

# Walter Reed National Military Medical Center Bethesda, MD

## **Technical Report Two:** Building and Central Plant Energy Analysis

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## Executive Summary:

Energy consumption and environmental pollutants from commercial buildings are becoming more important in the measure of how successful a buildings HVAC system performs. In order to quantify these values before the building is constructed the design engineer should create and analyze an energy model which represents the proposed HVAC system. Once an energy model is created it can not only be used for energy consumption it can also be used to calculate the annual building utility bills. Energy models can play an important role in the design phase when they are used to compare and contrast different system options and to see how different equipment set points affect the whole HVAC system design.

There are many different metrics on how to quantify a buildings proposed system energy savings such as comparing it against ASHRAE Standard 90.1 baseline models, or against the Commercial Building Energy Consumption Survey report. The program that was used to calculate the plant load data as well as the yearly energy consumption was Trane TRACE 700. The data inputs were taken from the building design documents as well as other information provided by the engineer.

After creating a block load energy model for both Building A and B, the resulting total annual energy consumption for heating and cooling loads of 74,010 MMBtu/year was calculated. This block load energy consumption that was calculated is within 7% of the energy consumption determined by the design engineer. The total utility cost that was computed for the consumed electricity and purchased steam is \$1,674,300 or \$2.80/sf. This yearly utility cost is under the average utility cost for buildings of this type by \$0.36/sf which results in a yearly utility savings of \$215,000. Knowing the characteristics of a buildings utility usage can provide insight into areas of improvement within the mechanical system to provide reduced energy consumption and source emissions.

## 1.0 Mechanical System Summary

Both Buildings A and B are served from a 100% dedicated outdoor air system (DOAS) which is supplied at a constant volume to the occupied zone. Building A has eight AHU's and Building B has three AHU's which are all rated at 50,000 cfm and located in each respective buildings basement mechanical space. Due to the large amount of energy consumption that is associated with having a DOAS system, eleven total energy wheels were installed in custom duct housings in order to offset some of the energy spent on cooling and dehumidifying such a large quantity of outdoor air. Building A also houses a rehabilitation pool which is served by a dedicated packaged air handler in order to better control the space conditions due to the pools large latent load.

Chilled water for both buildings is produced by three 1,000 ton water cooled centrifugal chillers which are located in the basement mechanical space of Building A. A 180 ton and a 250 ton heat recovery chiller are located in the basement of Building A and B respectively. These heat recovery chillers are able to reduce some of the heating hot water energy consumed by recovering heat from the chillers exiting condenser water stream and using it to heat water. Condenser water is piped to the adjacent patient parking structure where three 1,000 ton induced draft cooling towers with counter flow fan arrangements are located. No boilers have been installed in either building due to the existing campus steam generation plant which supplies both buildings with 125 psig steam. This high pressure steam is reduced to either 75 psig or 15 psig and is supplied to either a humidification steam generator or fed to heat exchangers for heating hot water and domestic hot water needs. Two pipe fan coils are used throughout both buildings to condition electrical and telecommunication closets.

## 2.0 System Design Load Estimation

Trane TRACE 700 Version 6.2 was used to determine the design load energy consumption of Walter Reed National Military Medical Center (WRNMMC) located in Bethesda, Maryland. TRACE was used for this energy analysis due to the relative ease of system inputs and user knowledge. A full 8,760 hour energy analysis was performed to determine the peak design heating and cooling loads of the system and also the date of their occurrence.

### 2.1 Block Load Assumptions

A block load analysis as opposed to a full space by space analysis was performed for this assignment. The advantages of using a block analysis for a building of this size is that the model calculation time is greatly reduced, the model file sizes are more manageable, and results are still accurate within reason. The information that was used to generate the block load model was taken directly from the design documents and other related engineering documents to determine things such as room areas, equipment characteristics, and building construction materials. Some of the assumptions that were made during the creation of this block model are listed below.

- 1) The exterior shell of the building was modeled as having a uniform wall construction as opposed to modeling the precast and Centria panels as separate pieces which is detailed in Section 2.4.

- 2) The exam room lighting and miscellaneous load values are used to represent a wide variety of rooms such as operating rooms, exam rooms, CT scan rooms, and Radiology rooms. All of these room types have widely varying internal loads as well as air change requirements. The loads in Table 3 are assumed to apply to all spaces under the occupancies listed.
- 3) Washington D.C. weather information was used

## 2.2 Weather Data

The weather data from the ASHRAE Handbook of Fundamentals (HOF) for Washington D.C. was used in this load analysis due to its close proximity to Bethesda. Tables 1 and 2 below show the design heating and cooling weather data that was used for this calculation. The most stringent of the design values given in TRACE or the HOF for Washington D.C. were used in this analysis and are highlighted in the tables below.

