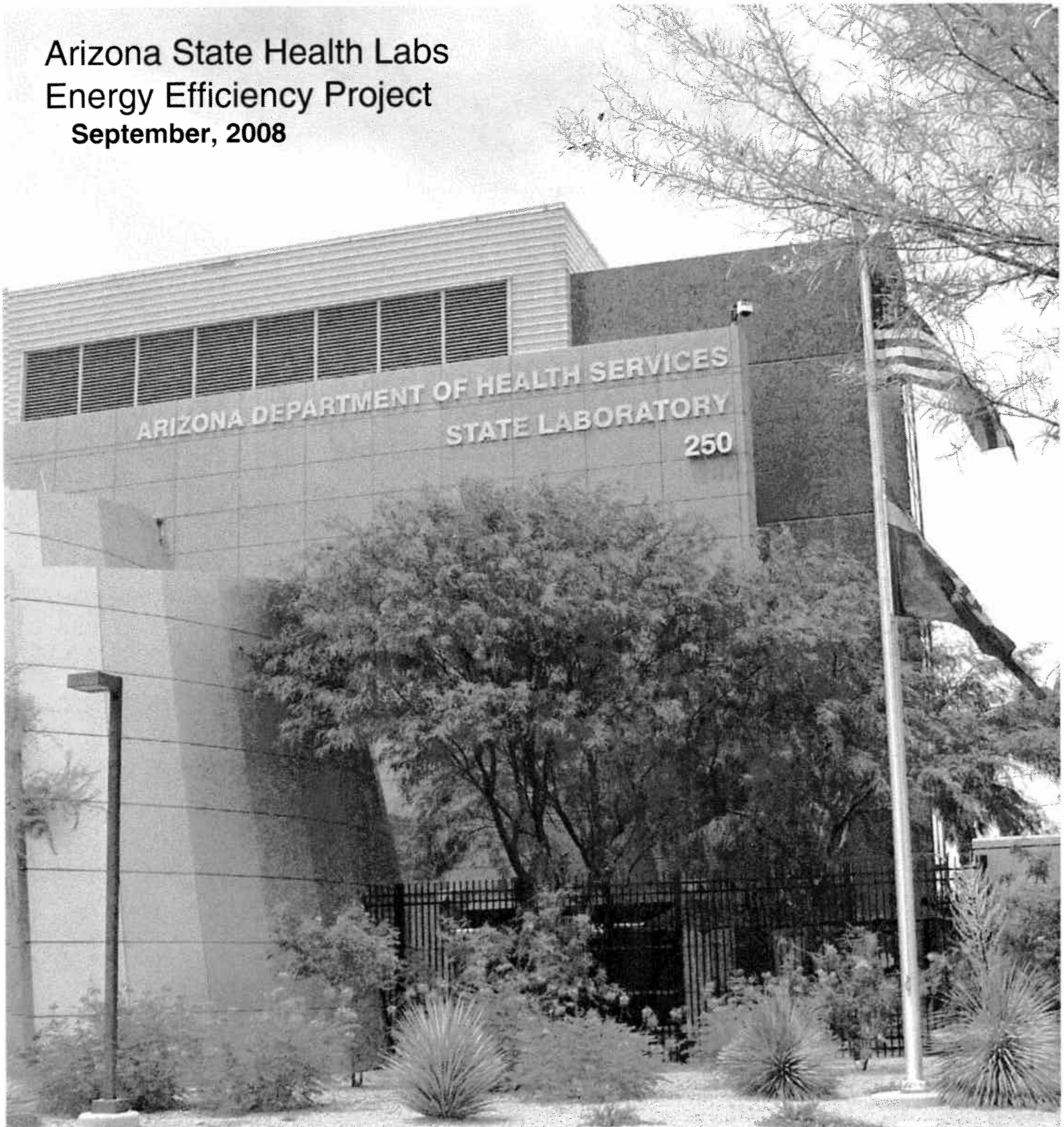
Arizona State Health Labs
Energy Efficiency Project
September, 2008



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Project Description

Biological safety laboratories such as the Arizona Department of Health Facility present unique challenges in their HVAC systems. The lab ventilation equipment has a primary role of maintaining safe working conditions by maintaining ventilation and pressurization standards as recommended by the National institute of Health (NIH), American Society Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Arizona State building codes, and Food and Drug Administration (FDA). The combination of these standards requires very high ventilation rates (in many cases exceeding 50 air changes per hour), and the use of 100% outside air (no recirculation of return air). In the relatively harsh climate of Phoenix, this means a great deal of cooling in the summer and a great deal of heating in the winter. As can be anticipated it also means extremely high gas and electric bills to cool and heat the ventilation air to maintain indoor comfort.

