-30.74
	CT CONTROL	Zone	242	0.00	0.76	280.8	369.9	32.44	0.00	0.40	-21.94
	DECONTAMINATION VESTIBULE	Zone	274	15.63	1.75	313.3	179.0	67.02	39.07	0.70	-52.32
	ELEC	Zone	25	0.00	2.73	254.0	93.1	128.91	0.00	0.40	-21.94
	ELEC	Zone	23	0.00	2.87	251.3	87.7	136.88	0.00	0.40	-21.94
	ELEC	Zone	25	0.00	2.73	254.0	93.1	128.91	0.00	0.40	-21.94
	EMS	Zone	260	10.87	1.29	270.4	210.2	57.09	27.18	0.51	-35.35
	EMS TOILET	Zone	48	59.56	1.75	170.9	97.7	122.86	100.00	0.70	-91.45
	EMS/STORAGE	Zone	45	0.00	2.12	260.7	122.7	97.76	0.00	0.40	-21.94
	EQUIPMENT STORAGE	Zone	202	0.00	0.82	278.8	341.9	35.10	0.00	0.40	-21.94
	EQUIPMENT STORAGE	Zone	200	0.00	0.86	282.4	326.7	36.73	0.00	0.40	-21.94
	EQUIPMENT STORAGE	Zone	123	0.00	1.01	283.5	281.5	42.62	0.00	0.40	-21.94
	EQUIPMENT STORAGE	Zone	227	0.00	0.76	275.8	361.1	33.23	0.00	0.40	-21.94
	FINANCIAL/ DISCHARGE	Zone	124	0.00	1.18	275.6	232.9	51.52	0.00	0.40	-21.94
	GREETER	Zone	208	0.00	0.78	278.1	357.8	33.54	0.00	0.40	-21.94
	INPATIENT ADMISSIONS	Zone	120	0.00	1.17	274.0	233.8	51.32	0.00	0.40	-21.94
	ISOLATION	Zone	188	22.86	1.75	262.7	150.1	79.93	57.14	0.70	-58.76
	ISOLATION	Zone	203	21.15	1.75	245.1	140.0	85.70	52.88	0.70	-57.24
	JANITORS CLOSET	Zone	49	0.00	1.62	264.2	162.6	73.78	0.00	0.40	-21.94
	LOCKERS	Zone	542	0.00	0.56	289.1	515.1	23.30	0.00	0.40	-21.94
	MAIN EMERGENCY ELECTRICAL	Zone	320	0.00	0.55	270.3	487.1	24.64	0.00	0.40	-21.94
	MAIN NORMAL ELECTRICAL	Zone	800	0.00	0.46	283.0	612.3	19.60	0.00	0.40	-21.94
	MAJOR MEDICAL	Zone	187	34.54	1.16	174.0	150.1	79.95	86.36	0.46	-45.81
	MAJOR MEDICAL	Zone	181	35.11	1.18	173.6	147.2	81.53	87.77	0.47	-46.97
	MD WORK	Zone	160	17.82	0.78	247.6	315.4	38.05	44.54	0.31	-24.34
	MEDICAL DIR	Zone	125	22.28	0.63	242.5	386.3	31.07	55.70	0.25	-20.89
	MEDICINE PREP	Zone	69	0.00	1.32	272.2	206.6	58.09	0.00	0.40	-21.94
	MEDICINE PREP	Zone	216	0.00	0.82	280.4	340.9	35.20	0.00	0.40	-21.94
	MEDICINE PREP/ STORAGE	Zone	175	0.00	0.85	276.5	324.0	37.04	0.00	0.40	-21.94
	MENS RESTROOM	Zone	150	19.00	1.75	377.5	215.7	55.63	47.51	0.70	-55.33
	MRI	Zone	470	15.19	1.05	223.7	213.1	56.31	37.97	0.42	-31.16
	MRI CONTROL	Zone	207	0.00	0.80	278.2	349.5	34.34	0.00	0.40	-21.94

System	Zone Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²
