

Technical Study Report

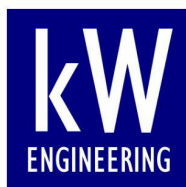
Product Testing
Anti-Sweat Heater Control

Presented to
Utah Power



Utah Power Energy FinAnswer program
Product Testing

Submitted By:



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Disclaimer

The intent of this report is to provide preliminary estimates of energy savings associated with installing anti-sweat heater controls on a glass door refrigerated display case. While the results in this report have been reviewed for technical accuracy and are believed to be reasonably accurate, the findings are preliminary estimates and actual results may vary. As a result, kW Engineering, Inc. is not liable if projected estimated savings or economics are not actually achieved. All savings estimates in the report are “ballpark” and for informational purposes, and are not to be construed as a design document or as guarantees.

Utah Power shall independently evaluate any advice or direction provided in this report. In no event will kW Engineering, Inc. be liable for the failure of the customer to achieve a specified amount of energy savings, the operation of the customer’s facilities, or any incidental or consequential damages of any kind in connection with this report.

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Executive Summary

Utah Power requested kW Engineering to evaluate the potential energy savings from installing ControlTec's AS-20 anti-sweat heater controls on refrigerated food cases and to determine if the anti-sweat heaters are controlled based on ambient conditions in the store.

A typical glass door refrigerated case at Dan's Food Store in Salt Lake City, UT was selected for the purpose of this study. A kW Engineering representative visited the store to perform baseline and post-installation power monitoring. Data was gathered for a period of three weeks before installation and for three weeks after installation of the controls.

Based on our monitored data and annual modeling, installing this control system on one 5-door refrigerated case will save approximately 6,228 kWh annually and reduce demand by 0.63 kW. The savings are due to reduction in amount of energy consumed by the anti-sweat heaters and associated refrigeration load. Table 1 below is a summary of the energy savings associated with AS-20 Controls.

Table 1 Summary of Energy Savings from Installation of AS20 Control on a 5-door case

	Measure Description	Baseline Energy Usage kWh/yr	Energy Usage w/ASH Controls kWh/yr	Demand Savings kW	Annual Savings kWh/yr
1	Anti-sweat Heater Controls	8,709	2,481	0.63	6,228

Project Understanding and Purpose

Glass door food cases use anti-sweat heaters to prevent fogging of the glass surface. Typically anti-sweat heaters run continuously adding heat to the case and increasing the cooling load. In dry climates the anti-sweat heaters do not need to run continuously to prevent fogging. Anti-sweat heater controls can limit the duty cycle of the heaters based on humidity in the store saving energy used by the heaters as well as reducing the refrigeration load.

ControlTec's AS-20 anti-sweat heater control limits the duty cycle of the heaters by continuously monitoring the store dewpoint temperature and glass temperature. The heaters will turn on when the glass temperature falls below the dewpoint temperature and remain on until the temperature of the glass is 2°F above the store dewpoint temperature.

Overview of Technical Approach

Several steps were required to determine the energy savings. These steps included:

- Monitor baseline energy use of a refrigerated case for a period of three weeks with no anti-sweat heater controls.
- Monitor the energy usage of the same case with AS-20 anti-sweat heater control system for a period of three weeks. Additionally record the air temperature and humidity (dewpoint) in close proximity to the case and outside the store.

- Develop a refrigeration model based on a correlation of outside air dewpoint temperature to in store dewpoint temperature.
- Compare the observed performance of the anti-sweat heater with controls to the modeled performance and adjust the model to match observed performance.
- Calculate annual energy savings associated with the installation of the control system.

Technical Approach

The refrigerated case at Dan's Food Store in Salt Lake City, UT was chosen to evaluate the energy savings associated with the AS-20 controls was a 5-door case containing frozen pizza and pre-packaged dinners. The case was a Hussmann reach-in freezer case with Anthony doors factory installed.



Figure 1 Refrigerated case used to evaluate ControlTec's AS-20 anti-sweat heater controls

The specifications for the doors are as follows.

