Mechanical Technical Assignment 2

Building and Plant Analysis

UNLV Greenspun Hall

Las Vegas, Nevada

Prepared By: **David Miller**
Mechanical Option

Prepared For: **Dr. James D. Freihaut**
October 24, 2008

Table of Contents

Executive Summary

Trane's Trace 700 was utilized to estimate peak and annual design loads. Design documents provided information regarding supply rates, occupancy, wall types and orientations, glazing types, mechanical equipment, lighting, and other miscellaneous loads.

The calculated estimate determined that heating was not needed and therefore negligible. The estimated cooling load was found to be higher than the design cooling load which constitutes a higher supply rate. This could be due to the fact that the photo-voltaic array which provides shade to the building was not included in the estimate. Over 50% of the cooling sources were determined to be from solar radiation and conduction gains. This occurred mainly during the 4 summer months in which average temperatures rise above 100 degrees F.

The annual cost of energy was calculated using the load source data in the cooling load estimation. The cost of gas was not included for this calculation because heating was previously determined to be negligible. Rates for electricity consumption were supplied by the Nevada Power company for the southern Nevada region.

KW and KWh were summed on a monthly basis to determine the total annual energy cost. Demand and consumption rates increase during the 4 summer months, which had a large affect on the final cost. The annual energy cost was determined to be $97,185.85 which can also be described as $1.10/ft2. Mechanical equipment with its corresponding cooling load accounted for nearly 50% of this cost which did not include the photo-voltaic array, which can supply roughly 15-30% of the buildings total energy.

Part I
Design Load Estimation

Assumptions

A design load estimation was performed using Trane's load analysis software, Trace 700. A complete analysis was executed using data from the design documents (floor areas, roof areas, wall areas and orientations, amount of glass, R and U values, and interior loads) and the following assumptions.

Construction	U-Value
Exterior Walls	0.060
Glazing	0.250
Roof	0.049
Ground Slab	0.001
Interior Walls	0.402
Interior Slabs	0.847

- Pressurized 'tight' construction was used, in which case, infiltration will be considered negligible
- Lighting is recessed fluorescent with a typical load of 1.1 w/ft^2
- Miscellaneous loads and weather data for Las Vegas, Nevada were based off values given in the ASHRAE Handbook of Fundamentals 2005
- All areas not specifically noted or described as a classroom, laboratory, auditorium, media center, conference room, or reception area were assumed to be classified as general office occupancy category
- The system will be treated as a VAV system with plenum/corridor return
- Chillers are parallel centrifugal with 200 ton capacity with an energy rate of 0.837 KW/ton
- Shade coefficients from solar array over the central courtyard was not taken into account
- Energy cost estimations did not include the photovoltaic array supplying a percentage of the building's power
- Although Greenspun Hall is a multi-purpose facility with mostly classroom and office space, the lighting and occupancy loads were based on the college's schedule:

Annual Schedule	All Year Round
Daily Schedule	7am – 10pm

Design vs. Estimate Comparison

Trane's Trace 700 was utilized to estimate peak and yearly design loads. Design documents provided information regarding supply rates, occupancy, wall types and orientations, glazing types, mechanical equipment, lighting, and other miscellaneous loads.

All rooms were entered into the program with the attributes specified in the design documents and were then assigned to their particular zones. 5 zones were created, 1 for each of the air-handling units. Chiller, cooling tower, compressor, fan, and pump data were input into the system in which the 5 zones were assigned to. The program proceeded to calculate peak and annual energy loads which were used to compare with the design documents. The ventilation and peak capacity results are given in the tables below.

Design Data				
Zone	**Total cfm**	**OA cfm**	**Total MBH**	**Tons**
AHU-1	21,000	10,200	777.2	64.8
AHU-2	17,000	3,600	758.0	63.2
AHU-3	7,000	7,000	381.0	31.8
AHU-4	8,200	8,200	370.0	30.8
AHU-5	5,100	5,100	274.2	22.9

Calculated Data				
Zone	**Total cfm**	**OA cfm**	**Total MBH**	**Tons**
AHU-1	22,022	11,702	689.2	57.4
AHU-2	19,217	4,365	684.9	57.1
AHU-3	7,732	7,590	402.3	33.5
AHU-4	9,428	8,950	386.4	32.2
AHU-5	6,540	5,272	281.3	23.4

Trace found all heating loads to be negative, suggesting that heating is not essentially required for the building's operation. Therefore only cooling capacity was calculated and heating capacity was determined to be negligible.

