Mechanical Breadth

The following Mechanical study was conducted in relationship with the addition of the gymnasium clerestories. The clerestories were added on the north and south sides of the gymnasium roof structure. The square footage of each clerestory is 480sf giving a total of 960sf of additional windows that need to be taken into consideration when calculating the heating and cooling loads required for the space. The R-value for the space envelope alters, which effects mechanical loads required for the gymnasium. The change in heating and cooling loads could cause the original mechanical equipment to be resized. It may also cause a large increase in electrical energy consumption.

In order to determine the heating and cooling loads for the space, the Hourly Analysis Program (HAP43) was utilized. The gymnasium system was created by putting in the wall assembly, window assembly, and other pertinent values. The only changes made to the system between the original and new load calculation was the window square footage on the north and south walls. From this program, the heating and cooling loads were determined. The original charts and graphs can be found in Appendix C. Below is a collaboration of the two tables and graphs.

	Original Loads		New Loads		Original & New Load Differences				Change in Tons	
	Cooling	Heating	Cooling	Heating	Cooling		Heating		Cooling	Heating
	kBTU	kBTU	kBTU	kBTU	kBTU	kwhr	kBTU	kwhr	Tons	Tons
January	30601	75301	31412	77882	811	81.10	2581	258.1	0.093866	0.298727
February	29899	41474	30732	41648	833	83.30	174	17.4	0.096412	0.020139
March	36306	34157	38133	34026	1827	182.70	-131	-13.1	0.211458	-0.01516
April	52151	6723	55963	6482	3812	381.20	-241	-24.1	0.441204	-0.02789
May	91620	3506	98206	3739	6586	658.60	233	23.3	0.762269	0.026968
June	140814	0	150134	0	9320	932.00	0	0	1.078704	0
July	162987	0	173042	0	10055	1,005.50	0	0	1.163773	0
August	159149	0	168971	0	9822	982.20	0	0	1.136806	0
September	113137	0	120939	0	7802	780.20	0	0	0.903009	0
October	71131	2633	75997	2749	4866	486.60	116	11.6	0.563194	0.013426
November	41372	20293	43057	20437	1685	168.50	144	14.4	0.195023	0.016667
December	31604	64866	32356	67155	752	75.20	2289	228.9	0.087037	0.264931
TOTAL	**960771**	**248953**	**1018942**	**254118**	**58171**	**5,817.10**	**5165**	**516.5**		

Because the COP for the mechanical equipment was unavailable the efficiency of the system was estimated using EER or Energy Efficiency Ratio. In order to convert from the thermal energy output (BTU) to electrical energy (kW-hr) needed to run the system, the following equation was used:

$$(811{,}000\ \text{BTU}) * \frac{\text{(w-hr)}}{\text{(10 btus)}} * \frac{\text{(1kw-hr)}}{\text{(1000w-hr)}} = 81.1\ \text{kwhr}$$

**The equation basically translates to: for every 10 BTUs of thermal energy required, 1 w-hr of electrical energy is needed.*

The above chart shows that a significant amount of cooling loads are required for summer months, and less heating load for the months of March and April. To determine if the mechanical equipment needs to be resized the BTUs were converted to tons. The equation used for the conversion is: 12,000BTU/hr = 1 ton. The BTU listed in the chart is BTU/month so an average of 720hrs/month was used to convert into BTU/hr. Because the change in amount of tons between the two systems is so small the impact on the entire system will be minuscule. Mechanical equipment is also sized with a built in safety factor, therefore the change in load for this space will not cause a large change in the chiller size.