Contents

Executive Summary

This report was prepared for the North Pocono High School that is currently under construction in Covington Township, Pa. The building is approximately 230,000 ft^2, and is three levels. It contains a gymnasium, auditorium, cafeteria, as well as specialty classrooms such as business labs, woodshops, and communication labs. The information provided in the report were the results of using the Trane Trace modeling software. The program was used to compare the cooling capacity of the mechanical system, as well as compare the supply and ventilation rates of the design to what the program output concluded. The program had varied results than what was used by the engineer, but this could be due to differences in schedules used by the program vs. what the engineer designed for or differences in the classifications of areas in the building by the software compared to what the designer categorized each space.

An energy model was also a result of the using the Trace program. However, one was not performed by the engineer because one was not requested by the owner, therefore there is no basis of comparison between the actual cost and what the program concluded the cost to operate the building for one year, which turned out to be $230,474/yr.

Design Analysis

The design load and energy model was performed by using the Trane Trace 700 program. The data that was entered was provided by the drawings and other construction documents. This information included:

- Zone Areas
- Wall Types
- Window Types
- Wall Orientation
- Window Types
- Occupant Density
- Lighting Density
- Mechanical Equipment Details

The analysis was done by breaking down North Pocono into 11 zones. There are 3 classroom zones:

- Lower Level Classrooms
- Middle Level Classrooms
- Upper Level Classrooms

Then there are 8 specific areas that were entered into the Trace modeling program:

- Administrative Area
- Gymnasium
- Auditorium
- Large Group Instruction
- Cafeteria
- Food Court
- Kitchen
- Lobby

The 8 zones were created because their occupancy classification and lighting density differed from that which was used in the classroom zones. The mechanical system was then broken down into the areas that are served by variable air volume systems and constant air volume systems, and the zones were matched accordingly. Table 1 is a comparison of what the computed cooling load was determined to be and what was designed for each zone.

Table 1 – Computed Cooling Load vs. Design cooling Load

Zone	Computed Cooling Load (ft^2/ton)	Design Cooling Load (ft^2/ton)
Lower Level Classrooms	397	375
Middle Level Classrooms	396	395

Table 1 – Computed Cooling Load vs. Design cooling Load (cont.)

Upper Level Classrooms	365	338
Administrative Area	335	314
Gymnasium	100	102
Auditorium	128	121
Large Group Instruction	224	112
Cafeteria	228	196
Food Court	50	34
Kitchen	149	48
Lobby	100	104

Overall the model provided slightly less cooling than what the design loads for North Pocono; with the exception of the instruction room and the kitchen. These discrepancies could be due to the fact that the software underestimated the usage of lights or occupancy level during the peak demand or because the areas entered into the software were grouped differently than what the engineer used.

Table 2 is a comparison of the total supply air that was calculated using the Trace program and what the engineer design for the Zones in North Pocono.

Table 2 - Computed Supply Air vs. Designed Supply Air

Zone	Computed Supply Air (cfm/ft^2)	Design Supply Air (cfm/ft^2)
Lower Level Classrooms	1.13	1.11
Middle Level Classrooms	1.07	1.04
Upper Level Classrooms	1.10	1.05
Administrative Area	.78	.97
Gymnasium	1.98	2.0
Auditorium	1.66	1.66
Large Group Instruction	1.83	1.83
Cafeteria	0.95	1.6
Food Court	0.14	1.14
Kitchen	3.32	3.32
Lobby	1.14	1.14

In conclusion the software provided varied results for the whole building compared to what was designed for the building. This could attributed to the possibility that the program's occupancy schedule and lighting schedule were different than what the engineer used in North Pocono's design.

Table 3 – Computed Ventilation Air vs. Design Ventilation Air

Zone	Computed Ventilation Air (cfm/ft^2)	Design Ventilation Air (cfm/ft^2)
Lower Level Classrooms	0.39	0.29
Middle Level Classrooms	0.30	0.41
Upper Level Classrooms	0.36	0.47

Table 3 – Computed Ventilation Air vs. Design Ventilation Air (cont.)