Door Specifications	
Make	Anthony
Model #	0101-P-R-LT-CF-L-NL-U-C-----
Type	Low temp
No. of Doors	5
Heater Amps (Frame)	3.09
Heater Amps (Door)	1.08
Light Amps	2.91
Doors	5
Volts	115
Phase	1
Hertz	60

Baseline Energy Usage

To determine baseline energy usage of the anti-sweat heaters, current loggers were installed on the anti-sweat heater circuits in the refrigerated case. Data was gathered at 90 second intervals for a period of three weeks.

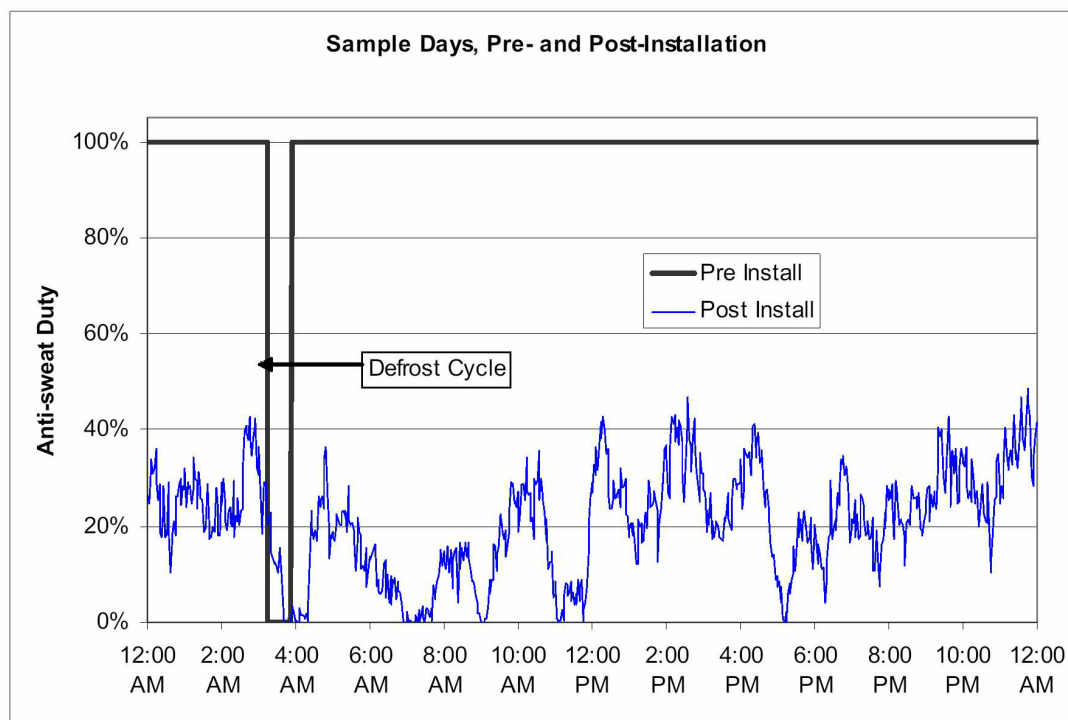
The data showed that the anti-sweat heaters operate continuously except during the defrost cycle. The defrost cycle for this case runs once a day for approximately 35 minutes. This data is shown on the graph of a sample day on the following page.

Post-Installation Energy Usage

To determine energy usage by the anti-sweat heaters with the AS-20 controls installed, current loggers were installed for a period of three weeks. Temperature and relative humidity were monitored in the store, close to the freezer case. Outside air temperature and relative humidity were also monitored for the same period. Data were gathered at 2 minute intervals. Our data showed that the store air temperature near the case was between 46 °F and 58 °F and the dewpoint temperature was between 14 °F and 33 °F.

Over the course of three weeks the monitored data shows the anti-sweat heaters operated 17% of the time. This is not necessarily an accurate representation of the duty of the heaters over the course of an entire year as it is based on a narrow range of dewpoint temperatures when outside humidity is low.

To determine the duty over the course of a year we used the monitored data to calculate the duty of the heaters over 30 minute intervals. As shown in the following graph, post-installation duty is obviously much lower than the continuously-running base case.

