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Investigation of the Effects of VendingMiser Installation on Energy Usage, Product Temperature, and Sales

Prepared for

*University of Louisville,
Louisville, Kentucky*

in cooperation with

*Pepsi Americas
Dixie-Narco*

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1.0 INTRODUCTION

1.1 Background

For the purpose of reducing energy use at the University of Louisville (UofL), the Kentucky Pollution Prevention Center (KPPC) performed energy assessments on four buildings on the Belknap Campus. In the reports on the buildings, KPPC recommended installing VendingMisers on all vending machines at the University. The VendingMiser is a device consisting of a Miser unit and an infrared occupancy sensor. The device deactivates the lights in the vending machine and prevents unnecessary compressor cycling when it senses no traffic in the vicinity of the machine for an extended period of time. Prior to installation, a meeting was held to address concerns of UofL's Pepsi Americas representatives, who stock beverage products and maintain the vending machines, regarding the loss of sales due to warmer beverages and unlit machines. A representative from Dixie-Narco, who owns the machines, expressed concerns about the effect of the device on the machines. To address these concerns, several references were provided of other universities using VendingMisers on refrigerated beverage machines as well as letters from Royal Vendors, PepsiCo and an engineering manager from Dixie-Narco. In addition to this, KPPC offered to conduct a pilot study on three vending machines on the Belknap Campus and provide conclusive evidence of the effects of the devices.

1.2 Parties Involved

This investigation is being performed with permission of Tim Gibson, Marketing Equipment Supervisor, of Pepsi Americas in coordination with Steve Michal of UofL Physical Plant and KPPC. The investigation is being performed by staff from KPPC, including Brandan Burfict and Curtis Nall, under the direction and supervision of Sieglinde Kinne, Energy Efficiency Specialist. Sales information for the test machines was provided by John Jolley from Pepsi Americas. The meetings were also attended by Sonny Altman of UofL Grants and Contracts and Elisa Stephens of UofL Legal.

Tom Brooks of Energy Conservation Group, a local distributor for VendingMisers, and Len Segal of USA Technologies, the manufacturer of the Misers, provided information where needed and provided UofL with three VendingMisers and three data loggers (make isWatts up? PRO) to track energy usage.

2.0 TEST SETUP DETAILS

2.1 Concerns to Resolve

Pepsi Americas expressed concern that the VendingMiser would lower sales in the machines by raising the product temperature and misleading potential customers to think that the machines are out of order because the lights are off. They were also concerned that repeatedly powering on and off the card reader available on some machines will render the reader inoperable. The University of Louisville was interested in quantifying energy savings in locations with varied occupancy and usage.

2.2 Test Machine Identification

It was decided that bottle machines, all the same model, would be tested. In order to test a variety of machine usage and location occupancy characteristics, three machines were identified as test machines. Two of three machines are equipped with the card reader device. The machines were chosen based on historical sales data, identifying a high medium and low usage machine for the test. The low traffic machine is located in an alcove on the second floor of Paul B. Lutz Hall. Its orientation in the recess of an office lobby also makes it the least frequently trafficked unit. The second unit is located in the basement of Louis D. Brandeis Hall (Law School) and is located near the entrance of a public study lounge. Due to late hours of use of this study lounge, the hours of use for this machine are also greater. The third machine identified for testing is in the first-floor lobby of Philip and Jane Davidson Hall. Due to the large number of classes held at Davidson Hall and the location of the machine near the main entrance/exit, this machine sees the most usage and the most traffic of the test group.

Test Machines			
Location	Traffic	Model Number	Serial Number
Lutz Hall	Low	DN501EMC	0559 6500BW
Brandeis Hall	Medium	DN501EMC	0120 6511CW
Davidson Hall	High	DN501E	1098 6537BX

2.3 Testing Equipment

For the testing phase of the investigation, equipment was used to monitor the energy usage and product temperature before and after the VendingMiser was installed. Energy usage was measured and logged using the Watts up? PRO data loggers from Electronic Educational Devices. Configured much like a single outlet power strip or surge protector, this plug-through data logger measures (at 2000Hz) the true RMS voltage and current of the appliance that is plugged into it. From these measurements, it integrally calculates the watt-hour usage of the appliance.