Administrative Area	0.53	0.43
Gymnasium	0.59	0.59
Auditorium	1.66	1.66
Large Group Instruction	1.83	1.83
Cafeteria	0.43	0.26
Food Court	0.13	.71
Kitchen	3.32	3.32
Lobby	0.45	0.45

In conclusion the model provided the correct amount of outdoor to the spaces that are being served by 100% outdoor air units (Auditorium, Large Group Instruction, Kitchen); the results for the other zones have varied result. The population density and lighting density that were entered into Trace equaled those set by the design criteria found in the documents therefore the discrepancies could be attributed to the difference in schedules between the Trace program and what the engineer used to design the mechanical system.

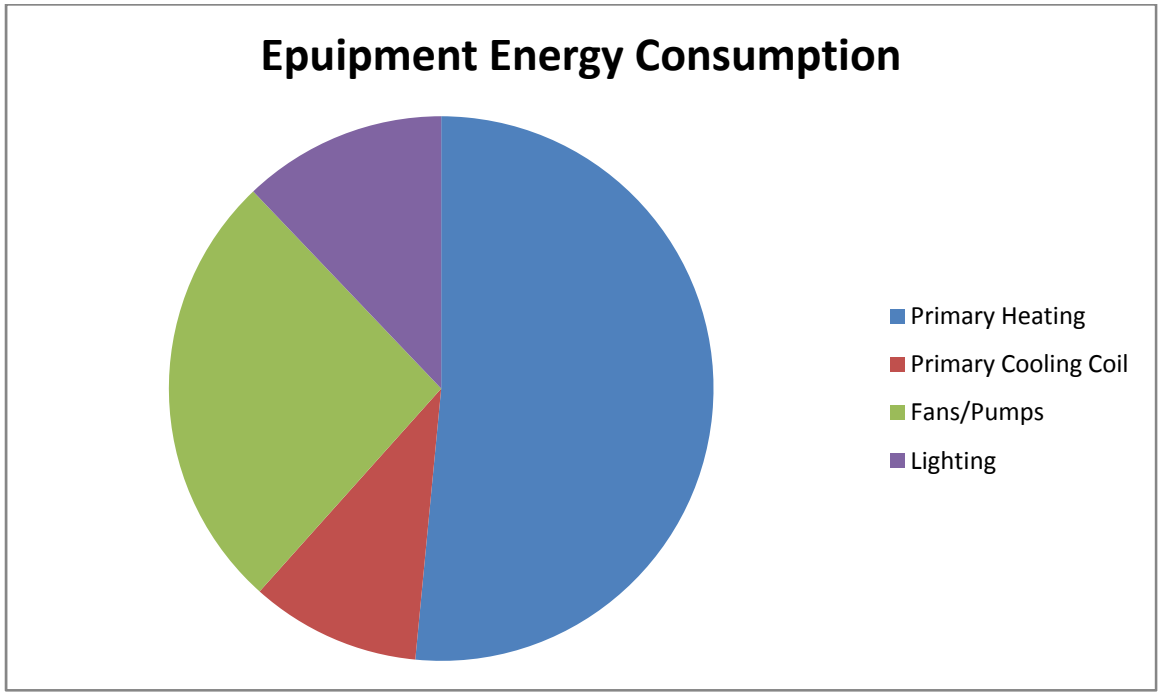
Energy Analysis

North Pocono consumes 2,122,698 kWh a year, and 71,682 therms of oil year. This works out to be a total of 138,204 Btu/(ft^2-yr). The total energy cost for North Pocono is $230,474/yr; this includes the $201,801/yr for electricity, and $28,673/yr for the oil consumed by North Pocono. The cost/SF for the building is $1.09/yr.

An energy model was not performed by the designer because the owner did not request one, therefore the results of shown here are what was modeled in the Trace program. The heating of the building accounts for 51% of the energy consumed while cooling accounts for 10%, fans and pumps account for 26% and lighting for 12% of the energy. This is reasonable given the area of the country the school is located and the usage of the building. The school would not be operating the cooling equipment during the hottest months of the year because the students are not in session during the summer months. The monthly breakdown for each value can be found in Table 4.