	Summer		
	Indoor Design (°F)	Outdoor Design 0.4% (°F)	TRACE 700 Default (°F)
Office	75	94.5	93.2
Exam	75		

Table 1 - Summer Design Weather Conditions

	Winter		
	Indoor Design (°F)	Outdoor Design 99.6% (°F)	TRACE 700 Default (°F)
Office	68	15.9	9.6
Exam	73		

Table 2 - Winter Design Weather Conditions

## 2.3 Miscellaneous and Lighting Loads

The lighting power densities and the miscellaneous equipment loads that were used in this calculation are shown in Table 3 below. Even though the minimum air change rate that is defined by the Unified Facilities Criteria rarely determines the ventilation rate supplied to the space, these values that were entered into the TRACE model are listed in Table 3 as well. All of the values that are listed in Table 3 have been used in the creation of room templates that were used in the energy model. The typical room templates that were used in the construction of this model for each specific room occupancy type are shown in Appendix A.

In order to provide an accurate representation for the building load conditions schedules were made for the occupancy, lighting, and miscellaneous loads. Some of these schedules were taken from ASHRAE data that is loaded within TRACE as well as schedules that were developed by the design engineer. The schedules that were used in the load model are shown in Appendix B.

Room Type	Lighting Load (W/sf)	Miscellaneous Load (W/sf)	People (ft <sup>2</sup> /person)	Minimum Air Changes Per Hour
Conference	0.7	1	20	6
Corridor	0.6	0.25	0	4
Electrical/Communications	0.55	10	0	-
Exam	1.15	3	60	5
Mechanical	0.55	10	0	-
Office	0.75	1	120	4
Patient Bedroom	0.75	0.5	100	12
Utility	0.6	0.25	0	4

Table 3 - Internal and Lighting Loads

## 2.4 Exterior Wall Construction

The actual exterior wall construction of the building consists of a composite of precast concrete panels along with metal Centria panels which are located above the glazing in order to mimic the historic facade. This composite facade was modeled as a single entity with a thermal resistance and density that is shown in Table 4. The weighting factors used were determined from taking area averages of both exterior components in order to get an accurate composite wall representation.

	Actual Installed Values			Composite Weighted Average	
	Weighting Factors	U-Value	Density (lb/ft <sup>3</sup> )	U-Value	Density (lb/ft <sup>3</sup> )
Centria Panel	23%	0.05	42.5	0.05847	157.62
Precast Concrete Panel	77%	0.061	192		

Table 4 - Installed vs. Modeled Wall Construction

## 2.5 System Load Analysis Results

Table 5 details cooling, heating, and ventilation check values that are compared to the actual designed system check values. The block load energy model resulted in values for each category that were larger than the actual design values. One of the reasons that these values differ is due to the simplifying room assumptions that were made for the block load energy model. The amount of equipment that is in each room in a hospital varies greatly with the medical task at hand. Even though rooms may be classified under the same occupancy the specific equipment within each space varies significantly. Very detailed information for each individual room must be known and modeled precisely in order to get the most accurate model of the buildings heating and cooling loads. With all of the simplifying assumptions that were made for this block load model the results still give a reasonably accurate representation of the loads that were used for actual system design.

	Cooling (ft <sup>2</sup> /ton)	Heating (Btuh/ft <sup>2</sup> )	Supply and Ventilation Air (cfm/ft <sup>2</sup> )
Building A	212.65	30.77	0.81
Building A Designed	242.34	20.81	0.78
Building B	190.43	40.44	0.93
Building B Designed	224.29	32.93	0.79

Table 5 - Block Load vs. Design Loads and Ventilation

### 3.0 System Energy Consumption and Operating Cost

The full year energy simulation was calculated using the same TRACE model that was used to determine the building design cooling and heating loads. The cooling equipment in both buildings uses electricity to operate while the heating equipment uses district steam that is purchased from the campus steam generation plant. The district steam plant places a charge on all of the buildings on campus that use steam and then uses that revenue to pay for their fuel, equipment maintenance, and personnel costs.

#### 3.1 Load Sources

There are many things within all commercial buildings that contribute to the overall net heat gain within occupied spaces. A large increase in building plant cooling capacity in recent years can be attributed to the increasing demand and utilization of computers with higher processing power. With WRNMMC housing medical offices as well as exam and operating rooms some of the loads described in the sections below will be unique to this occupancy classification.

##### 3.1.1 Equipment

There have been many recent advances in medical procedures and to the equipment that is used during these high tech operations due to many new breakthroughs in science and medicine. Usually with the more technology that is put within a piece of equipment the heat output increases due to a larger internal processor. A few examples of the medical equipment that is used within the facility are linear accelerators, MRI machines, and EKG machines. A fair portion of Building A is also dedicated for medical staff offices which all have been assumed to have personal computers within them. Computers are also being placed in nurse stations as well as team meeting and conference spaces throughout both buildings.

##### 3.1.2 Lighting

With improvements in lighting fixtures, the cooling load attributed to this building component has reduced greatly from what it has been in the past. However, the lighting load within a hospital building still contributes a fair amount of net heat gain due to the large amount of dedicated medical task lighting that is needed for precise medical procedures. These dedicated light fixtures are not on all the time but they still will add to the heat gain within operating and other exam rooms. The lighting heat gain percentage is also greater than other building types due to having a 24 hour building operation.

