Technical Assignment 1

ASHRAE Standard 62.1 and Standard 90.1 Design Compliance

Butler Memorial Hospital | New Inpatient Tower

Butler Healthcare Providers

Butler, PA

Table of Contents

Executive Summary

The New Inpatient Tower at the Butler Memorial Hospital is a 209,000 square foot addition seated in Butler, Pennsylvania that has just been completed in July 2010. The eight story tower was built to house state of the art operating and recovery rooms.

This document is an assemblage of research, documentation, and data collected from the New Inpatient Tower specifically targeted to analysis the compliance with ASHRAE Standards 62.1 and 90.1. These two standards have to do specifically with mechanical systems within the building and energy consumption. The mechanical system being analyzed is a central loop variable air volume system with terminal variable air volume boxes at discharge destinations.

It is apparent after doing extensive research that the New Inpatient Tower complies with ASHRAE Std. 62.1 Section 5 with regards to mechanical system design layout, construction practices, and installation guidelines all being met. When investigating the ventilation rates of outdoor air, it was found that all areas of the hospital are supplied with an outside air fraction 0.33: 33% of the supply air is taken from the outdoors. Data taken from Appendix B clearly shows that the required amount of outdoor air is easily met by the design. The building is designed to supply 53,812 CFM of outdoor air; however ASHRAE Std. 62.1 only calls for 15,962 CFM of outside air. The system supplies more than the required minimum outdoor air to improve indoor air quality and keep patients healthier.

When examining ASHRAE Std 90.1, it is apparent that the New Inpatient Tower at the Butler Memorial Hospital, as a whole, is in compliance. The only situations which were not in compliance dealt with the supply fans in air handlers being oversized, the scroll chiller which services the operating rooms having a COP below the recommended minimum, and two gas fired boilers below minimum efficiencies set forth by ASHRAE. However, these situations are not mistakes. They were done with good intentions and will be discussed further in the report.

In general, the New Inpatient Tower is in compliance with ASHRAE Standards 62.1 and 90.1 except in a few cases where special needs had to be met. A mechanical summary has also been included on the following pages in order to further discuss the design of the mechanical systems.

Introduction

The New Inpatient Tower at the Butler Memorial Hospital is an 8 story addition to the existing hospital located within Butler, PA. The lower 2 stories are underground and provide space for primarily mechanical rooms and storage. The 2nd through 7th floors house the bulk of the activity for the new addition, although it should be noted that due to the nature of the addition and matching floor-to-floor heights of the existing building, there is not a 4th floor. Above the 7th floor is a penthouse area housing air handlers and elevator equipment.

Level 2 is at ground level and serves as the main entry, equipped with retail and public space, a café, auditorium, chapel, and multiple conference rooms. The 3rd floor features mainly operating and recovery rooms. Level 5 is home to an abundance of critical care unit beds and nurse's stations. Floors 6 and 7 are identical and feature nurse's stations and inpatient beds accommodating patients recovering from surgery.

The façade of the tower is combination of aluminum curtainwalls, aluminum windows, metal wall panels, and red face brick. The roof system is thermoplastic membrane system.

Mechanical Summary

The Butler Memorial Hospital New Inpatient Tower mechanical is a very diverse and complex system combining many different features and innovative ideas to meet the needs of the hospital. The system is a variable air volume system with terminal boxes located near diffusers for flow control. 100% outside air economizer cooling is installed on all air handlers to save on cooling costs during temperate weather. The system configuration has redundancy in the chiller water system, with the ability to lose the chiller, pump, or cooling tower and remain functional. Radiant heat is used extensively in patient rooms along the perimeter of the building to provide individual thermal comfort control. There are a total of 8 air handling units with the 5 main units being VAV and the remaining 3 smaller units being constant volume.

System #	Area Served	Type	Supply CFM	Cooling Coil (EWT)	Heating Coil (EWT)
AHU-1	7th through lower level	VAV	62,000	44°F	180°F
AHU-2	7th through lower level	VAV	62,000	44°F	180°F
AHU-3	7th through lower level	VAV	62,000	44°F	180°F
AHU-4	Operating Rooms	VAV	18,500	34°F	180°F
AHU-5	Operating Rooms	VAV	18,500	34°F	180°F
AHU-6	1st Floor Chiller Room	CV	4,700	44°F	180°F
AHU-7	1st Floor Electrical Room	CV	4,000	44°F	180°F
AHU-8	Elevator Penthouse	CV	4,700	44°F	180°F

Table 1 - Air Handling Unit's Properties

The primary heating, air conditioning, and ventilation is performed by (3) 62,000 CFM rooftop air handlers. These three air handlers comprise a loop system which serves every area of the hospital except for operating rooms and a few specialty rooms. Due to the nature of the loop system, all 3 air handlers are coupled feeding every diffuser, there is natural redundancy built into the mechanical system. (2) 400 ton centrifugal chillers with variable speed drives provide AHU 1, 2, & 3 with cold water used for dehumidification and cooling. A central rooftop cooling tower serves as the primary means of cooling the condenser water which exits the two centrifugal chillers.

Rooftop air handling units 4 and 5 are located on a lower level roof (Floor 5) and provide the necessary heating, ventilating, and air-conditioning to the 8 operating rooms which are located on the 3rd floor. It should be noted that there is not a 4th floor in the hospital due to the retrofit application, therefore the 5th floor sits directly above the 3rd floor. The operating room air handlers are serviced by an adjacent 119 ton air-cooled scroll chiller supplying 34°F water. The lower temperature system is backed up by the primary chillers in case of emergency; 45°F primary water can still be supplied.

Air Handling Units 6, 7, & 8 are all smaller units which serve specific rooms with an extra need for cooling. AHU-6 and AHU-7 service the chiller and electrical room respectively. Both of these components utilize the 2 main chillers and boilers as there thermal source. They are also equipped with 100% air side economizer and are suspended within the room with ductwork throughout. AHU-6 which maintains the chiller room is also equipped with 100% make-up air for refrigerant purge exhaust mode.

On the heating side, (2) 215 BHP combustion gas/oil-fired hot water boilers supply all of the heating water for the entire building: this includes heating water to the air handling unit heating coils, unit heaters used for reheat within terminal boxes, duct heating coils, radiant ceiling panels around the perimeter of patient rooms, and finned tube radiation in the soffit/plenum area above the second floor to keep the cantilevered floor warm.

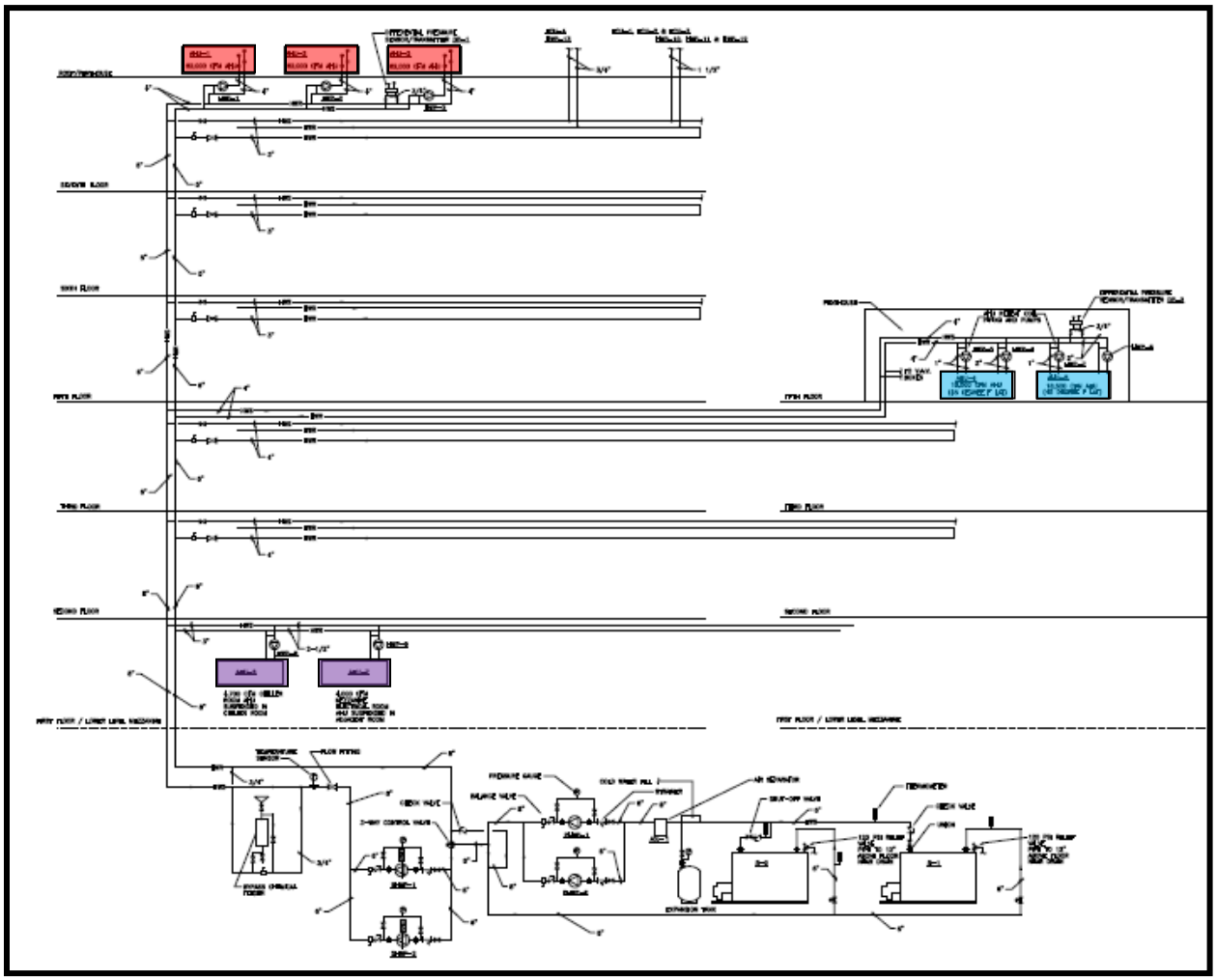

Figure 1: Location of Air Handlers *AHU-8 Not Shown

AHU-1, 2, 3 Serving Ground – 7th Floor

AHU- 4 & 5 Serving Operating Rooms

AHU- 6 & 7 Serving Chiller & Electrical Rooms

ASHRAE Standard 62.1 Compliance Analysis

Section 5: Systems and Equipment

5.1 Natural Ventilation

Due to the fact that the building in question provides ventilation by means of mechanical ventilation and there are no operable windows, natural ventilation does not apply.

5.2 Ventilation Air Distribution

All areas within the confines of the building coincide with ASHRAE Std 62.1 Section 6. Great detail was taken to ensure the proper intake and distribution of ventilation air within the building and all appropriate calculations have been made.

5.3 Exhaust Duct Location

Extensive planning ensures that all exhaust ducts are negatively pressurized with respect to adjacent areas and exit the building in areas which are not in close proximity to any air intake devices. Exhaust ducts which comply with this statement include, but are not limited to toilet room exhaust, patient isolation rooms, janitor's closets, and gas/oil fired boiler exhaust.

5.4 Ventilation System Controls

The hospital is equipped with zone control allowing the terminal VAV box to increase or decrease the amount of ventilation and supply air based upon the occupancy of the room. Minimum outdoor airflow is met at all times, which is in compliance with Section 6 of ASHRAE Std. 62.1.

5.5 Airstream Surfaces

All airstream ductwork is fabricated of galvanized sheet metal according to SMACNA Duct Construction Standards and are designed in accordance with Section 5.5 to meet the specifications necessary to resist mold growth and erosion.

5.6 Outdoor Air Intakes

Careful attention was taken to ensure that minimum distances between exhaust ports and air intake devices were upheld. The boiler exhaust is 40' from the nearest air intake and rises above the roof 32'. A minimum distance of 25' was kept between air intake louvers and the highest point of all exhaust flues as a general rule of thumb. All air intakes are at roof level therefore vehicular fumes are not an issue. The cooling tower is located 45' from nearest air intake therefore it also complies with Section 5.6. The exhaust system is designed such that it limits rain and snow entrainment and intrusion in accordance with ASHRAE Std 62.1.