Product temperature was measured and logged using the HOBO H8 unit. Each HOBO H8 logger has an internal temperature sensor on a 4 inch wire which is mounted on the circuit board inside the snap lid case. The sensor measures ambient air temperature over the operating range of the logger, -20°C to +70°C (-4°F to +158°F) with a response time of about 15 minutes in still air typical to 90%.

The third piece of testing equipment involved was the VendingMiser. The VendingMiser works by using a Passive Infrared Sensor to power-down a vending machine when the area around it is unoccupied and then power-up the machine when the area becomes reoccupied. The unit also measures current to determine when the compressor is cycling to prevent the unit from powering-down while the compressor is operating. This helps maintain the temperature of the product and prevent damage to the compressor from a high head-pressure start. To further insure that the vended product stays cold, the Miser measures the ambient temperature and powers the machine up every one to three hours regardless of occupancy conditions. Once started, power is maintained until the compressor cycle is complete.

2.4 Testing Methods

The testing phase consisted of two one-month trials. During the first month (September 2005), the three pre-identified test machines were monitored with respect to energy usage without the VendingMiser installed, in order to have control data. Efforts were made to retrieve the energy usage data from the Watts up? PRO loggers every two to three days. The variable sampling rate of this logger yielded samples that are approximately four minutes apart when the data was retrieved at that frequency. Temperature was measured and logged for one week of this month in the vending machine in Lutz Hall. Since Lutz Hall is the least used machine, any effect on the temperature in the machine would be most apparent on this machine.

At the start of the second trial month (October 2005), a VendingMiser was installed on each of the three pre-identified machines and the energy usage and temperature were again monitored in exactly the same manner as described above. As with the control period, no other aspects of the operation of the machines were modified during this period of the test.

3.0 ANALYTICAL METHODS

3.1 Energy Usage Analysis

The Watts up? PRO data logger, used to measure energy usage logged a cumulative running total of watt-hours of energy used by the machine. From this data, average power consumption was calculated by dividing the change in watt-hours over a sample period by the length of the sample period. This information, along with knowledge of the time at which the points were recorded allowed for the construction of a usage spreadsheet in MSExcel that includes the cumulative watt-hours and average power consumption (in W-hr/hr) at specific dates and times in September and October. A 15-point moving average was used to produce a useful trend-line for the graphing. This technique of averaging data creates a smoother curve than looking at the raw data, which allows trends to be identified. Profiles of energy usage trend-lines for each machine are provided in Appendices A to C.

Several characteristics of energy usage in these machines can be noted directly from the power graphs given.

- The base usage (when the compressor is not running) for Lutz Hall is roughly 169W (see Appendix A, pp. 12-15), for Brandeis Hall roughly 222W, and for Davidson Hall roughly 206W. The difference is probably primarily due to the additional power used by the card readers on Brandeis and Davidson. It should be noted that the base power of Brandeis is 23% greater (53W) than that of Lutz Hall and the base power of Davidson is 18% greater (37W) than Lutz Hall.
- The power usage of the VendingMiser is negligible (between 1W and 2W probably), so small it cannot be noted from the graphs.
- The frequency of the compressor cycling is reduced significantly with the VendingMiser installed, indicated by the trend line that shows definite periods where there was usage (line more saw-toothed) than the essentially flat line without the VendingMiser. *This indicates that the VendingMiser would have the benefit of extending the life of the compressors and reducing maintenance.*

3.2 Temperature

Temperature measurements made during the test periods using the HOBO H8 logger were plotted versus time to show temperature trends inside the vending machines and provide average, minimum, and maximum temperature data. These trends were overlaid on the graph of power consumption from the same periods to correlate energy usage and product temperature.