##### 3.1.3 People

The occupancy of these buildings is going to fluctuate greatly throughout the day with patient transfers, visitors, and medical staff changeovers. The design occupancies have had schedules applied to them for the percentage of the total amount of people that are assumed to be within the buildings during certain hours. The heat generation from building occupants varies widely due to different metabolic activity levels such as patient recovery, office spaces, exam rooms, and rehabilitation exercise areas which are all present in this facility.



### 3.1.4 Infiltration

Both new buildings have been designed to maintain a total building pressurization in order to prevent unconditioned air from entering building spaces. All rooms with exterior walls have been assumed to have a pressurization leakage from the occupied space to the outdoors of 0.06 cfm/sf of exterior wall. Maintaining building pressurization by having air leak out through the building envelope helps to reduce heating or cooling load associated with unconditioned air entering occupied spaces through walls or windows.

### 3.1.5 Air Change Requirements

The Unified Facilities Criteria (UFC) that was required to be followed as per the RFP stated minimum air change requirements for all of the different room templates used. These minimum air change requirements were set forth in order to ensure adequate ventilation and reduce the spread of infectious disease throughout the building. Due to the high internal heat load within the spaces the minimum air change requirements rarely determined the ventilation air flow. But when the ventilation air flow was increased due to this requirement the total load increased from having to condition a greater volume outside air.

## 3.2 System Energy Breakdown

The category that consumes the largest amount of electricity in the HVAC system is the complete cooling system. While the chilled water system alone consumes only 11.8% of the total energy when the supply fans and auxiliary pumps are added in the percentage jumps to 40.7% of the buildings yearly energy consumption as shown in Figure 1. The reason that the supply fans for the building consume such a large portion of energy is that they are centrally located in the basement mechanical rooms and must supply such a large volume of air all the way to the top floor of each building. Also, the fans must overcome a large pressure drop to push the air through the total energy wheels. This large fan energy consumption may be an area of redesign that will be looked into for the next part of the report process. The annual energy consumption is listed in Table 6 which breaks out the energy usage from separate parts of the HVAC system.

	Electric Consumption (kBtu)	Purchased Steam Consumption (kBtu)	Total Energy (%)
<b>Heating System</b>			
Primary Heating	201633	17549639	24.1%
Other Heating Accessories	135914		
<b>Cooling System</b>			
Cooling Compressor	7630846		11.8%
Tower/Condenser Fans	309668		
Condenser Pump	329183		
Other Cooling Accessories	494270		
<b>Auxiliary</b>			
Supply Fans	21211686		64.1%
Pumps	176214		
Stand-Alone Base Utilities	1404271		
Lighting	5883387		
Receptacles	18683448		

Table 6 - System Component Energy Consumption

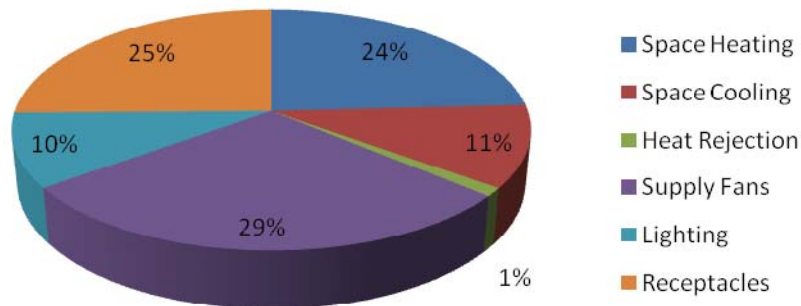


Figure 1 - System Component Energy Consumption

### 3.3 Building Energy Costs

The utility rates that WRNMMC is charged for electricity and purchased steam are shown in Tables 7 through 9. These rates were manually entered into the TRACE model in the form of utility schedules so that the energy consumption could be calculated during the yearly energy simulation. The electricity rates shown are from Pepco and the purchased steam rates for the campus steam plant were stated in the RFP for the project.

	January-May	June-December
Electric Consumption On Peak (\$/kWh)	0.051	0.053
Electric Consumption Mid Peak (\$/kWh)	0.048	0.048
Electric Consumption Off Peak (\$/kWh)	0.043	0.043

Table 7 - Electric Consumption Utility Rates

	January-May	June-October	November-December
Electric Demand (\$/kW)	6.741	8.551	6.741

Table 8 - Electric Demand Utility Rates

	January-December
Purchased Steam (\$/therm)	2.985

Table 9 - Purchased Steam Utility Rates

The total energy consumption from purchased steam and electricity are shown together in Figure 2 for each month during the year. As thought, the electricity peaks through the summer due to the need for the chillers to run near their peak in order to provide the cooling capacity required to keep the building within the space set points. The purchased steam consumption peaks through the winter months when the steam usage is highest due to the large demand on the steam to water heat exchangers. The electric consumption is still a significant portion of the total energy usage throughout the winter due to the high miscellaneous loads from hospital equipment that are relatively constant year round. This constant base cooling load may be further investigated during later parts of this project as an area to utilize base loaded chillers or another energy saving measure.