Table 4 – Equipment Energy Consumption

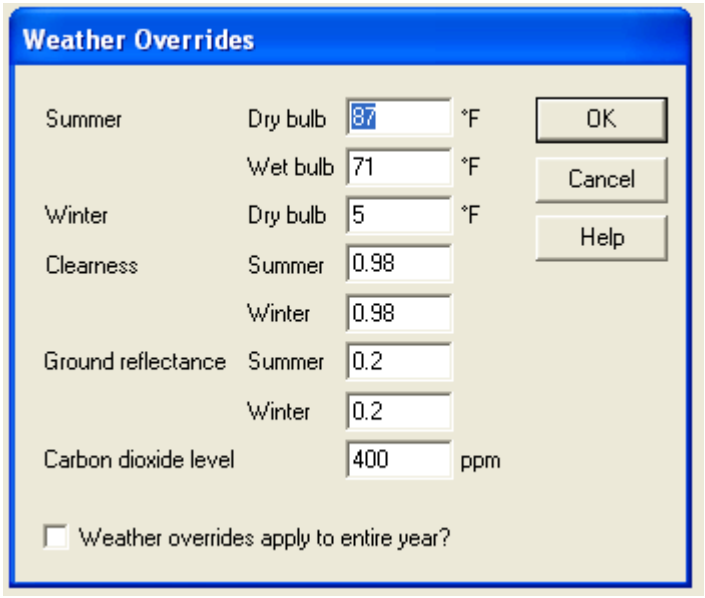
Source	Energy (kBtu/yr)	Percent of Total Energy
Primary Heating	7,323.8	51%
Primary Cooling	1,456.1	10%
Fans/Pumps	3,752.4	26%
Lighting	1,770.5	12%