3.3 Sales

Sales data from Pepsi Americas was analyzed by direct comparison of sales with and without the VendingMisers installed. Pepsi Americas provided sales information from September and October of both 2004 and 2005.

4.0 RESULTS

4.1 Energy Saving

Energy savings for the three machines are summarized below. The estimated annual cost savings were calculated by multiplying the kWh savings times 12 months and the rate the university pays for electricity, \$0.04/kWh.

Summary of Energy Savings					
Machine Location	September Energy Usage (kWh)	October Energy Usage (kWh)	Savings (kWh)	Percent Savings	Estimated Annual Cost Savings (at \$0.04/kWh)
Lutz Hall	217	81	136	63%	\$65.28
Brandeis Hall	241	164	77	32%	\$36.96
Davidson Hall	266	191	75	28%	\$36.00
AVERAGE	241	144	97	42%	\$46.72

For the month of September (during which the VendingMiser was not installed), the vending machine in Lutz Hall used **217 kWh**. In October this machine used only **81 kWh**. This is a reduction of **136 kWh** or **65%** with the VendingMiser installed. Usage profiles for each week of the test for the machine in Lutz Hall are located in **Appendix A**. These profiles show that the minimum running power of this machine, or the power used to run the lights, card reader, etc. was about 169 W. Without the VendingMiser installed the average power used by the unit was about 313 W. With the VendingMiser installed, the average power of the machine dropped to 102 W.

The machine in Brandeis Hall showed the median energy usage of **241kWh** for September compared to **164 kWh** in October. Installation of the VendingMiser resulted in savings of **77 kWh** or **32%**. Usage profiles for each week of the test for the machine in Brandeis Hall are located in **Appendix B**. Analysis of the profiles indicate a minimum running power of about 222 W and an average power consumption of 360 W without the VendingMiser. Installation of the VendingMiser reduced the average power to 237.

The Davidson Hall test machine had the highest energy usage of the three test machines, using **266 kWh** for September. Installation of the vending miser resulted in a reduction in energy used for October to **191 kWh**. This reduction in usage provided a savings of **75 kWh** or **28%**. Usage profiles for each week of the test are provided in **Appendix C**. The profiles indicate that the minimum running power of the machine is about 206 W. The machine average power consumption without the VendingMiser installed was 389 W. Installation of the VendingMiser reduced the average running power to 259 W.

4.2 Temperature Variation

The internal temperature of the vending machine in Lutz Hall for one week in September 2005 is plotted versus time and the power profile is given for the same time period on the following page (p.7). The same was done for a one week period in October. Temperature measurements made in the Lutz Hall vending machine indicate that the average internal temperature maintained in the machine was one degree cooler without the VendingMiser installed. However, the machine was refilled during the control period of the test (without the Miser) effectively raising the average temperature in the machine during this portion of the test. With this temperature spike removed, the average internal temperature of the machine was three degrees cooler without the Miser (about 45°F versus about 42°F). Of concern is the temperature gain during the weekend. The internal temperature climbed to around 47° to 48°F on Saturday, October 22.

4.3 Sales Analysis

Sales data from Pepsi Americas was analyzed by direct comparison of sales with and without the VendingMisers installed from September to October in 2005. The data received showed a significant decrease in sales for the month of October. To determine if it was possible that cooler weather was a factor in these numbers, KPPC asked for additional data from John Jolley on sales from the same period in 2004. The historical sales data indicates that weather is very much a determining factor in sales and that comparing September and October sales data does not tell us much about the effect of the VendingMiser on sales.