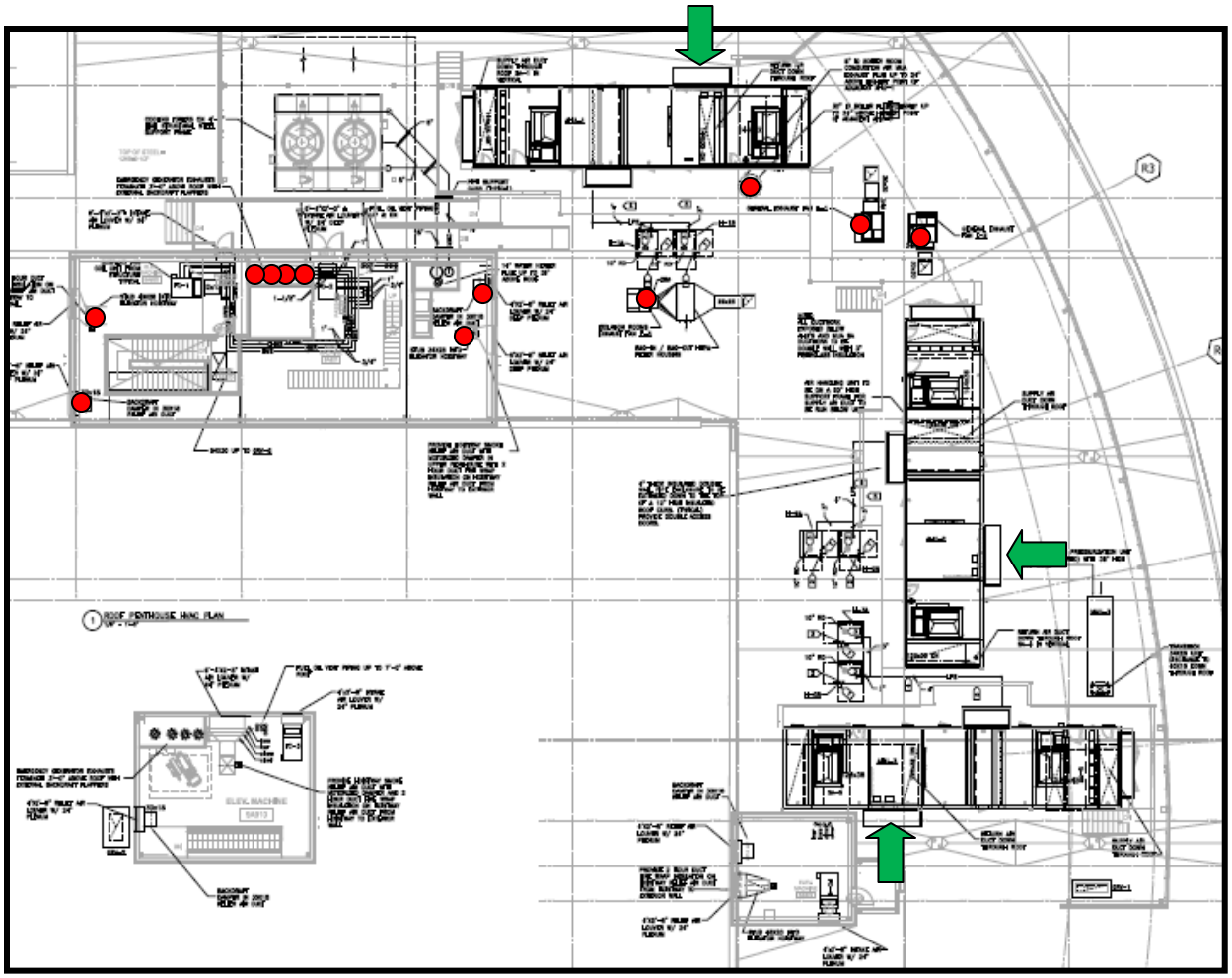

Figure 2: Air Intake vs. Exhaust Locations for AHU-1, 2, 3

Air Intake Areas

Exhaust Fume Vent Openings

5.7 Local Capture of Contaminants

All filters and contaminant collection devices have been designed appropriately to exhaust all contaminants through rooftop vents, which are high velocity and well above roof level, to ensure contaminants do not re-enter the building.

5.8 Combustion Air

The two gas/oil-fired boilers located in the 1st floor mechanical room are equipped with (4) exhaust manifolds and vents which carry the fumes from combustion up to the rooftop level and safely away from any air intake system.

5.9 Particulate Matter Removal

All air handlers are equipped with a pre-filter and/or final filter. The 2 filters are designated as either Type "A" or Type "B" with MERV efficiencies of 8 and 11 respectively. The filter class designated is higher than MERV 6 which is the minimum according to ASHRAE Std 62.1.

System #	Area Served	Type	Pre-filter	Main Filter
AHU-1	7th through lower level	VAV	MERV 8	MERV 11
AHU-2	7th through lower level	VAV	MERV 8	MERV 11
AHU-3	7th through lower level	VAV	MERV 8	MERV 11
AHU-4	Operating Rooms	VAV	MERV 8	MERV 11
AHU-5	Operating Rooms	VAV	MERV 8	MERV 11
AHU-6	1st Floor Chiller Room	CV	-	MERV 8
AHU-7	1st Floor Electrical Room	CV	-	MERV 8
AHU-8	Elevator Penthouse	CV	-	MERV 8

Table 2: AHU's and corresponding filter efficiencies

5.10 Dehumidification Systems

The building was designed for all rooms to be at a maximum relative humidity of 50% during summer months and a maximum relative humidity of 30% during the winter months. ASHRAE Std 62.1 maximum relative humidity is 65%, therefore the system complies. Although certain "sick" rooms and restrooms are negatively pressurized, the net amount of air intake compared to exhaust is positive which should reduce infiltration.

5.11 Drain Pans

All drain pans are designed to have a 1/8" minimum slope with the drain outlet located at the lowest point. The drain pan size was designed to be large enough to handle average quantities under normal circumstances.

5.12 Finned-Tube Coils

The finned radiant tube coils in the ceiling and floors will not apply to this section because they are not condensate producing coils due to the fact that they are utilized for heating. All other finned-tube coils used for cooling and dehumidification are equipped with an appropriate drain pan and meet the minimum adequate intervening access space of 18".

5.13 Humidifiers and Water-Spray Systems

Gas fired self-contained humidifiers producing low pressure steam and use only potable water from the city water source. All obstructions which are located downstream of the humidifiers are located a distance well beyond manufacturer's recommendations to prevent deposition of water vapor.

5.14 Access for Inspection, Cleaning, and Maintenance

All ventilation and air distribution units are built with inspection and maintenance in mind. All areas including outdoor air intake airways, mixed air plenums, heating and coiling coils, air cleaners, drain pans, fans and humidifiers of the air handlers are accessible and unobstructed such as to be in compliance.

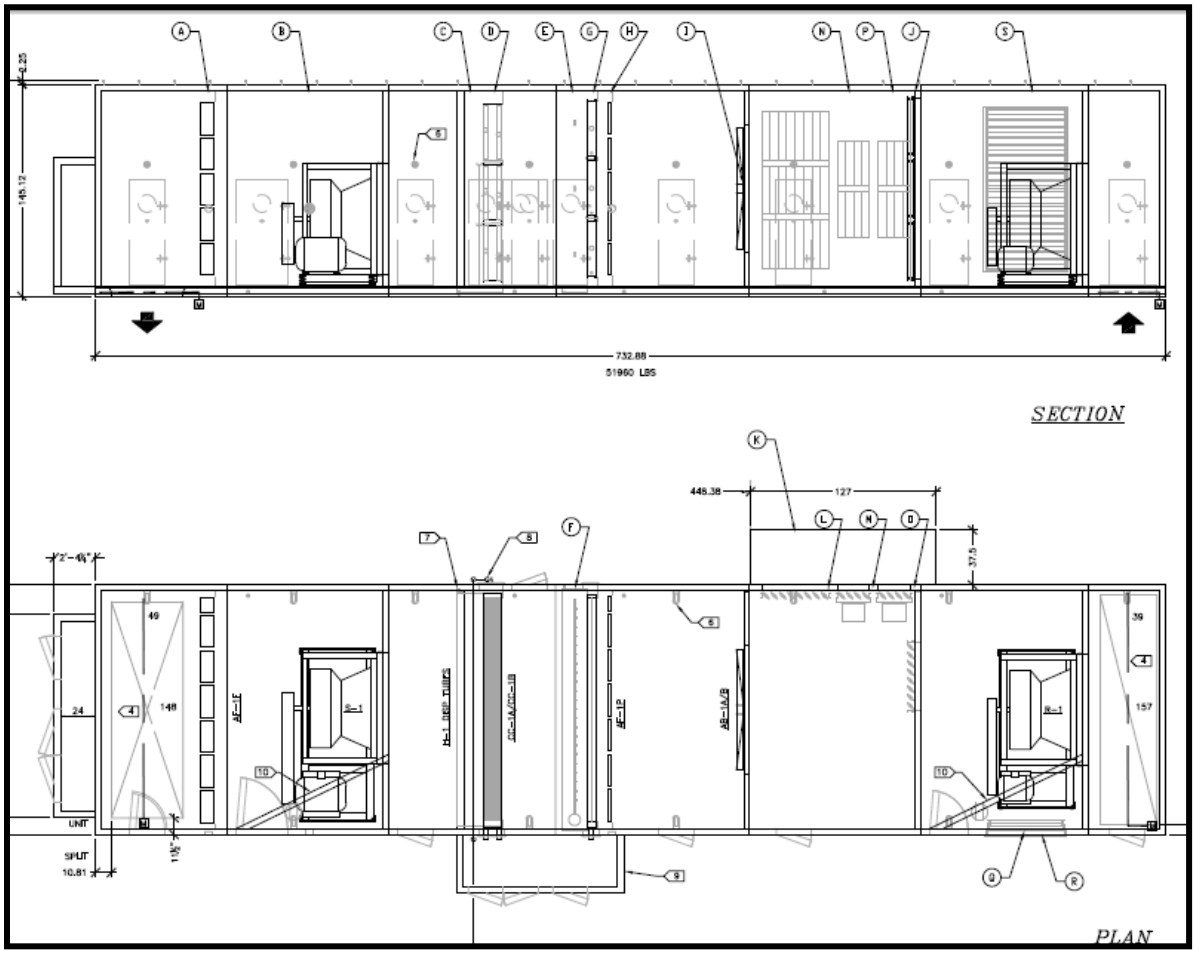

Figure 3: Typical AHU-1, 2, & 3

A	FILTERS : LIFT–OUT UPSTREAM VELOCITY : 477 FPM TYPE : 12" (MERV 14) RIGA V PH 95% SIZES : 30 @ 24 X 24 5 @ 24 X 12
B	FAN : 54" EPF SW, Arrangement–3 AIR FLOW : 62000 CFM RPM : 1012 T.S.P. : 8 in wc CLASS : II MOTOR : 125 HP, TEFC Prem–Eff, 460/3/60 RPM : 1750 (GROUNDED SHAFT) ISOLATORS : OS DEF : 2 in
C	UV LIGHTS
D	COOLING COIL, MODEL: SWS1208A TYPE : 8 ROW SIZES : 3 @ 39 X 153 CONN : RIGHT DRAIN : LEFT
E	STEAM HUMIDIFIER
F	DRAIN PAN
G	HEATING COIL, MODEL: SMH1101A TYPE : 1 ROW SIZES : 3 @ 39 X 153 CONN : RIGHT VEL : 499 FPM