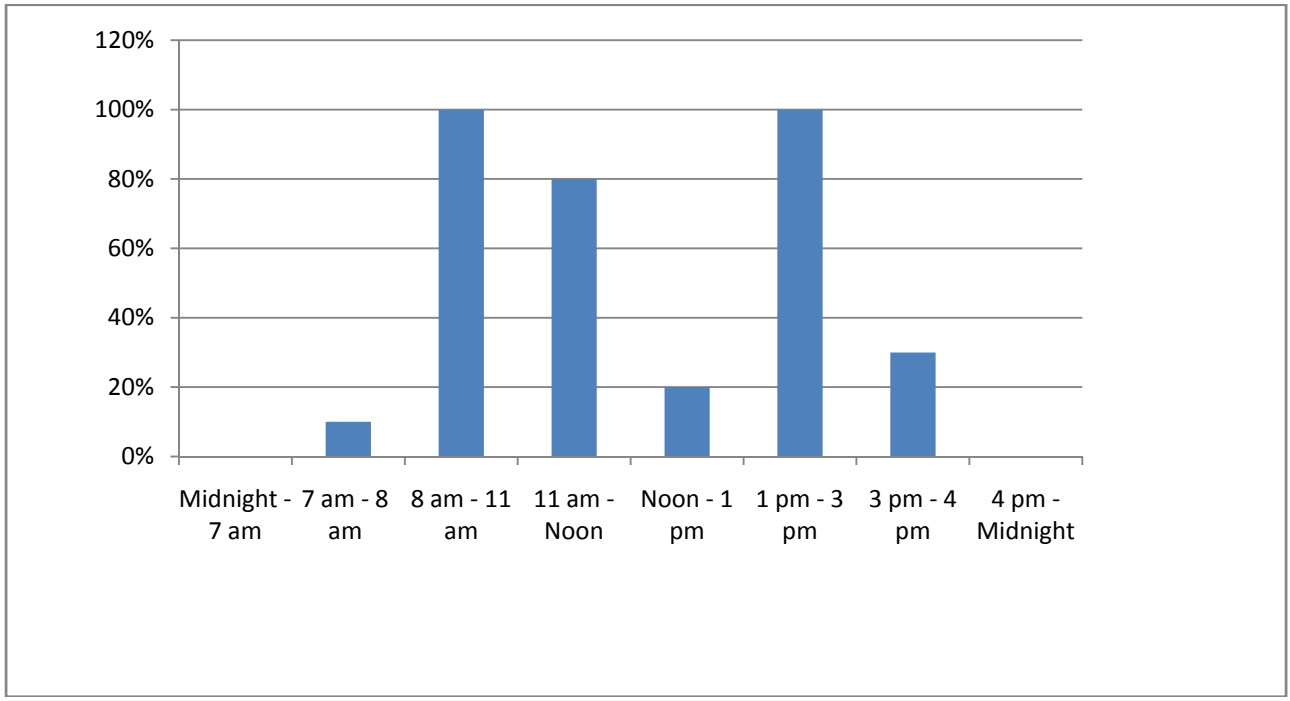
References

GPI Inc., 2007, Mechanical Construction Documents. GPI Inc., Scranton, PA, 2007.

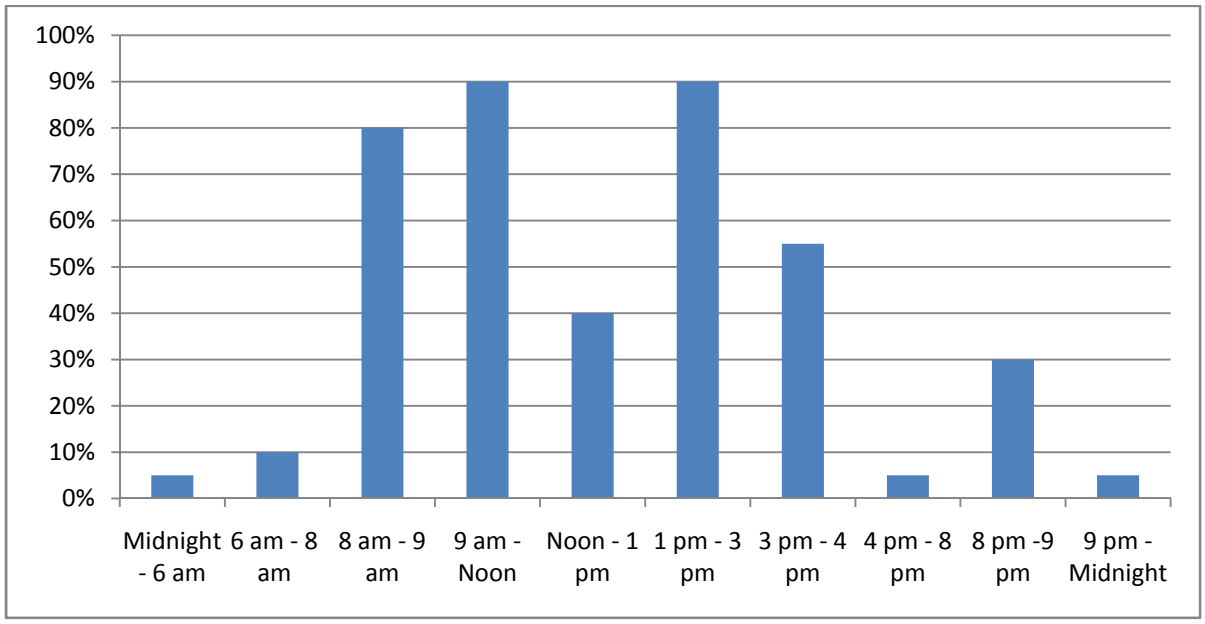
Appendix A - Weather Data for Wilkes-Barre Pennsylvania