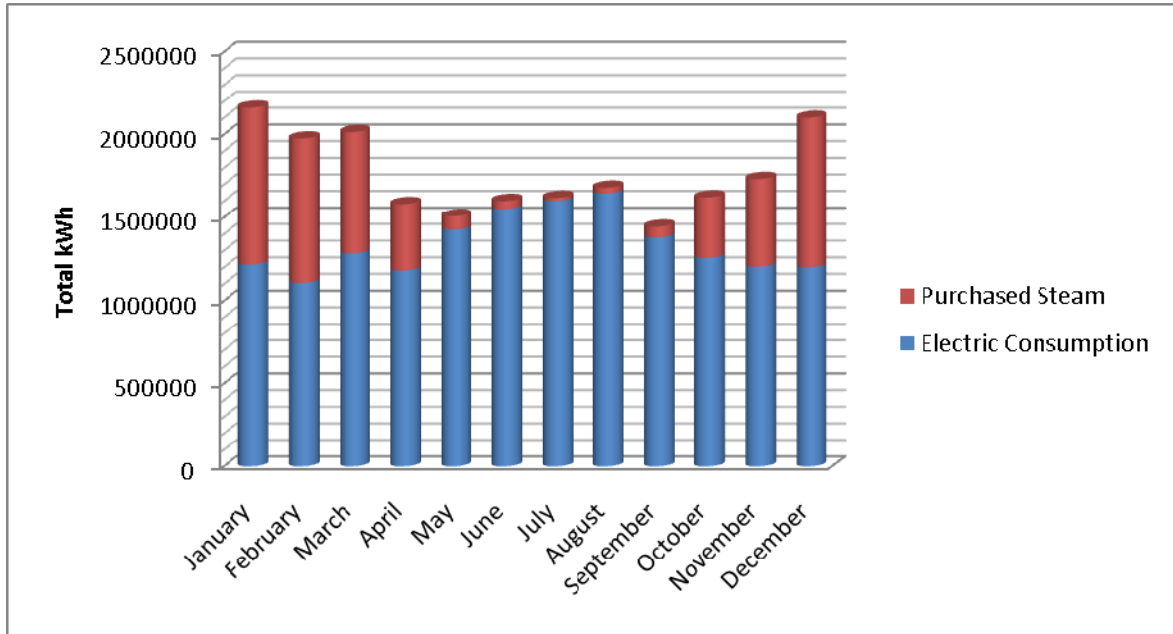


Figure 2 - Monthly Utility Consumption

The total cost to operate the HVAC system for an entire year was calculated to be \$1,674,300 with the highest monthly utility cost during the month of January due to the large amount of purchased steam. Figure 3 breaks down the monthly utility costs into the utility category in which they are associated with. Purchased steam is the most expensive energy utilized for WRNMMC at \$0.029/kBtu compared to an average electricity cost of \$0.014/kBtu for all of the consumption rates.