H	FILTERS : LIFT–OUT UPSTREAM VELOCITY : 477 FPM TYPE : 4" OPTI–PACK 65% SIZES : 30 @ 24 X 24
I	STRATIFICATION ELIMINATORS SIZES : 1 @ 85" DIA
J	RA DAMPER : PARALLEL BLADES MAKE : T.A. Morrison–1500 SIZE : 126 X 48
K	MOD OA HOOD TYPICAL OF 4
L	MOD OA DAMPER : PARALLEL BLADES MAKE : T.A. Morrison–1500 SIZE : 109 X 48
M	1/2 MIN OA DAMPER : PARALLEL BLADES MAKE : T.A. Morrison–1500 SIZE : 68 X 24
N	3 – 16 ENMOTRACK MONITORS
O	1/2 MIN OA DAMPER : PARALLEL BLADES MAKE : T.A. Morrison–1500 SIZE : 68 X 24
P	3 – 16 ENMOTRACK MONITORS

Q	EA DAMPER : PARALLEL BLADES MAKE : T.A. Morrison–1500 SIZE : 55 X 110
R	LOUVRE SIZE : 55 X 110 Std Louvre
S	FAN : 54" EPF SW, Arrangement–3 AIR FLOW : 52000 CFM RPM : 732 T.S.P. : 3.25 in wc CLASS : II MOTOR : 50 HP, TEFC Prem–Eff, 460/3/60 RPM : 1750 (GROUNDED SHAFT) ISOLATORS : OS DEF : 2 in
	UNIT MOUNTING Unit is designed to be mounted on a structural steel frame.
	Note : Calculated unit weights are shipping weights and do not reflect operating conditions

5.15 Building Envelope and Interior Surfaces

The exterior of the building is designed to prevent the entrance of liquid through the exterior wall. All seams and joints have been caulked or sealed as to limit the amount of liquid penetrating through cracks. A vapor barrier has been implemented in all exterior walls to eliminate condensation within the wall cavity. Any chilled pipe whose temperature has the potential to fall below the dew point has been insulated to prevent the formation of condensation on pipe walls.

5.16 Buildings with Attached Garages

There is not a parking garage attached to the inpatient tower, therefore the entry of vehicle exhaust into the building should not be a problem.

5.17 Air Classification and Recirculation

All air within the building has been classified in accordance with Table 5-2 and is appropriately designated. Whenever air is mixed with other air streams or enters a filtering device, the leaving air is re-designated an appropriate air class based on its quality. Due to the fact that only Class 1 air from the main portions of the hospital is being re-circulated and all Class 2 and above air from bathrooms and janitor's closets is being exhausted from the building, we should not have any problems.

5.18 Requirements for Buildings Containing ETS Areas and ETS-Free Areas

Due to the fact that the hospital is a no smoking environment and all smoking areas are designated 25' from the building, coupled with the fact that all exhaust vents rise well above the building roof, there should not be any issues with indoor air quality.

Section 6: Procedures

Because AHU-1, 2, & 3 are in a loop system and combined serve every room in the tower except for operating rooms and few mechanical rooms, it has been decided to analyze the ventilation rates of entire building. In addition to AHU-1, 2, & 3, air handlers 4 and 5, which serve the operating rooms, will also be analyzed within the analysis.

6.2 Ventilation Rate Procedure

Because the outdoor supply air entering the building is in accordance with ASHRAE Std. 62.1 Section 4.1 and has been deemed acceptable, Equation 6-1 can be used to determine the breathing zone outdoor airflow.

$$V_{bz} = R_p \times P_z + R_a \times A_z \quad \textbf{(6-1)}$$

V_{bz} = breathing zone airflow rate

R_p = outdoor airflow rate required per person

P_z = zone population (based on largest number of people expected to occupy space)

R_a = outdoor airflow rate required per unit area determined from Table 6-1

A_z = zone floor area (net occupiable floor area of zone)

Zone Air Distribution Effectiveness

Based upon Table 6-2, the hospital addition classifies as “ceiling supply of cool air” and therefore the corresponding value of E_z is shown below:

$$E_z = 1.0$$

Zone Outdoor Airflow

This is defined as the amount of outdoor airflow that must be provided to the zone by supply air distribution and is equal to the equation below:

$$V_{oz} = V_{bz}/E_z \quad \textbf{(6-2)}$$

Since $E_z = 0$ this reduces to:

$$V_{oz} = V_{bz}$$

Primary Outdoor Air Fraction

$$Z_p = V_{oz}/V_{pz} \quad \textbf{(6-5)}$$

Z_p = Zone primary outdoor air fraction

V_{pz} = Zone primary airflow (outdoor and re-circulated air to a certain zone)

Uncorrected Outdoor Air Intake

$$V_{ou} = D\Sigma_{all\ zones}(R_p \times R_z) + \Sigma_{all\ zones}(R_a \times A_z) \quad \textbf{(6-6)}$$

$$D = P_s / \Sigma_{all\ zones} P_z \quad \textbf{(6-7)}$$

Outdoor Air Intake $V_{ot} = V_{ou}/E_v$ **(6-8)**

Outdoor Airflow Calculation Assumptions

- I assumed that all operating rooms are similar in nature to a science lab requiring .18 CFM/ ft^2 and 10 CFM/person.
- Patient rooms were also assumed to be similar to a "bedroom/living area" requiring .06 CFM/ft^2 and 5 CFM/person.

ASHRAE 62.1 Conclusions

After analyzing the entire ventilation system to the Butler Memorial Hospital, it has been determined that every space meets or exceeds the required amount of ventilation air according to ASHRAE Std 62.1. As noted earlier, the bulk of the ventilation is done by AHU-1, 2, & 3 which comprise a loop sytem serving every area besides the operating rooms. The peak Z_p value for AHU-1, 2, & 3 occurs in the auditorium: required outside air/supply air = 980/4345 = .225. Therefore E_v =.9. AHU-4 & 5 had a peak Z_p value equal to 0.145 (392 CFM OA/2700 CFM Supply). This occurred in the sterile core area which is the central corridor for all operating rooms. Z_p in all areas, as designed, is equal to 0.33.

According to the tables within Appendix B, the uncorrected outside air needed is 14,366 CFM. However, the total outside air intake V_{ot} = (14,366)/0.9 = 15,962 CFM. The design calls for 53,812 CFM of outside air, and 153,848 CFM of total supply air. The as designed outdoor airflow rate is considerably higher, likely due to engineers using an outside airflow rate of 20 CFM/person which is well above ASHRAE standards. Due to the fact that AHU-1, 2, & 3 are each 62,000 CFM resulting in a total of 186,000 CFM, the air handlers are more than capable of meeting the load. The operating rooms require a minimum of 2,307 CFM of outside air, but are designed for 9,682 CFM of outside air and 29,340 CFM of total supply air. AHU-4 & 5 are both 18,500 CFM, resulting in a combined 37,000 CFM which can easily meet the required load.

It is apparent that the designers oversized all the air handlers to ensure the best indoor air quality and to improve reliability. They coupled AHU-1, 2, and 3 to improve redundancy in case one air handler fails. They also designed the building to supply a great deal more outside air than required by ASHRAE to ensure patients receive the finest air quality. All spaces have an outside air fraction of 0.33.

*All supporting calculations and tables can be found in Appendix B and Appendix C

ASHRAE Standard 90.1 Compliance Analysis

The following is a compliance analysis of Butler Memorial Hospital's New Inpatient Tower with ASHRAE Std 90.1 – 2007. The analysis will be done on a variety of systems including but not limited to building envelope, HVAC systems, service water heating, power, lighting, and electric motor efficiency.

Section 5: Building Envelope

5.1.4 Climate

The hospital is located in climate zone 5. See illustration below:

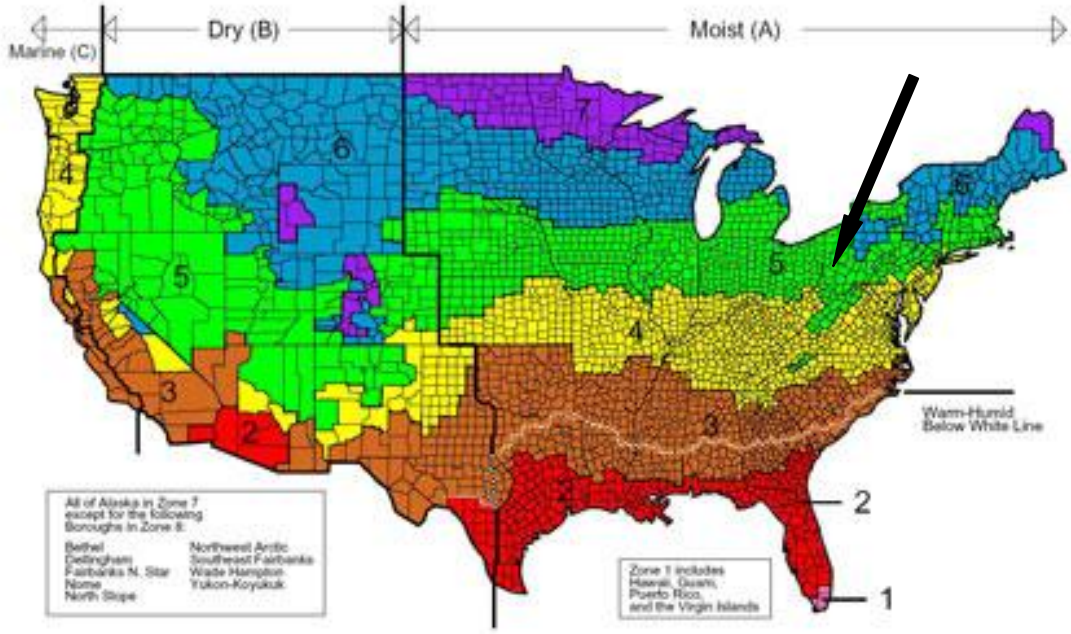

Figure 4: United States Climate Zones

5.4 Mandatory Provisions

All required insulation, doors, and fenestration meet or exceed the guidelines set for by ASHRAE. All exterior joints in vertical surfaces and non-traffic horizontal surfaces shall be sealed. These joints include perimeter joints between exterior cladding and frames of doors and windows. All entrances within the new addition are equipped with vestibules, capable of providing an air lock for the building with a door to door distance greater than 7 feet.

5.5 Prescriptive Building Envelope Option

By using the prescriptive method to analyze opaque surfaces and fenestration, the following results were found. Table 5.5-5 Building Envelope Requirements for Climate Zone 5 was used.