LSW Engineers was commissioned to analyze the existing building systems to see what cold be done to mitigate the high energy consumption and utility costs. The first step was to determine the magnitude and breakdown of utility bills. Further, the configuration of the ventilation systems and controls and the usage patterns of the building were studied.

Recommendations were developed which would lower the utility consumption, generally in two categories. The first category included reworking of the existing building control systems and minor control modifications with minor capital cost that could be implemented immediately. The second category involved recommendations requiring more significant capital costs which could be implemented as budget is available.

The approach to the study started with initial familiarization. Material reviewed included building plans, control vendor shop drawings, lab ventilation system drawings, biological safety cabinet/fume hood certification reports, test and balance reports, and similar material. After familiarization, a "long list" of potential measures was developed. This long list was analyzed for feasibility, and a "short list" recommended for implementation.

The first measure recommended for adoption was to isolate the paired redundant laboratory exhaust fans so that only one fan of each pair needed to be operated simultaneously. The previous operating sequence required both fans of each pair to be operated because there were no provisions for automatic motorized isolation dampers. The requisite dampers and controls were installed at each of five sets of paired fans (total of ten dampers), allowing five fans to be operated instead of ten. This resulted in the saving of over 90 HP, operating 24/7. The second measure recommended for implementation was to reset the discharge air temperature of the air handlers as high as possible so that only the required amount of cooling was provided. The previous control arrangement cooled all the supply air (approximately 100,000 cubic feet per minute) down to 57 degrees Fahrenheit and then used the building boilers to heat it back up to about 70 degrees Fahrenheit before it was discharged into the lab space. With the new control sequence, the supply fan discharge air was only cooled to 70 degrees, saving both cooling and heating energy. The higher discharge air temperature works particularly well because of the dry desert environment. Space relative humidity was controlled by a humidity override which provided additional cooling and heating (on the few days in the year which it is required) by dew point control.

The third measure recommended for implementation was set up of a temperature "dead band". This is accomplished by establishing a lower space heating set point different than the cooling setpoint at each thermostat location. Only enough heat is provided to satisfy the heating set point instead of heating all the supply air up to a single combined cooling and heating setting.

The fourth measure recommended for implementation is the "setback" of cooling and heating control points during unoccupied periods. The normal operating hours of the lab are approximately 7:00 am to 6:00 pm on week days, and closed on weekends. There is no benefit to maintaining normal "occupied" temperature settings if the staff is not present. During unoccupied hours (actually over half of the time) the temperatures are allowed to drift a few degrees above and below the "occupied" set points. As can be imagined, there is considerable savings to be achieved when this is multiplied by approximately 100,000 cubic feet per minute of outside air, and over half of the hours of operation in the course of a year.

The fifth measure recommended for implementation was the interlock of the cooling and heating valves with the air handlers so that the flow of the chilled water and heating hot water to the respective cooling and heating coils was stopped when the air handler was shut off. This simple measure will save pumping energy when the air handlers are shut down.

There are also several capital improvement measures recommended as budget is available. The first of these is evaporative pre-cooling of the outside air to remove cooling load from the building refrigeration system. Using this technique, a 40 HP. cooler motor can do the work of 300 to 400 hp of chillers, pumps, and cooling tower for much of the year. An innovative application of dew point control in the outside air keeps space relative humidity within acceptable units. This works very well with the temperature reset controls described earlier.