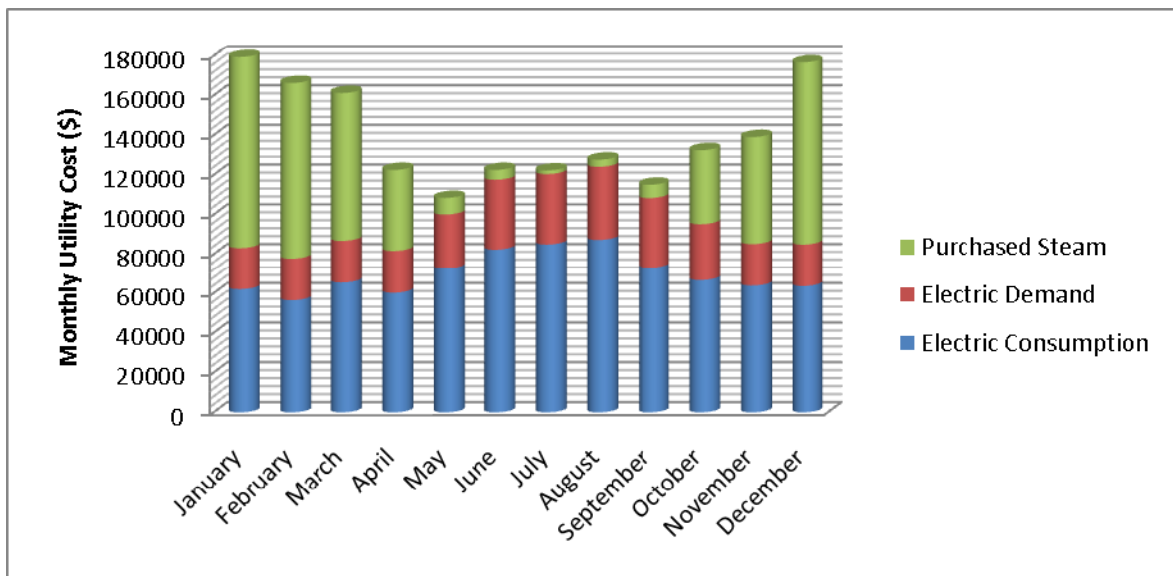


Figure 3 - Monthly Utility Cost

With a yearly utility cost of nearly \$1.7 million, the system breaks down to having an operating cost of \$2.80/sf for purchased utilities. This utility cost was compared to data compiled from the 2003 Commercial Buildings Energy Consumption Survey (CBECS) which is performed by the Energy Information Administration (EIA). The data shown in Table 10 was pulled from the CBECS survey and is shown to yield an average cost of \$3.16/sf for site utilities. This reduction of \$0.36/sf results in a net utility bill savings of over \$215,000/year. This utility savings every year is used to justify having a larger upfront mechanical system cost due to a shortened payback period.

	Fuel Type	Average Total CBECS Energy Use (Btu/sf)	% Fuel Type Utilized	Cost Per Square Foot (\$/sf)	Percent Total Building Square Footage	Composite Cost Per Square Foot (\$/sf)
Building A	Electric	112493	47%	\$0.74	75%	\$3.16
	Natural Gas	112493	53%	\$1.77		
Building B	Electric	227000	47%	\$1.50	25%	
	Natural Gas	227000	53%	\$3.59		

Table 10 - CBECS Average Utility Cost Per Square Foot

### 3.4 Building Energy Analysis

The design engineer did perform a full building energy analysis for this building as part of the LEED® certification process. The energy analysis was performed using Trane TRACE 700 version 6.1. The building energy model was also created in order to show the proposed system improvement over the ASHRAE Standard 90.1 baseline building. The proposed system was required in the RFP to exceed the ASHRAE Standard 90.1 baseline buildings energy consumption by 30% which was able to be modeled by the design engineer.

The energy model that was created calculated that the building uses 69,351 MMBtu/year. The block load model created for this report varies from the design engineer's model by 7%. This difference in the loads calculated is most likely due to the room equipment simplifying assumptions and the other assumptions that were stated earlier. Another reason for variation from the design engineer's model is that even though both models were calculated using the same program, the program versions were different. Different program versions may have different equipment coding written within them and to be sure the program manufacturer should be consulted to answer if any code changes that have been made. In order to not have any potential problems from version updates, the same version of the program should be used in order to maintain consistency between energy model alternatives.

### 4.0 System Emission Rates

The emissions rates for pollutants such as CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>x</sub>, and particulates have been calculated based upon the total energy consumption that was determined from the block load energy model. The typical source emission rates of electricity and natural gas for Maryland were taken from a report compiled by the

National Renewable Energy Laboratory (NREL). Maryland is located within the Eastern Interconnection region as shown on Figure 4.

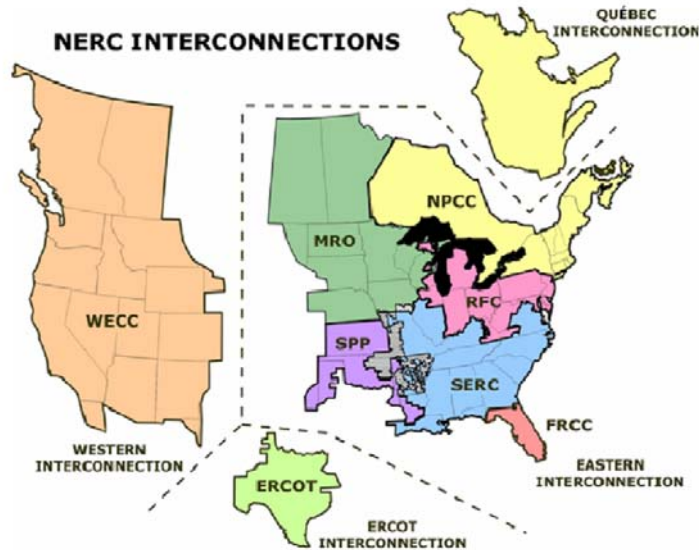


Figure 4 - NERC Interconnection Map

The source emission rates for all the interconnection areas are determined based upon how the electricity in that specific region is produced. Figure 5 shows the breakdown of how electricity is produced within each of the regions. This figure shows that the Eastern Interconnection produces over half of its electricity from bituminous and subbituminous coal. Coal is a very popular generation source for the eastern interconnection due to its great abundance in the Western Pennsylvania and West Virginia regions.