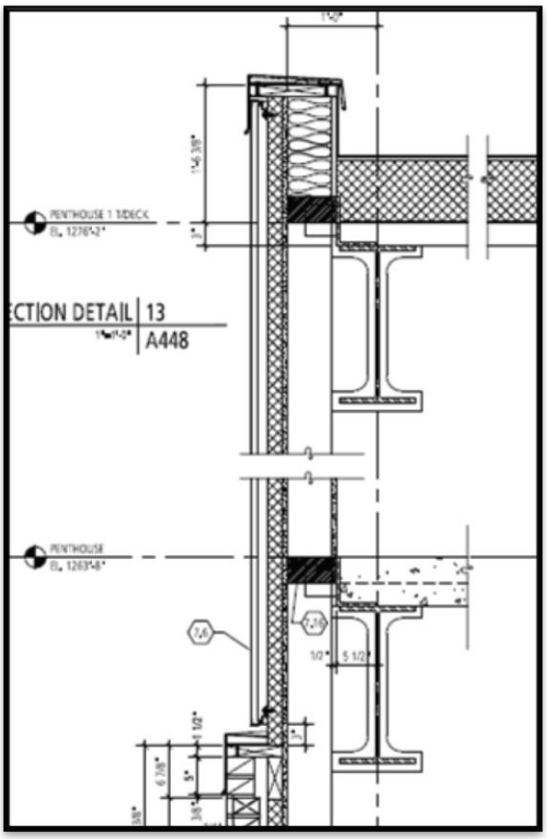

Figure 5: Exterior Wall Section (Composite Panel)

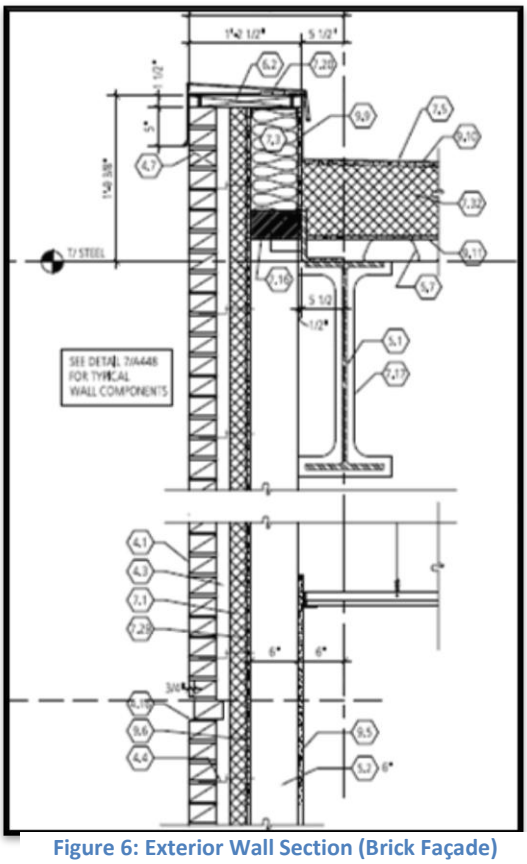

Figure 6: Exterior Wall Section (Brick Façade)

The following table is a compliance check for exterior building enclosures:

Compliance Check for Building Enclosures						
Element	Description	Prescribed By 90.1		As Designed		Compliant
		Assembly U Max	Insulation Min. R-Value	Assembly U Value	Insulation R Value	
Roof	Insulation Above Deck	.048	R-20	.06	R-33	YES
Walls, Above	Steel Framed	.090	R-13 + R-7.5	.10	R-19 + R-9*	YES
Walls, Below	Mass	.119	R-7.5	.11*	R-9*	YES
Floors	Steel Joist	.038	R-30	.5*	R-2*	NO
Fenestration						
Vertical	Aluminum Windows	.55	SHGC-.40	.28	N/A	Yes
Vertical	Entrance Door	.80	SHGC-.40	.66	N/A	Yes

Table 3: Building Enclosure Compliance Comparison

(*) Calculated value

It is stated in Standard 90.1 that the fenestration will not occupy more than 40% of the exterior wall surface. The table below shows the analysis done to determine whether or not the building is in compliance.

Fenestration Area By Floor				
Floor	Glass Area (ft^2)	Gross Wall Area (ft^2)	% Glass	Compliant
G	198.2	2,832	6.8%	Yes
1	211.5	3,776	5.5%	Yes
2	2,485	7,080	35.1%	Yes
3	3,066	7,974	38.4%	Yes
5	4,050	11,128	36.3%	Yes
6	3,985	11,128	35.8%	Yes
7	3,013	11,128	27.1`%	Yes

Table 4: Fenestration Percentage

The overall performance of the Butler Memorial Hospital New Inpatient Tower compared to Std 90.1 is mostly compliant. As seen in Table 3, our exterior walls and roof both are compliant. Floors did not meet the standard; however, this is not a large concern due to the fact that it will be the same temperature on both sides of the floor and no thermal gradiant should be evident As seen in Table 4, the building complies with fenestration requirements, which states the exterior glazing must be less than 40% of the overall exterior façade. It should be noted however that the exterior fenestration and wall areas were calculated by hand and are therefore subject to human error.

Section 6: Heating, Ventilation, and Air-Conditioning

6.2 Compliance Path

T here are two separate methods for analyzing a building's efficiency with regards to the HVAC system. The two paths are the Simplified Approach given in Section 6.3 and the Mandatory Provisions given in Section 6.4. Due to the fact that the Simplified Approach is only valid for buildings under 25,000 gross square feet and the Butler Memorial Hospital is over 200,000 gross square feet, the Mandatory Provision will be analyzed.

6.4 Mandatory Provisions

Because the Butler Memorial Hospital has just recently been completed, all of the data regarding the commissioning and verification of equipment efficiencies is not yet available; however, as designed efficiencies of mechanical equipment shall be discussed in Section 6.8.

The temperature control zoning typically consist of each patient room, isolation room, operating room, procedure room, and equipment room individually zoned, four Peri-op rooms per zone, and typically four support rooms or 1,000 square feet maximum per zone. Each zone will be equipped with an individual temperature sensor and thermostat with an accuracy of ±1°F. There is also a dual minimum air volume set-points programmed for occupied and unoccupied times on all variable air volume boxes to reduce air volumes during unoccupied times. It should also be noted that the perimeter radiant heat within patient rooms is coupled with the primary air system to ensure thermal comfort.

All outdoor air supply and exhaust, as well as vents are equipped with motorized dampers which are automatically closed when a space is not in use. The (5) main air handlers are equipped with optimum start controls and variable frequency drive fans to limit energy consumption under part load and to increase start-up efficiency. It should also be noted that all ductwork is properly sealed with a max leakage of 1% by means of a sealer or slip and drive connections.

6.5 Prescriptive Path

All air handlers within the building are equipped with an economizer capable of supplying 100% outside air, thereby meeting the minimum standard set forth by ASHRAE. Due to the nature of the system, when analyzing fan power system limitations using Table 6.5.3.1.1A, both equations for motor horsepower had to be used because not all air handlers are VAV.

For variable air volume air handlers (AHU-1 : 5) the following equation was used:

$$hp \leq CFM \times 0.0015$$

For constant volume air handlers (AHU-6 : 8) the following equation was used:

$$hp \leq CFM \times 0.0011$$

The tables below show whether or not each fan's horsepower is compliant with the limits set forth by ASHRAE.

Air Handler Supply Fans						
System #	Area Served	Type	hp	CFM	CFM x factor	Compliant
AHU-1	7th through lower level	VAV	125	62,000	93	NO
AHU-2	7th through lower level	VAV	125	62,000	93	NO
AHU-3	7th through lower level	VAV	125	62,000	93	NO
AHU-4	Operating Rooms	VAV	30	18,500	27.75	NO
AHU-5	Operating Rooms	VAV	30	18,500	27.75	NO
AHU-6	1st Floor Chiller Room	CV	5	4,700	5.17	YES
AHU-7	1st Floor Electrical Room	CV	5	4,000	4.4	NO
AHU-8	Elevator Penthouse	CV	5	4,700	5.17	YES

Table 5: Supply Fan hp Compliance Check

Air Handler Return Fans						
System #	Area Served	Type	hp	CFM	CFM x factor	Compliant
AHU-1	7th through lower level	VAV	50	52,000	78	YES
AHU-2	7th through lower level	VAV	50	52,000	78	YES
AHU-3	7th through lower level	VAV	50	52,000	78	YES
AHU-4	Operating Rooms	VAV	15	16,500	24.75	YES
AHU-5	Operating Rooms	VAV	15	16,500	24.75	YES
AHU-6	1st Floor Chiller Room	CV	-	-	-	-
AHU-7	1st Floor Electrical Room	CV	1	4,000	4.4	YES
AHU-8	Elevator Penthouse	CV	-	-	-	-

Table 6: Return Fan hp Compliance Check

Exhaust Fans						
System #	Area Served	Type	hp	CFM	CFM x .0011	Compliant
E-1	7th Floor Roof	CV	7.5	13,000	14.3	YES
E-2	7th Floor Roof	CV	7.5	12,200	13.4	YES
E-3	7th Floor Roof (Iso Rooms)	CV	10	7,000	7.7	NO
E-4	Chiller Room	CV	1	4,700	5.2	YES
PV-1	Ground and 1st General	CV	5	6,500	7.15	YES
PV-2	Ground Med Gas Storage	CV	.25	450	.495	YES
PV-3	OR Suite Substerile	CV	.75	3,000	3.3	YES
PV-4	1st Central Sterile	CV	.25	250	.275	YES
PV-5	1st Sterile Washer/Disinfect	CV	.25	550	.605	YES

Table 7: Exhaust Fan hp Compliance Check

Although all of the main air handlers, AHU-1 -5, are not compliant with ASHRAE Std 90.1, it is done with good cause. Due to the fact that air handlers 1, 2, and 3 are coupled together, if one air handler needs serviced or malfunctions, the other 2 are capable of meeting 75% of the design load. The fans which power these air handlers will need to be oversized to compensate for situations where redundancy is put into use. Similarly, AHU-4 & 5 also serve as back-ups for one another and must meet extra resistance due to HEPA filters in terminal boxes and therefore also have fans which are oversized.

No energy recovery system is necessary within the system because the outdoor air intake of all air handlers is 33%, which is far less than the 70% requirement set forth by ASHRAE.

6.7 Submittals

All HVAC systems are specified to be commissioned and tested upon installation to ensure that control devices are adjusted correctly, calibrated, and performing how they were designed.

6.8 Minimum Equipment Efficiency Tables

All chillers and boilers were checked to ensure compliance with ASHRAE Standard 90.1 Table 6.8.1C for the Scroll Chiller, 6.8.1I for the Centrifugal Chillers, and Table 6.8.1F for the boilers. It should be noted for the centrifugal chillers that the leaving evaporator water temperature is 42°F, entering condenser water is 85°F, and the flow rate is 2 gpm/ton, which results in a minimum COP of 4.63.

Chiller Efficiency Analysis				
System #	Area Served	COP	90.1 Min COP	Compliant
CH-1	Air Cooled Scroll Chiller (AHU-4 & 5)	2.6	2.8	NO
CH-2	Centrifugal Chiller (AHU-1, 2, &3)	5.93	4.63	YES
CH-3	Centrifugal Chiller (AHU-1, 2, &3)	5.93	4.63	YES

Table 8: Chiller Efficiency Compliancy

Boiler Efficiency Analysis				
System #	Area Served	Min. Eff.	90.1 Min. Eff.	Compliant
B-1	Gas/Oil Fired Hot Water Boiler	81%	82%	NO
B-2	Gas/Oil Fired Hot Water Boiler	81%	82%	NO

Table 9: Boiler Efficiency Compliancy

As noted in the charts above, the scroll chiller and boilers fall short of ASHRAE 90.1 Section 6. It should be noted, however, that when the building was designed the minimum efficiency for gas fired boilers over 2,500,000 Btu/h was 80% and only in March 2010 did ASHRAE raise the minimum efficiency to 82%, in which case the boilers no longer comply. The scroll chiller's COP is most likely low due to the fact that it is providing 34°F chilled water to the air handlers which service the operating rooms, instead of typical evaporator water temperatures around 43°F - 45°F.

An analysis of the cooling tower's compliance has also been performed and the results are below:

Cooling Tower Analysis				
System #	Area Served	gpm/hp	90.1 Required (gpm/hp)	Compliant
CT-1	Axial Fan Cooling Tower	60	≥38.2	YES
CT-2	Axial Fan Cooling Tower	60	≥38.2	YES

Table 10: Cooling Tower Efficiency Compliancy

Section 7: Service Water Heating

Domestic hot water is supplied by (2) 1,000 MBH gas fired, power-vent type water heaters with sealed combustion chamber located in the first floor mechanical room. These water heating storage tanks are capable of holding 250 gallons each and supplying 140°F water. It should be noted that only 110°F is supplied for patient use fixtures. Each system has a recovery capacity of 1130 gallons/hour at 100°F rise. Both water heaters are rated for 94% efficiency, which is well above the ASHRAE standard of 80% efficiency.

Section 8: Power

This section analyzes the power distribution within the building. It is specified within the standard that all feeders must have a maximum voltage drop of 2% at design load, and branch circuits must have a maximum voltage drop of 3% at design load. The New Inpatient Tower was designed in exact accordance with this standard and therefore complies with Section 8 of ASHRAE Std. 90.1.