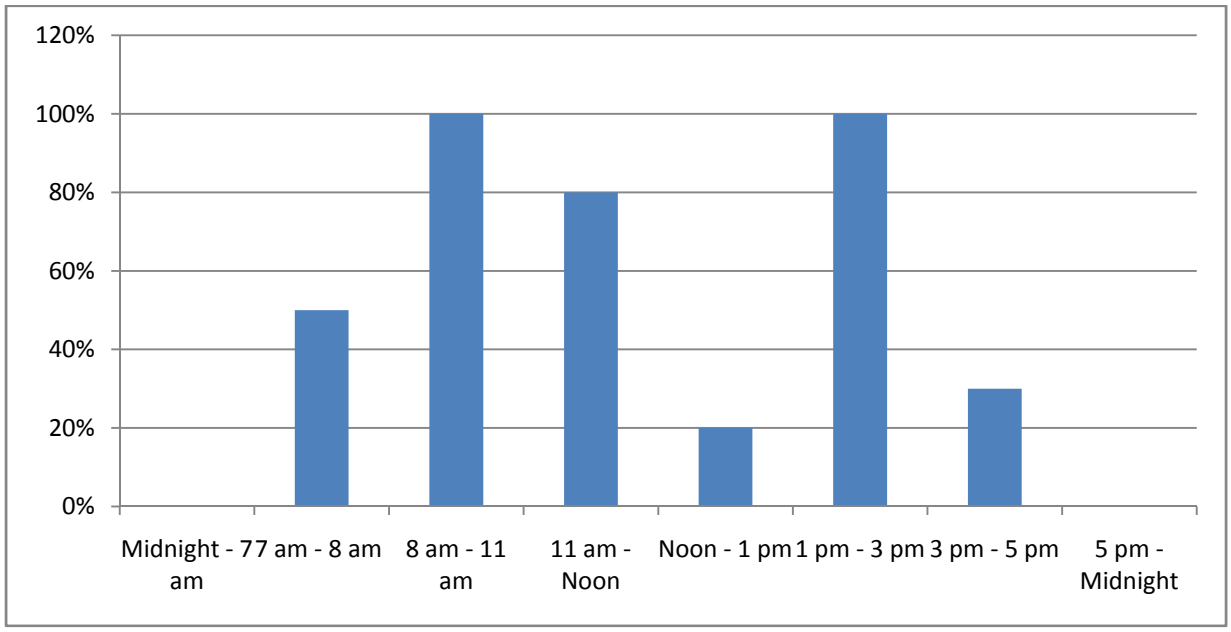
Appendix B – Occupancy Schedule (Design Day)



Appendix C – Lighting Schedule (Design Day)



Appendix D –Miscellaneous Equipment Schedule (Design Day)



Appendix E – Monthly Energy Consumption

Utility		Jan.	Feb.	Mar.	Apr.	May	June
Electric	On-Pk. Cons. (kWh)	242	228	202	131	174	242
	On-PK. Dem. (kW)	608	608	1,306	1,566	2,203	2,247
Oil	On-Pk Cons. (therms)	14,909	18,447	9,239	4,221	1,149	617

Utility		July	Aug.	Sept.	Oct.	Nov.	Dec.
Electric	On-Pk. Cons. (kWh)	192	10	173	140	156	233
	On-PK. Dem. (kW)	2,170	649	1,914	1,428	1,185	608
Oil	On-Pk Cons. (therms)	215	0	1,903	4,367	5,999	11,427

Appendix F – Monthly Energy Cost

Utility		Jan.	Feb.	Mar.	Apr.	May	June
Electric	On-Pk. Cons. ($)	7,277	7,268	6,432	4,167	7,714	6,117
	On-PK. Dem. ($)	4.945	4.945	10.616	12.735	17.907	18.271
Oil	On-Pk Cons. ($)	5,964	7,379	3,696	1,688	460	247
	Monthly Total ($)	18,636	19,592	20,743	18,590	23,934	26,232

Utility		July	Aug.	Sept.	Oct.	Nov.	Dec.
Electric	On-Pk. Cons. ($)	6,117	330	5,508	4,478	4,976	7,430
	On-PK. Dem. ($)	17.642	5.280	15.561	11.608	9.630	4.945
Oil	On-Pk Cons. ($)	86	0	437	1,747	2,399	4,571
	Monthly Total ($)	23,846	5,610	21,506	17,833	17,005	16,946