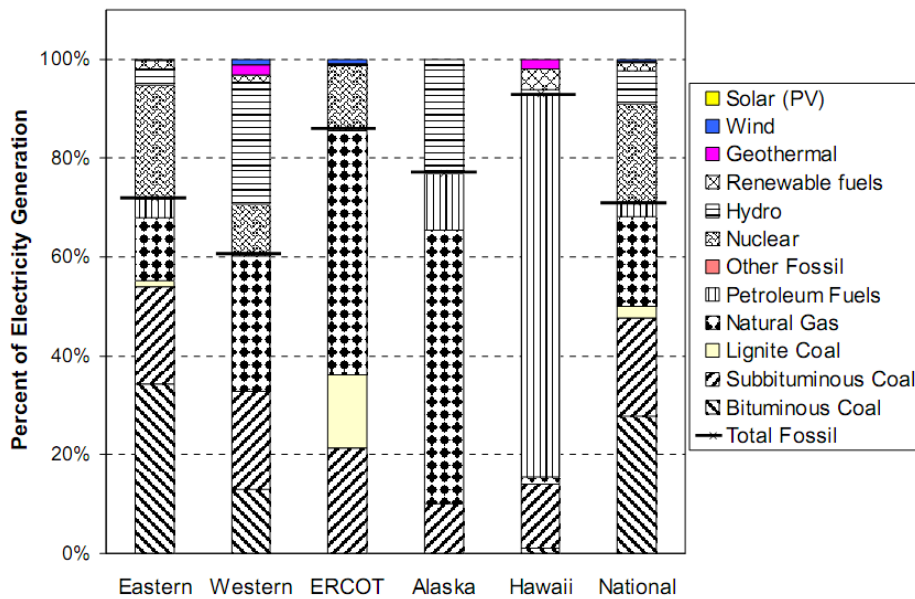


Figure 5 - Electricity Generation Sources

The total source pollution emissions that are generated from WRNMMC due to the use of electricity and natural gas are shown in Tables 11 and 12. Since WRNMMC uses purchased steam and does not have any on site boilers within the building, the natural gas consumption was calculated by using the campus steam plant boiler information provided from the engineer. The steam generating boilers that are used have an efficiency of 81% which resulted in the yearly natural gas consumption of 20,870 mcf as shown in Table 12. As seen below, CO<sub>2</sub> is the largest source emission from Building A and B.

	Total Electricity Usage (kWh)	Electricity Emission Factors (lb pollutant/kwh)	Total Pounds of Pollution
CO <sub>2</sub>	16065662	1.82	29239505
NO <sub>x</sub>		0.0031	49804
SO <sub>x</sub>		0.0111	178329
PM 10		0.0000925	1486

Table 11 - Electricity Source Emission Rates

	Total Natural Gas Usage (mcf)	Natural Gas Emission Factors (lb pollutant/mcf)	Total Pounds of Pollution
CO <sub>2</sub>	20870	122	2546140
NO <sub>x</sub>		0.111	2317
SO <sub>x</sub>		0.000632	13
PM 10		0.0084	175

Table 12 - Natural Gas Emission Rates

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## Appendix A – Typical Room Templates

### Typical Conference Room Template

**Create Rooms - Single Worksheet**

Alternative 1

Room description: WRA-Basement-Conference

Templates...

Room: WR Bldg A Conf. | Floor: 1 ft | Length: 1525 ft | Width: 0 ft

Internal: Conference | Roof: 0 ft | Equals floor:

Airflow: WR 6 AC min

Tstat: Conference

Constr: WR-A

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0

Internal loads...

People: 20 sq ft/person

Lighting: 0.7 W/sq ft

Misc loads: 1 W/sq ft

Airflows...

Cooling vent: 100 % Clg Airflow

Heating vent: 100 % Htg Airflow

VAV minimum: 100 % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

### Typical Corridor Template

**Create Rooms - Single Worksheet**

Alternative 1

Room description: WRA-Basement-Corridor

Templates...

Room: WR Bldg A Corr | Floor: 1 ft | Length: 11981 ft | Width: 691 ft

Internal: Corridor | Roof: 1 ft | Equals floor:

Airflow: WR 4 AC min

Tstat: Office

Constr: WR-A

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0

Internal loads...

People: 0 People

Lighting: 0.596 W/sq ft

Misc loads: 0.25 W/sq ft

Airflows...

Cooling vent: 100 % Clg Airflow

Heating vent: 100 % Htg Airflow

VAV minimum: 100 % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

Typical Electric and Telecommunications Room Template

**Create Rooms - Single Worksheet**

Alternative 1  
 Room description: WRA-Basement-Elec/Com

Templates...  
 Room: WR Bldg A Elec. | Floor: 1 ft | Width: 28082 ft  
 Internal: Electric | Roof: 0 ft | 0 ft  
 Airflow: WR Electrical | Equals floor  
 Tstat: Electrical Rooms  
 Constr: WR-A

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0

Internal loads...  
 People: 0 | People  
 Lighting: 0.538 | W/sq ft  
 Misc loads: 10 | W/sq ft

Airflows...  
 Cooling vent: 100 | % Clg Airflow  
 Heating vent: 100 | % Htg Airflow  
 VAV minimum: 100 | % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