Section 9: Lighting

9.2 Compliance Path

There are two methods for analyzing lighting power density. The first method explored is called the Building Area Method Compliance. This method simply refers to finding the total wattage serving the lighting load of the building and then dividing the total number of watts by the square footage. The second method that can be used is called the Space-By-Space Method. This approach involves finding the lighting density for each individual space and then comparing that density with the ASHRAE guidelines for a similar space. For the purpose of this report the Building Area Method was chosen and the results are shown below.

Lighting Compliance Analysis										
Fixture	Ground	1st	2nd	3rd	5th	6th	7th	Pent.	Watts/Fix	Tot. Watts
AF1			7						58	406
AM1			7	13	6	6	6		6	228
BF3						26	26		19	988
BF4					35	37	37		19	2071
CF1					117	117	117		58	20358
CF2			16						58	928
CF7			30						84	2520
DF1	24	20	193	34	28	29	29		52	18564
DF2		1		5					52	312
DF3		8			3	3	3		28	476
DF4					79	85	85		14	3486
DF5					105	105	105		28	8820
DF6			14						28	392
DF7			24						52	1248
DF9			31						52	1612
DF10					24	24	24		26	1872
DF11			58						56	3248
DG1					12	33	33		100	7800
DG2					72	78	78		50	11400
DG3				28					150	4200
DG4				13					150	1950
DG5			19						50	950
DG6			4						50	200
DH2	4		10						48	672
DH3			8						93	744
EG2	6	9	6	2					36	828
EM1	5	12	6	5	14	14	14	1	5	355
EM2	2	3	9	8	9	10	10		5	255
EM3	3	3	19	17	8	6	6		5	310
EM4		2	6	5	6	5	5		5	145
JF3	1	1	1	1	2	2	2	2	58	696
JF5			18						58	1044
JF7			14						58	812
LF1				96					174	16704
LF2	20	124	34	51	27	20	20		58	17168
LF3			5	19					85	2040
LF5				40					85	3400
LF6			24	3					45	1215
LF7				13					85	1105
MF1					48	52	52		76	11552
MF3	3		50	91	34	36	36		58	14500
MF4	14	11	57	97	36	34	34		31	8773
MF5			11	5	9	9	9		74	3182

MF6			4	90					58	5452
NF1	29	70	7	9	29	5	5	22	58	10208
NF2	22	14	8						26	1144
TG1			15						100	1500
TH1			12						48	576
TH3			12						48	576
UF1				5	9	8	8		32	960
UF3					11	19	19		18	882
TOTAL										200,827

Table 11: Lighting Load

Looking at the equation for lighting load compliance in ASHRAE Std 90.1 Section 9.5.1c, the installed interior lighting power cannot exceed the interior lighting power allowance. The allowance set forth by ASHRAE for hospitals is 1.2 Watts/ft^2. The following equation is used to determine the installed lighting power:

Lighting Density = Total # Watts / Total Square Footage

Lighting Density = 200,827 Watts / 209,678 ft^2 = **.957 Watts/ft^2**

Since the installed interior lighting power density of .957 watts/ft^2 ≤ 1.2 watts/ft^2 the hospital is in compliance with guidelines set forth by ASHRAE Standard 90.1 Section 9.

ASHRAE 90.1 Conclusions

After analyzing the building enclosure, HVAC systems, service water heating, and power and lighting, it can be determined that the New Inpatient Tower at the Butler Memorial Hospital falls short in a couple of key areas. The most pronounced deficiencies occurred with air handler supply fans, the scroll chiller, and boilers.

The rated horsepower in all five main air handlers when comparing volume flow rate to horsepower was oversized and did not meet ASHRAE guidelines. This is most likely due to the fact that the three main air handlers have to provide enough force to push the air down seven stories and the system is designed for inherent redundancy because of the three units being coupled together. The other two main air handlers which supply air to the operating rooms are also inherently redundant and the supply fans within the AHUs have to meet the extra resistance in the airflow path due to HEPA filters in the operating room terminal boxes.

The scroll chiller had a COP of 2.6 which is slightly below the ASHRAE recommended value of 2.8. This is most likely due to the fact that it is supplying 34°F water to the air handlers which is far lower than industry standards. As previously noted, the boilers efficiencies were in compliance with ASHRAE Std 90.1 – 2007; they have just become noncompliant since 3/2/2010 when higher minimum efficiencies were mandated. All other systems analyzed were in compliance with standards set forth by ASHRAE 90.1 – 2007.

APPENDIX A

List of Tables and Figures

List of Tables

List of Figures

APPENDIX B

Supplemental Ventilation Tables AHU-1, 2, & 3

BUTLER MEMORIAL HOSPITAL
INPATIENT TOWER ADDITION & RENOVATION - GROUND FLOOR
AIR CHANGE SCHEDULE

ROOM NO.	ROOM NAME	ROOM DATA AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz	DESIGN OA CFM ACTUAL	SUPPLY CFM TOTAL	OUTDOOR AIR FRACTION
0A333	MED/GAS STORAGE ROOM	186	0.06	N/A		11.16	132	400	0.33
0A334	EMERGENCY DISCONNECT	285	0.06	N/A		17.1	139	420	0.33
0A335	STORAGE	104	0.12	N/A		12.48	33	100	0.33
0A337	STORAGE	146	0.12	N/A		17.52	40	120	0.33
0A940	CORRIDOR	227	0.06	N/A		13.62	50	150	0.33
0A941	MECHANICAL CORRIDOR	657	0.06	N/A		39.42	112	340	0.33
0A942	STORAGE	446	0.12	N/A		53.52	201	610	0.33
0A944	ELEVATOR LOBBY	807	0.06	N/A		48.42	158	480	0.33
0A946	ELEVATOR LOBBY	993	0.06	N/A		59.58	403	1220	0.33
	TOTALS					**273**	**1,267**	**3,840**	

BUTLER MEMORIAL HOSPITAL
INPATIENT TOWER ADDITION & RENOVATION - FIRST FLOOR
AIR CHANGE SCHEDULE

ROOM NO.	ROOM NAME	ROOM DATA AREA	Ra	PPL (Zp)	Rp	Vbz = Voz	OA CFM ACTUAL	SUPPLY CFM TOTAL	OUTDOOR AIR FRACTION
1A101	TOILET	60							
1A102	STERILE STORAGE	1869	0.12			224.28	1010	3060	0.33
1A103	DECASING	159	0.06	2	5	19.54	40	120	0.33
1A104	OFFICE	115	0.06	1	5	11.9	33	100	0.33
1A105	HSKP	67	0.06						
1A106	STAFF LOUNGE	171	0.06	2	5	20.26	50	150	0.33
1A107	ASSEMBLY	1799	0.06	110	5	657.94	693	2100	0.33
1A110	E.T.O. ROOM	95	0.18	1	5	22.1	83	250	0.33
1A111	CART WASH	95	0.18			17.1	330	1000	0.33
1A112	STEAM STERILIZERS	137	0.18			24.66	530	1605	0.33
1A113	BARREL ROOM	43	0.18			7.74	33	100	0.33
1A114	VENDOR EQUIPMENT	291	0.12			34.92	76	230	0.33
1A115	HSKP	71	0.12			8.52	76	230	0.33
1A120	STORAGE	108	0.12			12.96	33	100	0.33
1A121	TOILET/SHOWER	72							
1A122	HOLDING	506	0.12	10	5	110.72	838	2540	0.33
1A123	FIRE ALARM PANELS	66	0.12	1	5	12.92	40	120	0.33
1A130	INSTRUMENT DECONTAM	955	0.18			171.9	574	1740	0.33
1A131	ELEV. MACHINE ROOM	188	0.12			22.56	162	490	0.33
1A200	TRASH/LINEN CHUTE	114	0.12			13.68	92	280	0.33
1A207	TOILET	65							
1A208	FACILITY STAFF ROOM	580	0.06	4	5	54.8	145	440	0.33
1A209	ELECTRICAL	184	0.06			11.04	106	320	0.33
1A210	STORAGE	143	0.12			17.16	43	130	0.33
1A211	STORAGE	338	0.12			40.56	76	230	0.33
1A212	ELEV. EQUIPMENT ROOM	143	0.12			17.16	89	270	0.33
1A213	SUMP ROOM	99	0.12			11.88	40	120	0.33
1A214	IT CLOSET	43	0.12			5.16	46	140	0.33
1A944	ELEVATOR LOBBY	785	0.06			47.1	277	840	0.33
1A945	PATIENT/SERVER ELEVATOR LOBBY	815	0.06			48.9	426	1290	0.33
1A948	CORRIDOR	1719	0.06			103.14	243	735	0.33
1A950	STORAGE	101	0.12			12.12	20	60	0.33
1A951	STORAGE	246	0.12			29.52	43	130	0.33
	TOTALS					**1,792**	**5,161**	**6,953**	

BUTLER MEMORIAL HOSPITAL

INPATIENT TOWER ADDITION & RENOVATION - SECOND FLOOR

AIR CHANGE SCHEDULE

ROOM NO.	ROOM NAME	ROOM DATA					OA CFM	SUPPLY CFM	OUTDOOR AIR
		AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz	ACTUAL	TOTAL	FRACTION
2A112	STORAGE	198	0.12			23.76	59	180	0.33
2A113	WOMEN'S	280							
2A114	HWKP	50	0.12			6	59	180	0.33
2A115	MEN'S	270							
2A116	COATS	238	0.12			28.56	59	180	0.33
2A119	SEATING	250	0.06	9	5	60	330	1000	0.33
2A120	CONTROL	53	0.06	1	5	8.18	25	75	0.33
2A121	TRAINING 'E'	753	0.06	38	7.5	330.18	594	1800	0.33
2A123	TRAINING 'A'	362	0.06	18	7.5	156.72	297	900	0.33
2A124	TRAINGING 'D'	388	0.06	19	7.5	165.78	297	900	0.33
2A126	FOYER	320	0.06			19.2	231	700	0.33
2A127	TRAINING 'B'	379	0.06	19	7.5	165.24	297	900	0.33
2A128	TRAINING 'C'	351	0.06	18	7.5	156.06	297	900	0.33
2A135	AUDITORIUM	3077	0.06	159	5	979.62	1434	4345	0.33
2A136	A/V ROOM/PREP	178	0.06	1	5	15.68	56	170	0.33
2A137	PANTRY	304	0.12	1	5	41.48	165	500	0.33
2A138	BOARD ROOM	1186	0.06	32	5	231.16	535	1620	0.33
2A140	CONFERENCE ROOM	463	0.06	16	5	107.78	353	1070	0.33
2A141	MEDICAL STAFF CONFERENCE ROOM	661	0.06	16	5	119.66	353	1070	0.33
2A142	MEN'S	214							
2A143	WOMEN'S	212							
2A201	ON CALL	98	0.06	1	5	10.88	33	100	0.33
2A202	PERF. OFFICE	86	0.06	1	5	10.16	33	100	0.33
2A203	STORAGE	95	0.12			11.4	33	100	0.33
2A204	CONFERENCE ROOM	372	0.06	16	5	102.32	248	750	0.33
2A205	SCRUB ALCOVE	102	0.06	1	5	11.12	33	100	0.33
2A208	ON CALL	98	0.06	1	5	10.88	33	100	0.33
2A209	ON CALL	98	0.06	1	5	10.88	33	100	0.33
2A210	TEAM LEADS	117	0.06	2	5	17.02	50	150	0.33
2A214	STAFF LOUNGE	405	0.06	4	5	44.3	185	560	0.33
2A215	CHART ROOM	120	0.06	1	5	12.2	50	150	0.33
2A216	PHYSICIAN LOUNGE	227	0.06	2	5	23.62	96	290	0.33
2A218	PRACTICE SPECIALIST	90	0.06	1	5	10.4	33	100	0.33
2A219	NURSE MGR PREP/RECOVERY	90	0.06	1	5	10.4	33	100	0.33
2A220	CRN/PAC	130	0.06	1	5	12.8	53	160	0.33
2A225	WOMEN'S LOCKER ROOM	822							
2A228	MEN'S LOCKER ROOM	822							
2A230	ELEC.	262	0.06			15.72	96	290	0.33
2A231	IT	141	0.06			8.46	69	210	0.33
2A232	LINEN/TRASH CHUTE	128	0.12			15.36	92	280	0.33
2A303	OFFICE	126	0.06	1	5	12.56	33	100	0.33
2A304	CHAPEL	870	0.06	16	5	132.2	475	1440	0.33
2A305	QUIET ROOM	150	0.06	3	5	24	66	200	0.33
2A306	PASTORAL CARE	80	0.06	1	5	9.8	33	100	0.33
2A307	PUBLIC ELEVATOR LOBBY	413	0.06			24.78	125	380	0.33
2A308	VELET	228	0.06	1	5	18.68	168	510	0.33
2A309	INFO	274	0.06	2	5	26.44	1188	3600	0.33
2A310	SEATING	638	0.06	12	5	98.28	1188	3600	0.33
2A314	RETAIL	1421	0.12	2	7.5	185.52	581	1760	0.33
2A315	COFFEE RETAIL AREA	142	0.12	1	7.5	24.54	56	170	0.33
2A316	WORKROOM	118	0.06	2	5	17.08	66	200	0.33
2A319	ED LOCKER ROOM	162					172	520	0.33
2A320	AUSTIN'S PLAYROOM	270	0.3	4		81	99	300	0.33
2A321	RESOURCE LIBRARY	327	0.12	4	5	59.24	116	350	0.33
2A322	CONSULT 1	66	0.06	1	5	8.96	36	110	0.33
2A323	CONSULT 2	132	0.06	1	5	12.92	40	120	0.33
2A324	CONSULT 3	125	0.06	1	5	12.5	50	150	0.33
2A325	CONSULT 4	165	0.06	1	5	14.9	53	160	0.33