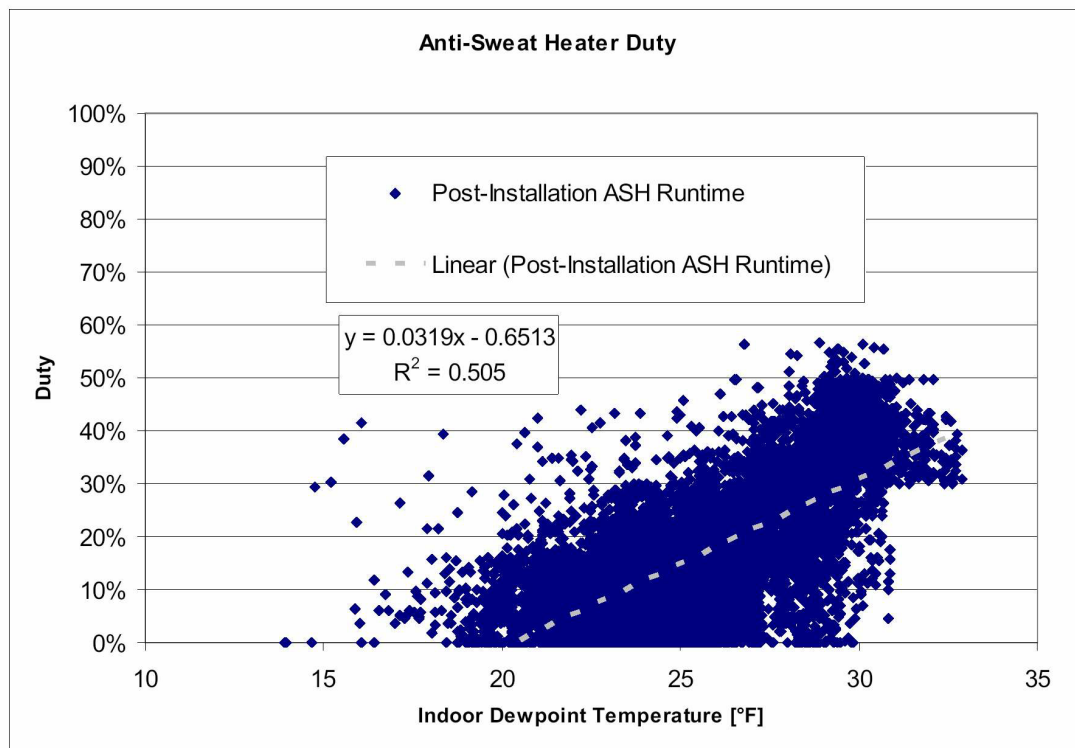
**Anti-Sweat Controller Savings**

The monitored post-installation period occurred in the middle of the winter when dewpoint temperatures in the store are at their lowest. For this reason, to simply

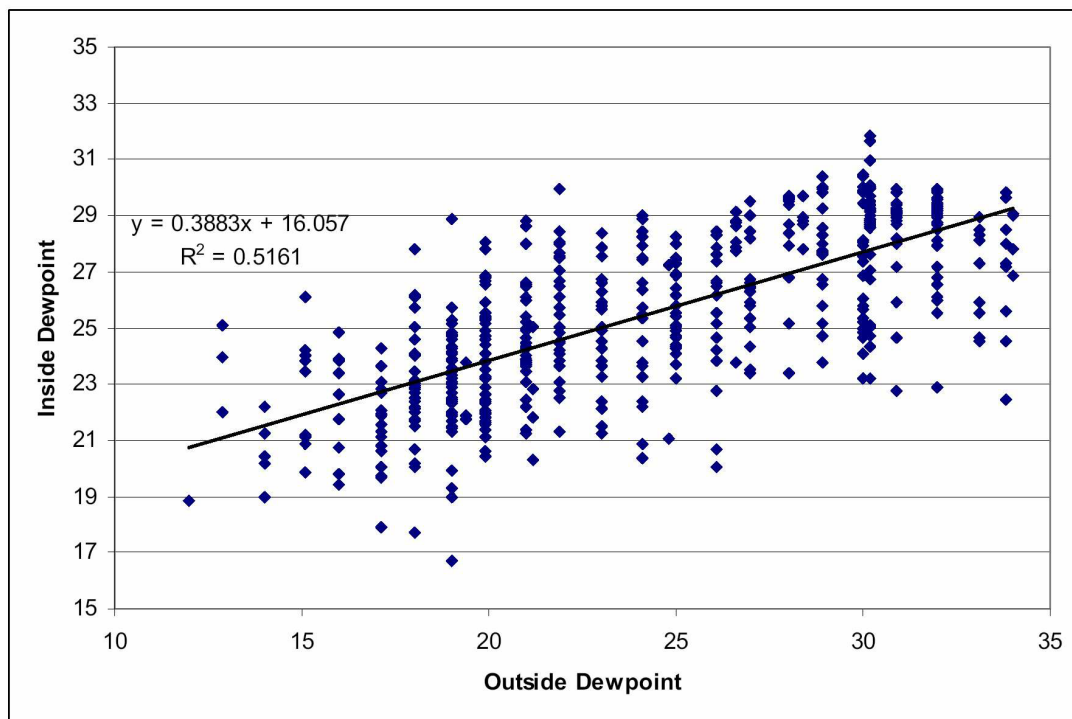
extrapolate the savings during the monitoring period to the whole year would overestimate energy savings.

