Feasibility Analysis for Retrofit of HVAC Systems at Rockbridge County High School

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ABSTRACT:

The Rockbridge County High School requested an assessment of the current energy consumption of the rooftop air conditioning units that serve the building. A study was undertaken to determine whether installing Variable Frequency Drives on the variable flow rooftop units would reduce operating costs sufficiently to be considered investment-worthy. This examination involves using utility bills, fan laws, fan curves, and engineering economics to obtain a simulation that can provide theoretical yearly savings figures and give an estimated return on investment. The present system is nearly 20 years old and the motors are running at full speed using mechanical dampers to modulate the flow. It was determined after a careful analysis that retrofitting the five variable flow rooftop units would be investment-worthy and would be the best course of action to minimize lifecycle cost. Since resources for this investment cannot be guaranteed, alternative options were also presented. For the first option, all units can be replaced at once and the school can start accumulating operational savings immediately. For the second option, the school can upgrade each unit as the funding becomes available and gain intermediate savings until the entire system gets upgraded The third option would be to continue to operate the system in its current configuration. After being presented with this information, the school can decide what course of action is best for them and will know what to expect in the way of energy returns for each option.

PURPOSE:

The purpose behind this project was to determine just how cost effective it would be to replace the aging guide vane system installed on the roof top HVAC units at Rockbridge County High School (RCHS) with VFD-controlled motors.

When RCHS was built on the site of the former Rockbridge Country Vocational Tech School in 1990, VFD technology was still in its infancy and extremely expensive. Due to the unreasonable expense of VFDs, it was decided to install inlet guide vanes (IGVs) on the variable flow rooftop air handlers (RTUs) to meet the various flow demands of those systems. The IGVs are all controlled by electric servos and made of high quality materials but are approaching the end of their service life. The IGVs on one of the units (RTU-1) had already failed before this study was commissioned, forcing the school to retrofit the RTU with a VFD. This VFD proved to be so successful that the head of Rockbridge County Schools' maintenance office, Tom Drake, contacted the Cooperative Engineering Center and asked the Center to look into performing a cost-benefit study for the further retrofit of the rest of the RTUs.

This project consisted of four main parts: data collection, fan curve simulation, scaling of data using the fan affinity laws, and a net present worth analysis. Using these four techniques, the objective was to provide the client, Rockbridge County Schools, with a number of options regarding the retrofit of their HVAC and hot water systems. It was desired to at least prove that the retrofit of all the RTUs would be beneficial and expedient to lowering the school's electricity costs.

RESULTS:

The following is a summary of the operating costs and present worth analysis, all formatted into tables to see the potential savings that can be acquired after the retrofit. All data was input into Microsoft Excel after being either retrieved or calculated. The findings for this project are printed below:

Summary of Options: Costs, Savings, and Payback

	Present Worth of Costs		Present Worth of Savings	
Year	Option 1	Option 2	Savings	Savings
0	$0.00	-$27,995.00	$0.00	0.000%
1	-$40,431.07	-$33,260.21	$7,170.86	17.736%
2	-$41,239.69	-$33,925.41	$7,314.28	17.736%
3	-$42,064.48	-$34,603.92	$7,460.56	17.736%
4	-$42,905.77	-$35,296.00	$7,609.77	17.736%
5	-$43,763.89	-$36,001.92	$7,761.97	17.736%
Total:	-$186,886.53	-$180,919.91	$33,146.22	3.193%

	Cost			
Rooftop Unit	**Pre-Retrofit**	**Post-Retrofit**	**Savings**	**Percentage**
RTU-4	$3,919.27	$2,134.21	$1,785.05	45.546%
RTU-5	$2,623.94	$1,387.15	$1,236.79	47.135%
RTU-6	$4,450.55	$2,452.82	$1,997.73	44.887%
RTU-7	$3,587.07	$2,754.56	$832.51	23.209%
RTU-8	$3,188.50	$1,869.73	$1,318.78	41.360%

Yearly Savings:	$7,170.86
Total Savings:	$5,966.61
Payoff Period:	3.90

Table 1-3: Total Present Worth