	NOURISH	Zone	18	0.00	2.45	233.8	95.6	125.56	0.00	0.40	-21.94
	NOURISH	Zone	19	0.00	2.44	233.8	96.0	125.06	0.00	0.40	-21.94
	NOURISH	Zone	109	0.00	1.04	284.5	272.5	44.04	0.00	0.40	-21.94
	NOURISHMENT	Zone	174	0.00	0.84	275.9	329.1	36.47	0.00	0.40	-21.94
	NURSE MGR	Zone	90	15.41	0.91	262.7	289.5	41.46	38.52	0.36	-27.04
	OFFICE	Zone	143	10.71	1.31	266.7	204.2	58.76	26.77	0.52	-35.78
	OFFICE	Zone	90	15.41	0.91	262.7	289.5	41.46	38.52	0.36	-27.04
	P TUBE	Zone	19	0.00	2.44	233.8	96.0	125.06	0.00	0.40	-21.94
	P TUBE	Zone	18	0.00	2.45	233.8	95.6	125.56	0.00	0.40	-21.94
	P01 PSYCH TREATMENT	Zone	188	25.98	1.54	214.2	139.1	86.27	64.95	0.62	-54.15
	P02 PSYCH TREATMENT	Zone	188	26.01	1.54	214.1	139.2	86.19	65.01	0.62	-54.11
	P03 PSYCH TREATMENT	Zone	188	28.07	1.42	208.0	146.0	82.21	70.18	0.57	-51.63
	P04 PSYCH TREATMENT	Zone	216	28.69	1.21	187.0	154.5	77.68	71.71	0.48	-44.23
	P05 PSYCH TREATMENT	Zone	216	28.69	1.21	187.0	154.5	77.68	71.71	0.48	-44.23
	P06 PSYCH TREATMENT	Zone	187	23.95	1.67	205.7	122.9	97.63	59.87	0.67	-57.13
	P07 PSYCH TREATMENT	Zone	187	22.99	1.74	208.9	119.8	100.15	57.47	0.70	-58.67
	P08 PSYCH TREATMENT	Zone	187	23.04	1.74	208.8	120.0	99.98	57.61	0.70	-58.57
	PATIENT DRESSING	Zone	62	0.00	1.41	269.2	191.0	62.84	0.00	0.40	-21.94
	PATIENT DRESSING	Zone	83	0.00	1.21	276.9	229.0	52.41	0.00	0.40	-21.94
	PATIENT DRESSING	Zone	53	0.00	1.53	265.1	173.3	69.26	0.00	0.40	-21.94
	PATIENT DRESSING	Zone	53	0.00	1.53	265.1	173.3	69.26	0.00	0.40	-21.94
	PATIENT TOILET	Zone	60	47.62	1.75	200.9	114.8	104.54	100.00	0.70	-80.81
	PATIENT TOILET	Zone	66	43.20	1.75	213.0	121.7	98.59	100.00	0.70	-76.88
	PATIENT TOILET	Zone	79	36.00	1.75	242.4	138.5	86.65	89.99	0.70	-70.46
	PATIENT TOILET	Zone	56	50.79	1.75	191.9	109.7	109.41	100.00	0.70	-83.64
	PATIENT TOILET	Zone	61	47.06	1.75	202.6	115.7	103.68	100.00	0.70	-80.32
	PATIENT TOILET	Zone	48	59.52	1.75	170.6	97.5	123.07	100.00	0.70	-91.42
	PATIENT TOILET	Zone	50	56.62	1.75	176.5	100.8	119.00	100.00	0.70	-88.83
	PATIENT TOILET	Zone	56	51.02	1.75	189.4	108.3	110.85	100.00	0.70	-83.84
	PATIENT TOILET	Zone	66	43.47	1.75	214.0	122.3	98.12	100.00	0.70	-77.12
	PATIENT TOILET	Zone	51	56.01	1.75	179.1	102.3	117.27	100.00	0.70	-88.28