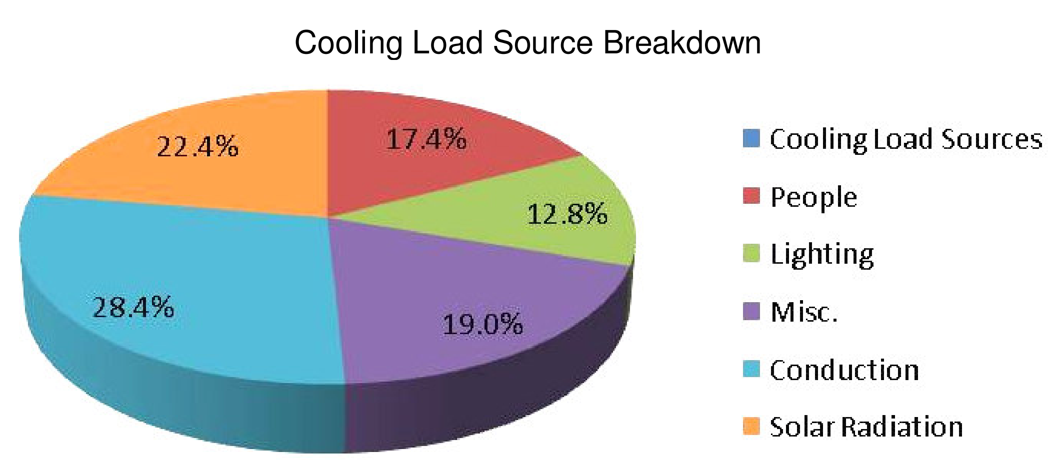
The estimated data, for the most part, was exaggerated in comparison to the design data given. This could largely be due to the fact that the solar array of photovoltaic panels located above the central courtyard was not taken into account. It provides shade for the roof load of the ground level, which is the central courtyard, and for wall and glazing loads due to the buildings orientation. The difference between design and estimated data is summed up in the following tables.

Percent Error Comparison (%)			
Zone	Total cfm	OA cfm	Capacity
AHU-1	4.87	14.73	-12.89
AHU-2	13.04	21.25	-10.68
AHU-3	10.46	8.43	5.35
AHU-4	14.97	9.15	4.55
AHU-5	28.24	3.37	2.18

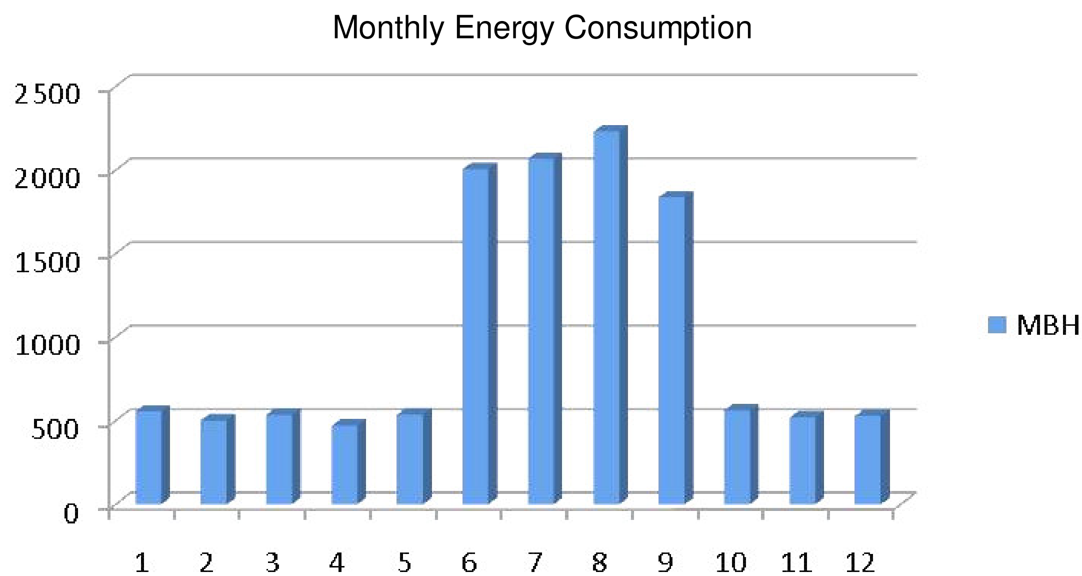
Through further comparison between the energy model and the design values, supply ventilation rates and loads were calculated based on usable floor area. In congruence with the data above, the cooling load was exaggerated in the estimate, which led to a greater supply rate as well. Ventilation rates are similar because they are based off of the same occupancy.