Typical Exam Room Template

**Create Rooms - Single Worksheet**

Alternative 1  
 Room description: WRA-Basement-Exam

Templates...  
 Room: WR Bldg A Exam | Floor: 1 ft | Width: 11309 ft  
 Internal: Exam | Roof: 0 ft | 0 ft  
 Airflow: WR 5 AC min | Equals floor  
 Tstat: Exam  
 Constr: WR-A

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0

Internal loads...  
 People: 60 | sq ft/person  
 Lighting: 1.146 | W/sq ft  
 Misc loads: 3 | W/sq ft

Airflows...  
 Cooling vent: 100 | % Clg Airflow  
 Heating vent: 100 | % Htg Airflow  
 VAV minimum: 100 | % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

Typical Mechanical Room Template

Create Rooms - Single Worksheet

Alternative 1

Room description: WRA-Basement-Mech

Templates...

Room: WR Bldg A Elec. | Floor: 1 ft | Width: 117 ft

Internal: Electric | Roof: 0 ft | 0 ft

Airflow: WR Bldg B - 0.30 cfm/s

T stat: Mechanical Rooms

Constr: WR-A

Wall..

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0

Internal loads...

People: 0 | People

Lighting: 0.538 | W/sq ft

Misc loads: 10 | W/sq ft

Airflows...

Cooling vent: 0.3 | cfm/sq ft

Heating vent: 0.3 | cfm/sq ft

VAV minimum: 100 | % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

Typical Office Template

Create Rooms - Single Worksheet

Alternative 1

Room description: WRA-Basement-Office

Templates...

Room: WR Bldg A Office | Floor: 1 ft | Width: 7206 ft

Internal: Office | Roof: 0 ft | 0 ft

Airflow: WR 4 AC min

T stat: Office

Constr: WR-A

Wall..

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0
	0	12.5	0	0	0	0

Internal loads...

People: 120 | sq ft/person

Lighting: 0.773 | W/sq ft

Misc loads: 1 | W/sq ft

Airflows...

Cooling vent: 100 | % Clg Airflow

Heating vent: 100 | % Htg Airflow

VAV minimum: 100 | % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

Typical Patient Bedroom Template

Create Rooms - Single Worksheet

Alternative 1

Room description: WRB-Floor 3-Patient Bedroom

Templates...

Room: WR Bldg B Pat Bedm | Floor: 1 ft | Width: 6424 ft

Internal: B Patient Bedroom | Roof: 1 ft | 4628 ft

Airflow: WR 12 AC min | Equals floor

Tstat: Patient Bedroomm

Constr: WR-B

Wall...

Description	Length (ft)	Height (ft)	Direction	% Glass or Qty	Length (ft)	Height (ft)
	0	16.67	0	0	0	0
	0	16.67	0	0	0	0
	0	16.67	0	0	0	0

Internal loads...

People: 100 sq ft/person

Lighting: 0.749 W/sq ft

Misc loads: 0.5 W/sq ft

Airflows...

Cooling vent: 100 % Clg Airflow

Heating vent: 100 % Htg Airflow

VAV minimum: 100 % Clg Airflow

Single Sheet | Rooms | Roofs | Walls | Int Loads | Airflows | Partn/Floors

## Appendix B – Design Load Schedules

### Library Members

#### Schedules

Simulation type: Reduced year		Utilization		
	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	
Lights - WR Hospital	January - December	Midnight	7 a.m.	30.0
	Saturday	7 a.m.	8 a.m.	40.0
		8 a.m.	6 p.m.	70.0
		6 p.m.	9 p.m.	50.0
Heating Design	9 p.m.	Midnight	30.0	Utilization
	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	
January - December	Midnight	Midnight	0.0	Utilization
	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	
	Midnight	7 a.m.	30.0	Utilization
	7 a.m.	8 a.m.	50.0	Utilization
Cooling design	8 a.m.	4 p.m.	90.0	Utilization
	4 p.m.	11 p.m.	50.0	Utilization
	11 p.m.	Midnight	30.0	Utilization
	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	
Midnight	Midnight	100.0	Utilization	
January - December	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	
	Midnight	8 a.m.	30.0	Utilization
	8 a.m.	4 p.m.	70.0	Utilization
	4 p.m.	Midnight	30.0	Utilization

## Library Members

### Schedules

		Simulation type: Reduced year			
		Start time	End time	Percentage	Utilization
<b>LIGHTS- WR OFFICE</b>					
January - December	Weekday	Midnight	5 a.m.	10.0	
		5 a.m.	7 a.m.	20.0	
		7 a.m.	8 a.m.	30.0	
		8 a.m.	noon	90.0	
		noon	1 p.m.	80.0	
		1 p.m.	5 p.m.	90.0	
		5 p.m.	6 p.m.	50.0	
		6 p.m.	8 p.m.	30.0	
		8 p.m.	10 p.m.	20.0	
		10 p.m.	11 p.m.	10.0	
		11 p.m.	Midnight	5.0	
January - December	Saturday	Start time	End time	Percentage	Utilization
		Midnight	6 a.m.	10.0	
		6 a.m.	8 a.m.	20.0	
		8 a.m.	noon	30.0	
		noon	5 p.m.	20.0	
		5 p.m.	Midnight	10.0	
Heating Design		Start time	End time	Percentage	Utilization
		Midnight	Midnight	0.0	
January - December	Cooling design	Start time	End time	Percentage	Utilization
		Midnight	Midnight	100.0	
January - December	Sunday	Start time	End time	Percentage	Utilization
		Midnight	6 a.m.	10.0	
		6 a.m.	5 p.m.	20.0	
		5 p.m.	Midnight	10.0	