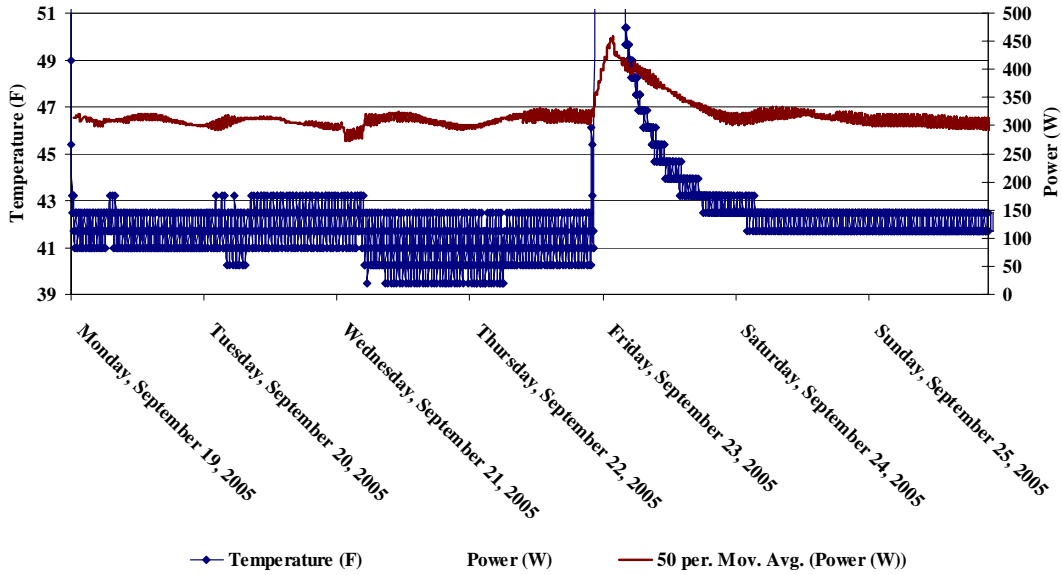
Comparing sales from 2004 to 2005 also did not help us determine if there was an impact on sales from installing the vending miser. Taken all-together, it can be seen that although sales fell off in October, that would appear to be expected from historical data, but that overall sales were 38% down anyway from 2004 for those months.

The following tables and the sales graphs on pages 8 and 9 present the sales data that was collected.

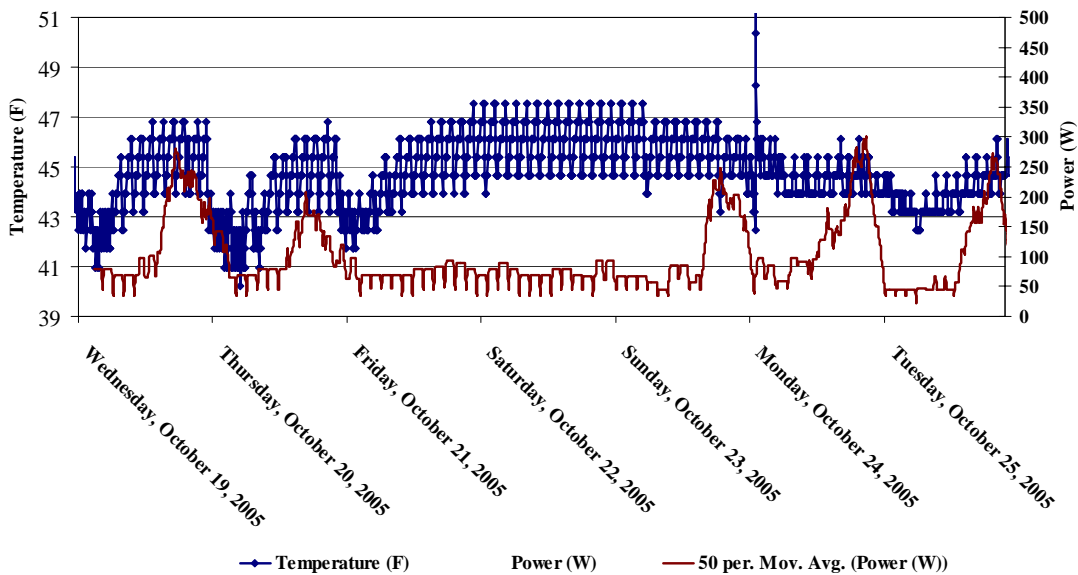
Vending Sales for Sept. 04 - Oct 04 (Cases)			
Building	Sept. Sales	Oct. Sales	% Change
Lutz Hall '04	24	8	-66.7%
Brandies Hall (Law School)	37	45	21.6%
Davidson Hall	168	102	-39.3%
Totals	229	155	