	Cooling Load	Supply Rate	Ventilation Rate
	ft^2/ton	cfm/ft^2	cfm/ft^2
Design	553.76	0.66	0.38
Estimate	580.68	0.74	0.42

The loads on a building in Las Vegas are influenced greatly by the intense temperature and solar radiation of the region. This greatly contributes to the buildings cooling load. A break down of the sources of the cooling load is described in the pie chart below in which the role of solar radiation and conduction is obvious at over 50% of the total load.



The cooling load is further described on a monthly basis in the chart below. In southern Nevada, there is a 4 month time period in which temperatures swell. All other months have daily averages similar to indoor design temperatures. Therefore the following bar graph shows the relationship between the cooling load and its corresponding month in which this time period of high temperatures directly constitutes higher cooling load.



Summary

All flow rates and equipment performance characteristics described in Technical Assignment I were used to determine this outcome. The estimated data was inflated in comparison to the design data in most cases which led to a greater supply rate. The majority of the cooling load source is due to the high temperatures and solar heat gain of the region during the 4 summer months, which creates a large amount of conduction and solar radiation gain.

Part II
Energy Cost Analysis

Energy Cost Analysis

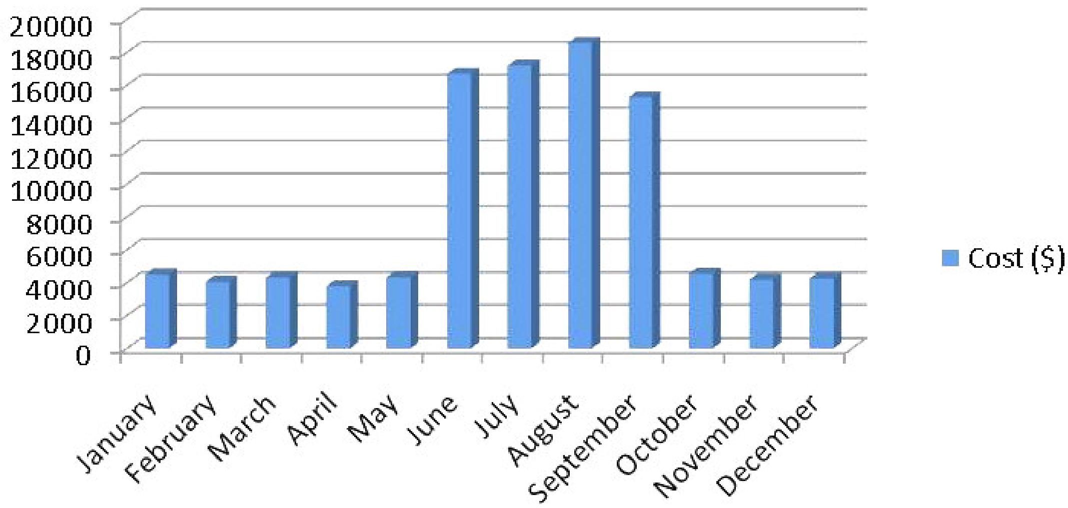
The annual cost of energy was calculated using the load source data in the previous section. The cost of gas was not included for this calculation because heating was previously determined to be negligible. Rates for electricity consumption were supplied by the Nevada Power company for southern Nevada and are described in the table below.