2A330	SEATING	323	0.06	12	5	79.38	248	750	0.33
2A331	INTERVIEW 2	114	0.06	2	5	16.84	40	120	0.33
2A332	INTERVIEW 1	117	0.06	2	5	17.02	40	120	0.33
2A333	RECEP.	300	0.06	2	5	28	162	490	0.33
2A334	SEATING	1440	0.06	14	5	156.4	416	1260	0.33
2A335	SEATING	480	0.06	14	5	98.8	416	1260	0.33
2A901	CORRIDOR	639	0.06			38.34	198	600	0.33
2A905	GALLERY	1370	0.06			82.2	330	1000	0.33
2A910	CORRIDOR	860	0.06			51.6	300	910	0.33
2A911	CORRIDOR	690	0.06			41.4	165	500	0.33
2A912	CORRIDOR	960	0.06			57.6	165	500	0.33
2A918	PASSAGEWAY	73	0.06			4.38	40	120	0.33
2A919	PASSAGEWAY	655	0.06			39.3	58	175	0.33
2A920	PASSAGEWAY	654	0.06			39.24	107	325	0.33
2A930	CORRIDOR	739	0.06			44.34	205	620	0.33
2A932	PRE-FUNCTION	798	0.06			47.88	211	640	0.33
2A945	ELEVATOR LOBBY	737	0.06			44.22	139	420	0.33
2A948	LOBBY	1800	0.06			108	330	1000	0.33
2A949	LOBBY	2715	0.06			162.9	396	1200	0.33
2A950	ELEVATOR LOBBY	150	0.06			9	53	160	0.33
	TOTALS					**4,883**	**15,204**	**46,070**	

BUTLER MEMORIAL HOSPITAL

INPATIENT TOWER ADDITION & RENOVATION - THIRD FLOOR

AIR CHANGE SCHEDULE

ROOM NO.	ROOM NAME	ROOM DATA					DESIGN OA CFM	SUPPLY CFM	OUTDOOR AIR
		AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz	ACTUAL	TOTAL	FRACTION
3A100	ELEVATOR LOBBY	1316	0.06			78.96	792	2400	0.33
3A104	ELEC.	78	0.06			4.68	172	520	0.33
3A105	MENS TOILET	51							
3A106	WOMENS TOILET	51							
3A107	CONSULT 2	95	0.06	2	5	15.7	40	120	0.33
3A108	CONSULT 1	95	0.06	2	5	15.7	40	120	0.33
3A110	PERI-OP3	107	0.06	1	5	11.42	33	100	0.33
3A111	PAT. TLT	58							
3A112	STAFF TOILET	55							
3A113	CLEAN HOLDING	118	0.06			7.08	43	130	0.33
3A114	NOURISHMENT	90	0.06	1	5	10.4	66	200	0.33
3A115	CAREGIVER	490	0.06	1	5	34.4	172	520	0.33
3A116	PATIENT BELONGING STOR.	180	0.12			21.6	40	120	0.33
3A120	PAT. TLT	54							
3A121	STAFF LOUNGE/LOCKERS	271	0.06		5	16.26	116	350	0.33
3A123	STAFF TOILET	60							
3A125	STAFF TOILET	53							
3A129	HSKP	42							
3A130	PAT. TLT	53							
3A131	SOILED HOLDING	64							
3A132	IT ROOM	88	0.06			5.28	46	140	0.33
3A133	STAFF LOUNGE	101	0.06	2	5	16.06	36	110	0.33
3A134	CONTROL	150	0.06	2	5	19	66	200	0.33
3A135	PHYS. LOUNGE	382	0.06	4	5	42.92	172	520	0.33
3A136	ANESTH. LOUNGE	415	0.06	4	5	44.9	185	560	0.33
3A137	TRASH/LINEN CHUTE	129	0.06			7.74	260	260	1
3A150	PERI-OP 15	101	0.06	1	5	11.06	43	130	0.33
3A151	PERI-OP 16	113	0.06	1	5	11.78	43	130	0.33
3A152	PERI-OP 17	112	0.06	1	5	11.72	43	130	0.33
3A153	PERI-OP 18	112	0.06	1	5	11.72	43	130	0.33
3A154	PERI-OP 19	113	0.06	1	5	11.78	43	130	0.33
3A155	PERI-OP 20	112	0.06	1	5	11.72	43	130	0.33

3A156	PERI-OP 21	112	0.06	1	5	11.72	43	130	0.33
3A157	PERI-OP 22	112	0.06	1	5	11.72	43	130	0.33
3A158	PERI-OP 23	112	0.06	1	5	11.72	43	130	0.33
3A159	PERI-OP 24	112	0.06	1	5	11.72	43	130	0.33
3A160	PERI-OP 25	112	0.06	1	5	11.72	43	130	0.33
3A161	PERI-OP 26	112	0.06	1	5	11.72	43	130	0.33
3A162	PERI-OP 27 (SWING-PACU)	112	0.06	1	5	11.72	43	130	0.33
3A163	PAT. TLT	58							
3A165	PERI-OP 14	111	0.06	1	5	11.66	33	100	0.33
3A166	PERI-OP 13	109	0.06	1	5	11.54	33	100	0.33
3A167	PAT. TLT	51							
3A168	PERI-OP 12	110	0.06	1	5	11.6	33	100	0.33
3A169	PERI-OP 11	114	0.06	1	5	11.84	33	100	0.33
3A170	PERI-OP 10	116	0.06	1	5	11.96	33	100	0.33
3A174	PERI-OP 9	126	0.06	1	5	12.56	33	100	0.33
3A175	PERI-OP 8	126	0.06	1	5	12.56	33	100	0.33
3A176	PERI-OP 7	115	0.06	1	5	11.9	33	100	0.33
3A177	PAT. TLT	66							
3A178	PERI-OP 6	111	0.06	1	5	11.66	33	100	0.33
3A179	PERI-OP 5	110	0.06	1	5	11.6	33	100	0.33
3A180	PERI-OP 4	110	0.06	1	5	11.6	33	100	0.33
3A184	PAT. TLT	55							
3A185	PERI-OP 2	158	0.06	1	5	14.48	43	130	0.33
3A186	PERI-OP 1	158	0.06	1	5	14.48	43	130	0.33
3A202	CLEAN HOLDING	122	0.06			7.32	23	70	0.33
3A204	HSKP	50							
3A205	PACU ISO 15	120	0.06	1	5	12.2	73	220	0.33
3A206	PACU ISO 14	120	0.06	1	5	12.2	73	220	0.33
3A209	PACU 13	80	0.06	1	5	9.8	30	90	0.33
3A211	PACU 12	80	0.06	1	5	9.8	30	90	0.33
3A212	SOILED HOLDING	72	0.06			4.32	30	90	0.33
3A213	PACU 11	80	0.06	1	5	9.8	43	130	0.33
3A215	PACU 10	80	0.06	1	5	9.8	33	100	0.33
3A216	CAREGIVER	190	0.06	2	5	21.4	73	220	0.33
3A217	PACU 9	80	0.06	1	5	9.8	33	100	0.33
3A219	PACU 8	80	0.06	1	5	9.8	43	130	0.33
3A220	IV TEAM STATION	110	0.06	1	5	11.6	66	200	0.33
3A221	SOILED HOLDING	58							
3A222	EQUIPMENT ROOM	115	0.12			13.8	50	150	0.33
3A225	PACU ISO 1	118	0.06	1	5	12.08	73	220	0.33
3A227	PHYS. THERAPY	88	0.06	2	5	15.28	33	100	0.33
3A228	STORAGE	182	0.12			21.84	33	100	0.33
3A229	SPECIMEN ROOM	47	0.06	1	5	7.82	17	50	0.33
3A231	PACU 2	80	0.06	1	5	9.8	30	90	0.33
3A233	PACU 3	80	0.06	1	5	9.8	30	90	0.33
3A234	STAFF TOILET	56							
3A235	PHYS. DICT.	99	0.06	2	5	15.94	33	100	0.33
3A236	STORAGE	225	0.12			27	33	100	0.33
3A237	ELEC. ROOM	126	0.06			7.56	248	750	0.33
3A238	PACU 4	80	0.06	1	5	9.8	30	90	0.33
3A240	PACU 5	80	0.06	1	5	9.8	30	90	0.33
3A241	PACU 6	80	0.06	1	5	9.8	30	90	0.33
3A243	PACU 7	80	0.06	1	5	9.8	30	90	0.33
3A301	SOILED CART	123	0.12			14.76	59	180	0.33
3A302	HSKP	88	0.12			10.56	26	80	0.33
3A315	HSKP	68	0.12			8.16	17	50	0.33
3A320	ELEC.	129	0.12			15.48	172	520	0.33
3A321	STAFF TLT	51							
3A322	STAFF TLT	51							
3A323	PERFUSION SUPPLIES	123	0.12	1	5	19.76	33	100	0.33
3A335	EQUIPMENT	744	0.06			44.64	241	730	0.33
3A336	PLATE READER ROOM	52	0.06	1	5	8.12	33	100	0.33
3A340	ANESTH. WORK	320	0.18	2	10	77.6	142	430	0.33
3A341	CYSTO. ROOM	410	0.18	4	10	113.8	307	930	0.33
3A342	CYSTO. STORAGE	136	0.12			16.32	40	120	0.33
3A343	ENDO.	410	0.18	3	10	103.8	307	930	0.33