To predict the anti-sweat heater runtime over the course of an entire year we used a bin simulation method. Weather data from the National Renewable Energy Laboratory's Typical Meteorological Years (TMY2) for Salt Lake City, Utah was summarized into 5 degree bins. The corresponding dewpoint temperatures were used to estimate the post-installation anti-sweat heater duty for the whole year.

Using the monitored data we examined the relationship between anti-sweat heater duty and store dewpoint temperature and found a linear relationship (see graph next page). We then assumed that controller will cycle the anti-sweat heaters in a similar manner over a slightly wider range of dewpoint temperatures over the course of the year. The following graph below shows the duty of the anti-sweat heaters pre-installation and post-installation of the AS-20 controls over the range of observed dewpoint temperatures in the store. This is an example of one of the two monitored cases.



Because the controllers rely on the conditions in the store, we needed to also determine a relationship for finding the annual dew point temperatures inside the store. To simply assume that the dewpoint temperatures during the monitoring period represented the average annual conditions would likely overestimate the savings. This is because the monitoring period occurred during the winter when outside conditions were very cold and the water-carrying capacity of the air is at its lowest. Instead, we developed a correlation between the outside air dew point temperature and the dew point temperatures monitored inside the store during the monitoring period. The data used to develop this correlation are shown in the following graph.



As shown in the graph, there is a strong correlation between outside and inside conditions. The linear relation shown in the graph was used to then estimate the dewpoint temperature in the store in our annualized energy savings calculations.

Annual Energy Savings

The energy use of the anti-sweat heaters was estimated based on the relationship between anti-sweat heater duty and store dewpoint. The following relationship was used, based on the linear relationship found in the post-installation data. The average of the two monitored cases resulted in the following.

	Dew Point [F]	% on
Min On Cycle	20	0%
Max On Cycle	51	100%

Using this reset schedule in our model, and the correlation between outside and inside dewpoint temperatures, the annual energy savings achievable by installing the AS-20 control system on the anti-sweat heaters were estimated.

Energy savings were also estimated for reduced refrigeration loads using an average system efficiency, and assuming that 50% of the anti-sweat heat becomes a load on the refrigeration system. A typical low temperature refrigeration system efficiency of 1.4 kW/ton (equivalent to a COP of 2.5) was used to estimate refrigeration system savings.

Results

Total estimated annual energy savings for the anti-sweat controllers were 6,228 kWh and average annual peak demand savings were 0.63 kW. This represents a total average reduction in energy use of the door and frame anti-sweat heaters of 72%. These results

include the interactive savings associated with reduced loads on the refrigeration system.

Additional Observations

During site visits after installation of the AS-20 control system, the glass doors were clear and free of any condensation.

Typical Costs Effectiveness**Measure Cost**

The vendor estimates an incremental installed cost for the anti-sweat controllers of \$250 per door. For the tested 5-door reach-in configuration this would have resulted in a total project cost of \$1250.

Cost Savings

Based on Utah Power's Rate Schedule 6, typical annual energy cost savings for the controller on the tested 5-door reach in freezer case would be about \$255. Under the FinAnswer program, the controller would be eligible for an incentive equal to half of the installed cost, or about \$625. This would "buy down" the simple payback of the measure to about 2.5 years.