Vending Sales for Sept. 05 - Oct 05 (Cases)			
Building	Sept. Sales	Oct. Sales	% Change
Lutz Hall '05	11	8	-27.3%
Brandies Hall (Law School)	22	6	-72.7%
Davidson Hall	116	77	-33.6%
Totals	149	91	

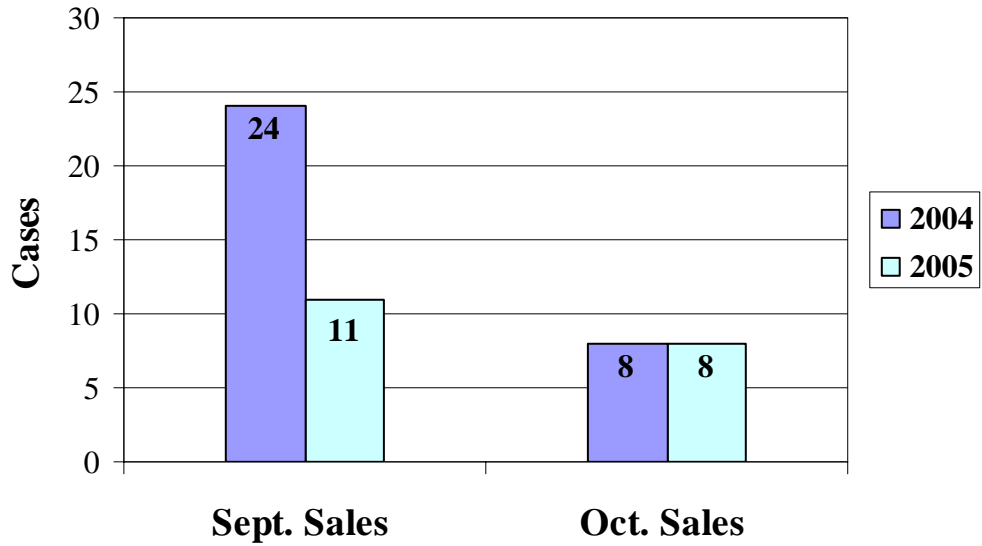
Temperature in Lutz Hall Vending Machine - Power Usage with No VendingMiser Installed



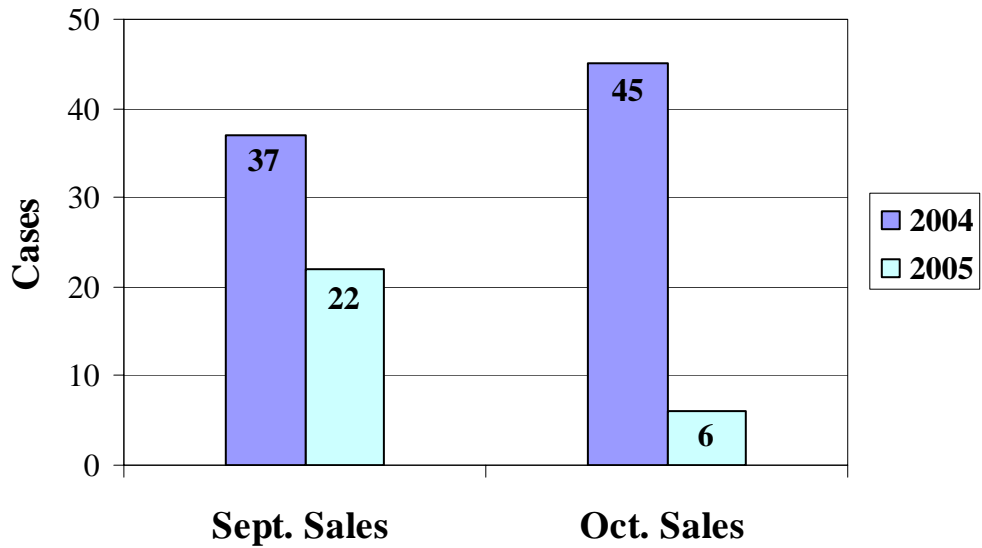
Temperature in Lutz Hall Vending Machine - Power Usage with VendingMiser Installed