3A344	CLEANING STOR.	99	0.12			11.88	73	220	0.33
3A345	SCOPE DECONTAM.	198	0.12			23.76	106	320	0.33
3A348	STAFF TOILET	59							
3A349	SOILED HOLDING	74	0.12			8.88	26	80	0.33
3A350	HSKP	53							
3A906	CORRIDOR	665	0.06			39.9	145	440	0.33
3A908	PASSAGEWAY	431	0.06			25.86	79	240	0.33
3A910	CORRIDOR	1023	0.06			61.38	218	660	0.33
3A912	STRET/WHCHR. ALCOVE	149	0.06			8.94	26	80	0.33
3A914	CORRIDOR	319	0.06			19.14	66	200	0.33
3A920	CORRIDOR	1073	0.06			64.38	215	650	0.33
3A922	PASSAGEWAY	140	0.06			8.4	30	90	0.33
3A925	PASSAGEWAY	140	0.06			8.4	30	90	0.33
3A930	CORRIDOR	287	0.06			17.22	59	180	0.33
3A940	CORRIDOR	672	0.06			40.32	152	460	0.33
3A943	CORRIDOR	207	0.06			12.42	40	120	0.33
3A945	ELEVATOR LOBBY	419	0.06			25.14	248	750	0.33
3A946	HALLWAY	286	0.06			17.16	50	150	0.33
3A950	CORRIDOR	399	0.06			23.94	66	200	0.33
3A960	CORRIDOR	1748	0.06			104.88	680	2060	0.33
3A970	CORRIDOR	652	0.06			39.12	314	950	0.33
3A985	CORRIDOR	664	0.06			39.84	304	920	0.33
3A990	CORRIDOR	1312	0.06			78.72	607	1840	0.33
3B401	ANESTH. CHAIR	105	0.06	1	5	11.3	33	100	0.33
3B402	ANESTH. OFFICE	275	0.06	4	5	36.5	86	260	0.33
3B403	CLINICAL SUPERVISOR	105	0.06	1	5	11.3	33	100	0.33
3B404	CHIF CRNA	110	0.06	1	5	11.6	33	100	0.33
3B981	CORRIDOR	340	0.06			20.4	79	240	0.33
3B408	NURSE STATION	104	0.06	2	5	16.24	41	125	0.33
3B409	OR DIRECTOR	105	0.06	1	5	11.3	33	100	0.33
3B410	SCHEDULING OFFICE	111	0.06	1	5	11.66	36	110	0.33
3B414	STORAGE	289	0.12			34.68	89	270	0.33
	TOTALS					**2,249**	**9,898**	**29,465**	

BUTLER MEMORIAL HOSPITAL

INPATIENT TOWER ADDITION & RENOVATION - FIFTH FLOOR

AIR CHANGE SCHEDULE

		ROOM DATA					DESIGN OA CFM	SUPPLY CFM	OUTDOOR AIR
ROOM NO.	ROOM NAME	AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz	ACTUAL	TOTAL	FRACTION
5A100	ELEVATOR LOBBY	640	0.06	20	5	138.4	396	1200	0.33
5A100A	FAMILY WAITING	733	0.06	26	5	173.98	693	2100	0.33
5A101	ELEC.	126	0.06			7.56	257	780	0.33
5A102	WOMEN'S PUBLIC TOILET	68							
5A103	MEN'S PUBLIC TOILET	68							
5A104	CONSULT	115	0.06	1	5	11.9	33	100	0.33
5A105	WORKSTATION	179	0.06	2	5	20.74	76	230	0.33
5A110	DICTATION	70	0.06	1	5	9.2	33	100	0.33
5A111	FAX/PRINT	60	0.06	1		3.6	33	100	0.33
5A112	CLEAN HOLDING	138	0.06			8.28	50	150	0.33
5A113	HSK	52							
5A114	MEDICATION	131	0.06	1	5	12.86	36	110	0.33
5A116	R.T. VENT STORAGE	199	0.12			23.88	106	320	0.33
5A117	WORKSTATION	142	0.06	3	5	23.52	79	240	0.33
5A118	COPY	83	0.06	1	5	9.98	50	150	0.33
5A119	DICTATION	116	0.06	1	5	11.96	33	100	0.33
5A120	POC WORKROOM	48	0.06	1	5	7.88	33	100	0.33
5A125	INTENSIVIST OFFICE	99	0.06	1	5	10.94	33	100	0.33
5A126	CV SURGEONS OFFICE	103	0.06	1	5	11.18	33	100	0.33
5A127	MEDICATION	138	0.06	1	5	13.28	36	110	0.33
5A128	CLEAN HOLDING	193	0.06			11.58	63	190	0.33
5A129	HSK	45							
5A131	STAFF TOILET	60							

5A131	STAFF TOILET	60							
5A136	FAX/PRINT	61	0.06	1	5	8.66	33	100	0.33
5A137	DICTATION	79	0.06	1	5	9.74	33	100	0.33
5A138	ELEC.	120	0.06			7.2	172	520	0.33
5A139	WORKSTATION	78	0.06	3	5	19.68	79	240	0.33
5A142	STAFF TOILET	48							
5A143	STAFF LOCKER	233							
5A144	STAFF BREAK	224	0.06	6	5	43.44	178	540	0.33
5A145	TRASH & LINEN CHUTE	124	0.06			7.44	56	170	0.33
5A147	CLEAN EQUIPMENT	466	0.06			27.96	165	500	0.33
5A151	STAFF CONFERENCE	313	0.06	3	5	33.78	79	240	0.33
5A152	R.T. OFFICE	67	0.06	1	5	9.02	79	240	0.33
5A153	SOILED HOLDING	158	0.12			18.96	40	120	0.33
5A154	NOURISHMENT	104	0.06	1	5	11.24	79	240	0.33
5A155	I.T.	178	0.06			10.68	56	170	0.33
5A157	HOTEL OFFICE	61	0.06	1	5	8.66	33	100	0.33
5A158	OFFICE	90	0.06	1	5	10.4	33	100	0.33
5A159	OFFICE	76	0.06	1	5	9.56	33	100	0.33
5A160	OFFICE	138	0.06	1	5	13.28	33	100	0.33
5A201	CCU PATIENT ROOM	225	0.06	2	5	23.5	92	280	0.33
5A201a	TLT	54							
5A202	CCU PATIENT ROOM	235	0.06	2	5	24.1	92	280	0.33
5A202a	TLT	54							
5203	CCU PATIENT ROOM	249	0.06	2	5	24.94	92	280	0.33
5A203a	TLT	54							
5A204	CCU PATIENT ROOM	248	0.06	2	5	24.88	92	280	0.33
5A204a	TLT	54							
5A205	CCU PATIENT ROOM	248	0.06	2	5	24.88	92	280	0.33
5A205a	TLT	54							
5A206	CCU PATIENT ROOM	248	0.06	2	5	24.88	92	280	0.33
5A206a	TLT	54							
5A207	CCU PATIENT ROOM	259	0.06	2	5	25.54	92	280	0.33
5A207a	TLT	54							
5A208	CCU PATIENT ROOM	248	0.06	2	5	24.88	92	280	0.33
5A208a	TLT	54							
5A209	CCU PATIENT ROOM	250	0.06	2	5	25	92	280	0.33
5A209a	TLT	54							
5A210	CCU PATIENT ROOM	262	0.06	2	5	25.72	92	280	0.33
5A210a	TLT	54							
5A211	CCU PATIENT ROOM (ISOLATI	248	0.06	2	5	24.88	122	370	0.33
5A211a	TLT	54							
5A212	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A212a	TLT	54							
5A213	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A213a	TLT	54							
5A214	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A214a	TLT	54							
5A215	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A215a	TLT	54							
5A216	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A216a	TLT	54							
5A217	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A217a	TLT	54							
5A218	CCU PATIENT ROOM	232	0.06	2	5	23.92	86	260	0.33
5A218a	TLT	54							
5A219	CCU PATIENT ROOM	273	0.06	2	5	26.38	86	260	0.33
5A219a	TLT	54							
5A220	ANTE-ROOM	37	0.06			2.22	26	80	0.33
5A224	ANTE-ROOM	90	0.06			5.4	33	100	0.33
5A225	CCU (ISOLATION) ROOM	226	0.06	2	5	23.56	122	370	0.33
5A225a	TLT	54							
5A226	CCU PATIENT ROOM	210	0.06	2	5	22.6	79	240	0.33
5A226a	TLT	54							
5A227	CCU PATIENT ROOM	210	0.06	2	5	22.6	79	240	0.33
5A227a	TLT	54							
5A228	CCU PATIENT ROOM	210	0.06	2	5	22.6	79	240	0.33

5A229	CCU PATIENT ROOM	210	0.06	2	5	22.6	79	240	0.33
5A229a	TLT	54							
5A904	CORRIDOR	124	0.06			7.44	33	100	0.33
5A905	CORRIDOR	285	0.06			17.1	89	270	0.33
5A908	PASSAGE	215	0.06			12.9	66	200	0.33
5A909	WHEELCHAIR/STRETCHER	148	0.06			8.88	33	100	0.33
5A910	CORRIDOR	669	0.06			40.14	178	540	0.33
5A920	CORRIDOR	977	0.06			58.62	165	500	0.33
5A932	PASSAGE	132	0.06			7.92	26	80	0.33
5A934	PASSAGE	177	0.06			10.62	26	80	0.33
5A935	WHEELCHAIR/STRETCHER	158	0.06			9.48	33	100	0.33
5A937	WORKSTATION	145	0.06	3	5	23.7	79	240	0.33
5A940	CORRIDOR	1042	0.06			62.52	277	840	0.33
5A944	PATIENT/SERVICE ELEVATOR	325	0.06			19.5	234	710	0.33
5A945	ELEVATOR LOBBY	330	0.06			19.8	86	260	0.33
5A947	CORRIDOR	1021	0.06			61.26	125	380	0.33
5A950	CORRIDOR	700	0.06			42	172	520	0.33
	TOTALS					**1,751**	**7,108**	**21,540**	

BUTLER MEMORIAL HOSPITAL

INPATIENT TOWER ADDITION & RENOVATION - SIXTH FLOOR

AIR CHANGE SCHEDULE

ROOM NO.	ROOM NAME	ROOM DATA					DESIGN OA CFM ACTUAL	SUPPLY CFM TOTAL	OUTDOOR AIR FRACTION
		AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz			
6A100	ELEVATOR LOBBY	640	0.06	20	5	138.4	396	1200	0.33
6A100A	FAMILY WAITING	733	0.06	26	5	173.98	693	2100	0.33
6A101	ELEC.	126	0.06			7.56	257	780	0.33
6A102	WOMEN'S PUBLIC TOILET	68							
6A103	MEN'S PUBLIC TOILET	68							
6A104	CONSULT	115	0.06	1	5	11.9	33	100	0.33
6A105	WORKSTATION	179	0.06	2	5	20.74	76	230	0.33
6A110	DICTATION	70	0.06	1	5	9.2	33	100	0.33
6A111	FAX/PRINT	60	0.06	1	5	8.6	33	100	0.33
6A112	CLEAN HOLDING	138	0.06	0		8.28	50	150	0.33
6A113	STAFF TOILET	52							
6A114	MEDICATION ROOM	131	0.06	1	5	12.86	36	110	0.33
6A116	EQUIPMENT	199	0.06	1	5	16.94	50	150	0.33
6A117	WORKSTATION	142	0.06	2	5	18.52	79	240	0.33
6A118	MONITOR WORKROOM	65	0.06	2	5	13.9	50	150	0.33
6A119	DICTATION	72	0.06	1	5	9.32	50	150	0.33
6A120	COPY	101	0.06	1	5	11.06	33	100	0.33
6A125	HOTELING OFFICE	138	0.06	1	5	13.28	33	100	0.33
6A126	HSK	111							
6A127	MEDICATION	122	0.06	1	5	12.32	36	110	0.33
6A128	CLEAN HOLDING	174	0.06			10.44	63	190	0.33
6A135	STAFF TOILET	80							
6A136	FAX/PRINT	61	0.06	1	5	8.66	33	100	0.33
6A137	DICTATION	79	0.06	1	5	9.74	33	100	0.33
6A138	ELEC.	120	0.06			7.2	172	520	0.33
6A140	OFFICE	91	0.06	1	5	10.46	33	100	0.33
6A141	OFFICE	88	0.06	1	5	10.28	33	100	0.33
6A142	STAFF CONFERENCE	247	0.06	6	5	44.82	158	480	0.33
6A143	STAFF LOCKER	233	0.06			13.98	73	220	0.33
6A144	STAFF BREAK	224	0.06	4	5	33.44	178	540	0.33
6A146	TRASH & LINEN CHUTE	124	0.06			7.44	112	340	0.33
6A149	POC WORKROOM	69	0.06	1	5	9.14	33	100	0.33