		Consumption	Demand Charge	Flat Rate
		(per KWh)	(per KW)	(per Month)
Summer	On-Peak	0.0906	9.05	268
	Mid-Peak	0.07672	0.41	
	Off-Peak	0.0613	0	
All Other Times		0.0614	0.5	

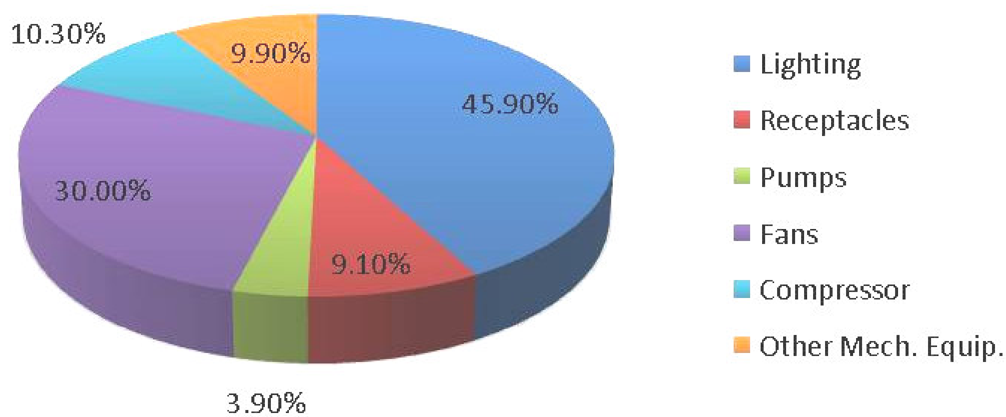
In order to determine a monthly energy cost, KW and KWh must be summed and then multiplied by the correct coefficient. These values are displayed in the table below.

		January	February	March	April	May	June	July	August	September	October	November	December	Annual
KWh	On-Peak	29725	25670	27940	24655	28760	63420	65865	75085	57300	32025	27925	28640	487010
	Mid-Peak	0	0	0	0	0	30175	33680	36670	29215	0	0	0	129740
	Off-Peak	0	0	0	0	0	44810	47020	48905	42065	0	0	0	182800
	Other Times	0	0	0	0	0	0	0	0	0	0	0	0	0
KW	On-Peak	118	114	114	115	118	542	550	552	512	118	118	118	3089
	Mid-Peak	0	0	0	0	0	0	0	0	0	0	0	0	0
	Off-Peak	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other Times	0	0	0	0	0	370	374	374	346	0	0	0	1464

Through the values of the two tables above, monthly energy cost was determined and displayed on the following bar graph. The annual energy cost was determined to be $97,185.85. Once again the 4 month period when temperatures and cooling loads are high is apparent. This shows that the relationship between energy cost and cooling load is a direct correspondence.



The affect cooling load on the annual energy cost is more evident on the pie chart below, which is a breakdown of energy cost sources of the building. Mechanical equipment cost accounted for almost 50% of the annual cost. The lighting load is embellished on this chart because it includes the lighting loads for the numerous broadcasting studios on the ground floor of Greenspun Hall, which require special lighting.



Summary

The annual cost for operating the building was determined to be $97,185.85. This number does not include the photo-voltaic array which should produce enough power to supply energy to 15-30% of the building. When compared to the square footage of the building, the cost of operation was $1.10/ft^2. Most of the energy cost is generated in the 4 month period from June through September in which temperatures are very high. This reflects Nevada Power's prices per KW and KWh during this summer time period in which demand for electricity is immense.

An energy analysis was performed by the mechanical engineers using Trace 600. The results were similar to the estimations above because the same entry data was used. Differences included their use of a specialized VAV system with greater efficiency and the cooling capacity differences in Part I of this report.