	PATIENT TOILET	Zone	73	39.15	1.75	229.6	131.2	91.44	97.87	0.70	-73.27
	PATIENT TOILET/ SHWR	Zone	67	42.33	1.75	226.2	129.2	92.85	100.00	0.70	-76.11
	PATIENT TOILET/ SHWR	Zone	69	41.12	1.75	224.6	128.3	93.52	100.00	0.70	-75.02
	RESUSC A	Zone	371	9.63	2.10	436.8	208.0	57.69	24.08	0.84	-56.38
	RESUSC B	Zone	307	11.65	2.10	409.2	194.8	61.59	29.13	0.84	-58.54
	SECURITY/ NURSE STATION	Zone	153	0.00	0.67	287.0	427.6	28.06	0.00	0.40	-18.53
	SOILED	Zone	78	0.00	1.15	273.4	237.8	50.47	0.00	0.40	-21.94
	SOILED	Zone	125	0.00	1.01	279.5	276.6	43.39	0.00	0.40	-21.94
	SOILED	Zone	78	0.00	1.23	275.3	223.2	53.77	0.00	0.40	-21.94
	SOILED	Zone	60	0.00	1.42	268.0	189.1	63.48	0.00	0.40	-21.94
	STAFF TOILET	Zone	51	56.01	1.75	179.1	102.3	117.27	100.00	0.70	-88.28
	STAFF TOILET	Zone	51	55.94	1.75	178.3	101.9	117.81	100.00	0.70	-88.22
	STAFF TOILET/ SHOWER	Zone	82	34.75	1.75	247.1	141.2	85.00	86.87	0.70	-69.35
	STAFF TOILET/ SHOWER	Zone	72	39.47	1.75	225.9	129.1	92.95	98.67	0.70	-73.56
	STORAGE	Zone	50	0.00	1.55	264.0	169.8	70.67	0.00	0.40	-21.94

System	Zone Room	Type	Floor Area ft²	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²
	TEAM WORK	Zone	160	16.07	0.87	253.7	291.4	41.18	40.17	0.35	-26.22
	TECH WORK	Zone	77	22.31	0.63	242.4	386.7	31.03	55.78	0.25	-20.87
	TEL/DATA	Zone	228	0.00	0.80	281.0	349.5	34.33	0.00	0.40	-21.94
	TRIAGE A	Zone	223	16.01	2.10	340.4	162.1	74.02	40.02	0.84	-63.19
	TRIAGE B	Zone	222	16.12	2.10	339.2	161.5	74.29	40.29	0.84	-63.31
	VENDING/ PHONE	Zone	49	0.00	2.13	267.0	125.3	95.74	0.00	0.40	-21.94
	VESTIBULE	Zone	135	0.00	3.24	284.9	87.8	136.64	0.00	0.40	-21.94
	WAITING	Zone	1,317	71.29	2.10	204.6	97.4	123.20	100.00	0.84	-122.27
	WAITING	Zone	276	71.29	2.10	189.5	90.2	132.98	100.00	0.84	-122.27
	WATER CLOSET	Zone	80	35.71	1.75	236.2	135.0	88.91	89.28	0.70	-70.21
	WOMENS RESTROOM	Zone	150	19.00	1.75	377.5	215.7	55.63	47.51	0.70	-55.33
	X-RAY	Zone	327	21.87	1.05	202.1	192.5	62.35	54.68	0.42	-34.73
	X-RAY	Zone	324	22.05	1.05	201.5	191.9	62.53	55.11	0.42	-34.82
Phase 2		**System - System 7 - Packaged RTU VAV Reheat Chill Water & Hot Water**	**31,823**	**28.89**	**0.86**	**197.1**	**229.7**	**52.25**	**41.71**	**0.49**	**-36.64**

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