6A150	SOILED HOLDING	148	0.06			8.88	112	340	0.33
6A151	NOURISHMENT	104	0.06	1	5	11.24	79	240	0.33
6A152	I.T.	179	0.06			10.74	53	160	0.33
6A201	MED/SURG	225	0.06	2	5	23.5	96	290	0.33
6A201a	TLT	54							
5A202	MED/SURG	235	0.06	2	5	24.1	99	300	0.33
6A202a	TLT	54							
6A203	MED/SURG	249	0.06	2	5	24.94	102	310	0.33
6A203a	TLT	54							
6A204	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
6A204a	TLT	54							
6A205	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
6A205a	TLT	54							
6A206	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
6A206a	TLT	54							
6A207	MED/SURG	259	0.06	2	5	25.54	102	310	0.33
6A207a	TLT	54							
6A208	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
6A208a	TLT	54							
6A209	MED/SURG	250	0.06	2	5	25	102	310	0.33
6A209a	TLT	54							
6A210	MED/SURG	262	0.06	2	5	25.72	109	330	0.33
6A210a	TLT	54							
6A211	MED/SURG	248	0.06	2	5	24.88	116	350	0.33
6A211a	TLT	54							
6A212	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A212a	TLT	54							
6A213	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A213a	TLT	54							
6A214	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A214a	TLT	54							
6A215	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A215a	TLT	54							
6A216	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A216a	TLT	54							
6A217	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A217a	TLT	54							
6A218	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
6A218a	TLT	54							
6A225	MED/SURG	226	0.06	2	5	23.56	96	290	0.33
6A225a	TLT	54							
6A226	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
6A226a	TLT	54							
6A227	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
6A227a	TLT	54							
6A228	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
6A228a	TLT	54							
6A229	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
6A229a	TLT	54							
6A231	ANTE-ROOM	105	0.06			6.3	33	100	0.33
6A232	MED/SURG (ISOLATION)	248	0.06	2	5	24.88	122	370	0.33
6A232a	TLT	36							
6A233	ANTE-ROOM	105	0.06			6.3	33	100	0.33
6A234	MED/SURG (ISOLATION)	248	0.06	2	5	24.88	122	370	0.33
6A234a	TLT	36							
6A235	ANTE-ROOM	105	0.06			6.3	33	100	0.33
6A236	MED/SURG (ISOLATION)	248	0.06	2	5	24.88	122	370	0.33
6A236a	TLT	36							
6A905	CORRIDOR	285	0.06			17.1	89	270	0.33
6A908	PASSAGE	215	0.06			12.9	66	200	0.33
6A909	WHEELCHAIR/STRETCHER	148	0.06			8.88	33	100	0.33
6A910	CORRIDOR	669	0.06			40.14	178	540	0.33
6A920	CORRIDOR	977	0.06			58.62	165	500	0.33
6A932	PASSAGE	132	0.06			7.92	26	80	0.33
6A935	WHEELCHAIR/STRETCHER	158	0.06			9.48	33	100	0.33

6A937	WORKSTATION	128	0.06	2	5	17.68	79	240	0.33
6A940	CORRIDOR	1042	0.06			62.52	277	840	0.33
6A944	PATIENT/SERVICE ELV LOBBY	325	0.06			19.5	234	710	0.33
6A945	ELEVATOR LOBBY	330	0.06			19.8	86	260	0.33
6A947	CORRIDOR	1021	0.06			61.26	172	520	0.33
6A950	CORRIDOR	700	0.06			42	172	520	0.33
	TOTALS					**1,709**	**7,587**	**22,990**	

BUTLER MEMORIAL HOSPITAL

INPATIENT TOWER ADDITION & RENOVATION - SEVENTH FLOOR

AIR CHANGE SCHEDULE

ROOM NO.	ROOM NAME	ROOM DATA					DESIGN OA CFM ACTUAL	SUPPLY CFM TOTAL	OUTDOOR AIR FRACTION
		AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz			
7A100	ELEVATOR LOBBY	640	0.06	20	5	138.4	396	1200	0.33
7A100A	FAMILY WAITING	733	0.06	26	5	173.98	693	2100	0.33
7A101	ELEC.	126	0.06			7.56	257	780	0.33
7A102	WOMEN'S PUBLIC TOILET	68							
7A103	MEN'S PUBLIC TOILET	68							
7A104	CONSULT	115	0.06	1	5	11.9	33	100	0.33
7A105	WORKSTATION	179	0.06	2	5	20.74	76	230	0.33
7A110	DICTATION	70	0.06	1	5	9.2	33	100	0.33
7A111	FAX/PRINT	60	0.06	1	5	8.6	33	100	0.33
7A112	CLEAN HOLDING	138	0.06			8.28	50	150	0.33
7A113	STAFF TOILET	52							
7A114	MEDICATION ROOM	131	0.06	1	5	12.86	36	110	0.33
7A116	EQUIPMENT	199	0.06	1	5	16.94	50	150	0.33
7A117	WORKSTATION	142	0.06	2	5	18.52	79	240	0.33
7A118	MONITOR WORKROOM	65	0.06	2	5	13.9	50	150	0.33
7A119	DICTATION	72	0.06	1	5	9.32	50	150	0.33
7A120	COPY	101	0.06	1	5	11.06	33	100	0.33
7A125	HOTELING OFFICE	138	0.06	1	5	13.28	33	100	0.33
7A126	HSK	111							
7A127	MEDICATION	122	0.06	1	5	12.32	36	110	0.33
7A128	CLEAN HOLDING	174	0.06			10.44	63	190	0.33
7A135	STAFF TOILET	80							
7A136	FAX/PRINT	61	0.06	1	5	8.66	33	100	0.33
7A137	DICTATION	79	0.06	1	5	9.74	33	100	0.33
7A138	ELEC.	120	0.06			7.2	172	520	0.33
7A140	OFFICE	91	0.06	1	5	10.46	33	100	0.33
7A141	OFFICE	88	0.06	1	5	10.28	33	100	0.33
7A142	STAFF CONFERENCE	247	0.06	6	5	44.82	158	480	0.33
7A143	STAFF LOCKER	233	0.06			13.98	73	220	0.33
7A144	STAFF BREAK	224	0.06	4	5	33.44	178	540	0.33
7A146	TRASH & LINEN CHUTE	124	0.06			7.44	112	340	0.33
7A149	POC WORKROOM	69	0.06	1	5	9.14	33	100	0.33
7A150	SOILED HOLDING	148	0.06			8.88	112	340	0.33
7A151	NOURISHMENT	104	0.06	1	5	11.24	79	240	0.33
7A152	I.T.	179	0.06			10.74	53	160	0.33
7A201	MED/SURG	225	0.06	2	5	23.5	96	290	0.33
7A201a	TLT	54							
7A202	MED/SURG	235	0.06	2	5	24.1	99	300	0.33
7A202a	TLT	54							
7A203	MED/SURG	249	0.06	2	5	24.94	102	310	0.33
7A203a	TLT	54							
7A204	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
7A204a	TLT	54							
7A205	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
7A205a	TLT	54							

7A206	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
7A206a	TLT	54							
7A207	MED/SURG	259	0.06	2	5	25.54	102	310	0.33
7A207a	TLT	54							
7A208	MED/SURG	248	0.06	2	5	24.88	102	310	0.33
7A208a	TLT	54							
7A209	MED/SURG	250	0.06	2	5	25	102	310	0.33
7A209a	TLT	54							
7A210	MED/SURG	262	0.06	2	5	25.72	109	330	0.33
7A210a	TLT	54							
7A211	MED/SURG	248	0.06	2	5	24.88	116	350	0.33
7A211a	TLT	54							
7A212	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A212a	TLT	54							
7A213	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A213a	TLT	54							
7A214	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A214a	TLT	54							
7A215	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A215a	TLT	54							
7A216	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A216a	TLT	54							
7A217	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A217a	TLT	54							
7A218	MED/SURG	232	0.06	2	5	23.92	116	350	0.33
7A218a	TLT	54							
7A225	MED/SURG	226	0.06	2	5	23.56	96	290	0.33
7A225a	TLT	54							
7A226	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
7A226a	TLT	54							
7A227	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
7A227a	TLT	54							
7A228	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
7A228a	TLT	54							
7A229	MED/SURG	210	0.06	2	5	22.6	92	280	0.33
7A229a	TLT	54							
7A231	ANTE-ROOM	105	0.06			6.3	33	100	0.33
7A232	MED/SURG (ISOLATION)	248	0.06	2	5	24.88	122	370	0.33
7A232a	TLT	36							
7A233	ANTE-ROOM	105	0.06			6.3	33	100	0.33
7A234	MED/SURG (ISOLATION)	248	0.06	2	5	24.88	122	370	0.33
7A234a	TLT	36							
7A235	ANTE-ROOM	105	0.06			6.3	33	100	0.33
7A236	MED/SURG (ISOLATION)	248	0.06	2	5	24.88	122	370	0.33
7A236a	TLT	36							
7A905	CORRIDOR	285	0.06			17.1	89	270	0.33
7A908	PASSAGE	215	0.06			12.9	66	200	0.33
7A909	WHEELCHAIR/STRETCHER	148	0.06			8.88	33	100	0.33
7A910	CORRIDOR	669	0.06			40.14	178	540	0.33
7A920	CORRIDOR	977	0.06			58.62	165	500	0.33
7A932	PASSAGE	132	0.06			7.92	26	80	0.33
7A935	WHEELCHAIR/STRETCHER	158	0.06			9.48	33	100	0.33
67A937	WORKSTATION	128	0.06	2	5	17.68	79	240	0.33
7A940	CORRIDOR	1042	0.06			62.52	277	840	0.33
7A944	PATIENT/SERVICE EL LOBBY	325	0.06			19.5	234	710	0.33
7A945	ELEVATOR LOBBY	330	0.06			19.8	86	260	0.33
7A947	CORRIDOR	1021	0.06			61.26	172	520	0.33
7A950	CORRIDOR	700	0.06			42	172	520	0.33
	TOTALS					**1,709**	**7,587**	**22,990**	

APPENDIX C

Supplemental Ventilation Tables AHU-4 & 5

BUTLER MEMORIAL HOSPITAL

INPATIENT TOWER ADDITION & RENOVATION - THIRD FLOOR OPERATING ROOMS

AIR CHANGE SCHEDULE (AHU-4 & 5)

		ROOM DATA					DESIGN OA CFM	SUPPLY CFM	OUTDOOR AIR
ROOM NO.	ROOM NAME	AREA (Az)	Ra	PPL (Zp)	Rp	Vbz=Voz	ACTUAL	TOTAL	FRACTION
3A304	OR 10 FLUORO	647	0.18	8	10	196.46	950	2880	0.33
3A305	SUB STERILE	110	0.18	2	10	39.8	69	210	0.33
3A306	MED. ROOM	53	0.18	1	5	14.54	102	310	0.33
3A310	OR 9	691	0.18	8	10	204.38	950	2880	0.33
3A311	OR 8	665	0.18	8	10	199.7	950	2880	0.33
3A312	SUB STERILE	110	0.18	2	10	39.8	69	210	0.33
3A313	OR 7	691	0.18	8	10	204.38	950	2880	0.33
3A317	STERILE CORE	1627	0.18	10	10	392.86	891	2700	0.33
3A325	OR 6 (CARDIAC)	733	0.18	8	10	211.94	1003	3040	0.33
3A326	PERFUSION	242	0.18	2	10	63.56	323	980	0.33
3A330	SUB STERILE	123	0.18	2	10	42.14	73	220	0.33
3A331	OR 5 (CARDIAC)	719	0.18	8	10	209.42	1003	3040	0.33
3A332	OR 4 (ORTHO)	741	0.18	10	10	233.38	1244	3770	0.33
3A333	SUB STERILE	114	0.18	2	10	40.52	69	210	0.33
3A334	OR 3 (NERURO)	746	0.18	8	10	214.28	1033	3130	0.33
	TOTALS					**2,307**	**9,682**	**29,340**	