The second capital project recommended is heat recovery from the exhaust air. During normal building operations, the lab exhaust fans will discharge air from the fume hoods at about 70 degrees Fahrenheit to 75 degrees Fahrenheit to the outside. Through the course of the year this air must be "made up" by bringing in outside air varying from 120 degrees Fahrenheit in the summer to 30 degrees Fahrenheit in the winter. A "run around loop" exchanges heat between the exhaust air streams and the outside air streams. This loop is only feasible in the EF-4 system since it is not contaminated from biologically toxic emissions. Savings are achieved during both cooling and heating modes. This measure develops particular synergy with the first measure to provide two stage evaporative cooling which amplifies the effect of both measures operating together.

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Projected Energy and Utility Cost Savings are presented in the following table for each of the modifications described.

PROJECTED ANNUAL SAVINGS SUMMARY				
Measure	**Electrical KWH**	**Electrical Savings**	**Gas Therms**	**Gas Savings**
1. Control Modifications				
a. Fan Dampers	577,233	$57,723	-	-
b. Cold Deck Reset	316,820	31,682	47,523	$47,523
c. Temp. Deadband	-	-	53,463	53,463
d. Unoccupied Setback	72,473	7,247	5,435	5,435
2. Outside Air Pre-Cooling	415,826	41,583	-	-
3. Heat Recovery	221,774	22,177	8,316	8,316
4. Hood Sensors	300,000	30,000	20,000	20,000
ANNUAL TOTAL:	**1,904,126**	**$190,412**	**134,737**	**$134,737**
Approximate Annual Utility Cost, Most Recent Year Before Modifications				
Measure	**Electrical KWH**	**Electrical Cost**	**Gas Therms**	**Gas Cost**
		$500,000		$250,000
Percentage Annual Savings Projected				
Measure	**Electrical KWH**	**Electrical Cost**	**Gas Therms**	**Gas Cost**
		38%		54%

Original or Innovative Application of New or Existing Technologies.

This study proposes an innovative application of dew point control and two stage evaporative cooling to create considerable savings in utility costs. The unique biological safety laboratory environment requires use of 100% outside air in the ventilation system for safety reasons. By using dewpoint control of the proposed evaporative pre cooling equipment, considerable utility cost savings can be achieved while maintaining comfortable temperature and humidity levels in the building.

Future Value to the Engineering Profession

The techniques developed in this study will be applicable to almost any building with large quantities of outside air. This would include laboratories, hospitals, industrial, and some applications in education and large assembly. Wider application of the control strategies and systems developed here has the potential to redefine conventional approaches to these types of buildings while achieving considerable energy and cost savings. Based on some initial feedback from facility utility bills, the owner is already seeing savings of 30% to 50%. These preliminary results are before the control work is even complete, let alone the capital improvements. The quality of the results strongly punctuates the value of high quality engineering to the client, to the profession, and to the environment.

For further information contact LSW Engineers Arizona, Inc. 602-249-1320, ATTN: John Littrell or Lance Jones

Social, Economic, and Sustainable Design Considerations.

Very considerable electricity and gas savings are attributable to the implementation of the study recommendations. When fully implemented, it is expected that the facility annual utility consumption and cost will be reduced on the order of 40%, which demonstrates a significant commitment to sustainable design and the environment.

Complexity

By their nature, biological safety laboratories (especially level 3 and higher) are some of the most complex buildings possible. There is an extensive interplay between NIH standards, building codes, OSHA standards, ASHRAE guidelines, and rules of good practice which must be reconciled and integrated into the building HVAC design. Some extremely hazardous and toxic materials are handled in the lab so safety is a paramount concern. At the same time, the 100% outside air ventilation requirements can create some extremely high utility bills in the harsh Arizona climate. The measures proposed in the study are respectful of all the above complex considerations and will at the same time result in very significant energy and cost savings.

Exceeding Owner/Client Needs

The client/owner was involved in every step of the analytical process from concept development to analysis and implementation. Working as a cohesive team, the LSW staff and the client were able to achieve the study goals of reducing energy consumption and cost. The study costs fell within the study budget and the study time period was within the required schedule. Initial feedback from recent utility bills is very promising, showing large month over month savings from 2007 to 2008 in excess of 40%.