## Library Members

### Schedules

		Simulation type: Reduced year			
	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	<u>Utilization</u>	
<b>People - WR Hospital</b>					
January - December	Sunday	Midnight	8 a.m.	30.0	Utilization
		8 a.m.	4 p.m.	70.0	
		4 p.m.	Midnight	30.0	
January - December	Saturday	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	<u>Utilization</u>
		Midnight	7 a.m.	30.0	
		7 a.m.	8 a.m.	35.0	
		8 a.m.	9 a.m.	40.0	
		9 a.m.	5 p.m.	70.0	
		5 p.m.	7 p.m.	40.0	
		7 p.m.	Midnight	30.0	
Heating Design		<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	<u>Utilization</u>
		Midnight	Midnight	0.0	
January - December	Weekday	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	<u>Utilization</u>
		Midnight	7 a.m.	30.0	
		7 a.m.	8 a.m.	40.0	
		8 a.m.	9 a.m.	50.0	
		9 a.m.	5 p.m.	80.0	
		5 p.m.	6 p.m.	50.0	
		6 p.m.	8 p.m.	40.0	
		8 p.m.	10 p.m.	35.0	
		10 p.m.	Midnight	30.0	
January - December	Cooling design	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	<u>Utilization</u>
		Midnight	Midnight	100.0	

## Library Members

### Schedules

People - WR Office	Simulation type: Reduced year			
Heating Design	Start time	End time	Percentage	Utilization
	Midnight	Midnight	0.0	
January - December Sunday	Start time	End time	Percentage	Utilization
	Midnight	4 a.m.	0.0	
	4 a.m.	8 a.m.	5.0	
	8 a.m.	Midnight	0.0	
January - December Cooling design	Start time	End time	Percentage	Utilization
	Midnight	Midnight	100.0	
January - December Saturday	Start time	End time	Percentage	Utilization
	Midnight	6 a.m.	0.0	
	6 a.m.	8 a.m.	10.0	
	8 a.m.	noon	30.0	
	noon	5 p.m.	10.0	
	5 p.m.	7 p.m.	5.0	
	7 p.m.	Midnight	0.0	
January - December Weekday	Start time	End time	Percentage	Utilization
	Midnight	6 a.m.	0.0	
	6 a.m.	7 a.m.	10.0	
	7 a.m.	8 a.m.	20.0	
	8 a.m.	noon	95.0	
	noon	1 p.m.	50.0	
	1 p.m.	5 p.m.	95.0	
	5 p.m.	6 p.m.	30.0	
	6 p.m.	10 p.m.	10.0	
	10 p.m.	Midnight	5.0	



Library Members

Schedules

		Simulation type: Reduced year			
		Start time	End time	Percentage	Utilization
<b>Misc - Low rise office</b>					
January - December	Cooling design to Weekday	Midnight	7 a.m.	5.0	
		7 a.m.	8 a.m.	80.0	
		8 a.m.	10 a.m.	90.0	
		10 a.m.	noon	95.0	
		noon	2 p.m.	80.0	
		2 p.m.	4 p.m.	90.0	
		4 p.m.	5 p.m.	95.0	
		5 p.m.	6 p.m.	80.0	
		6 p.m.	7 p.m.	70.0	
		7 p.m.	8 p.m.	60.0	
		8 p.m.	9 p.m.	40.0	
		9 p.m.	10 p.m.	30.0	
		10 p.m.	Midnight	20.0	
<b>Heating Design</b>					
		<b>Start time</b>	<b>End time</b>	<b>Percentage</b>	<b>Utilization</b>
January - December	Saturday to Sunday	Midnight	Midnight	0.0	
		<b>Start time</b>	<b>End time</b>	<b>Percentage</b>	<b>Utilization</b>
		Midnight	Midnight	5.0	

Library Members

Schedules

		Simulation type: Reduced year		
		<u>Start time</u>	<u>End time</u>	<u>Percentage</u>
Misc - Hospital				
January - December	Cooling design to Sunday	Midnight	7 a.m.	70.0
		7 a.m.	noon	100.0
		noon	1 p.m.	90.0
		1 p.m.	5 p.m.	100.0
		5 p.m.	10 p.m.	90.0
		10 p.m.	Midnight	70.0
Heating Design		<u>Start time</u>	<u>End time</u>	<u>Percentage</u>
		Midnight	Midnight	0.0
				Utilization