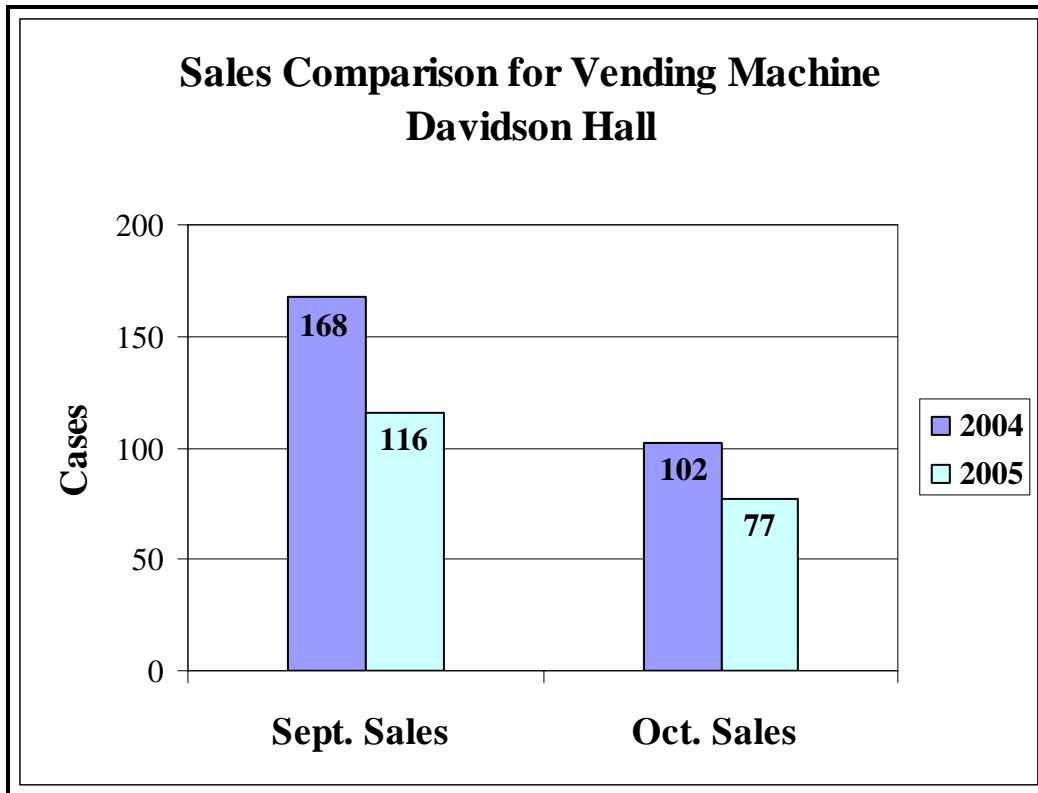


Sales Comparison for Vending Machine Lutz Hall



Sales Comparison for Vending Machine Brandeis Hall





One thing can be concluded; since energy usage is tied to sales, some part of the energy saving is due to the drop in sales. In order to investigate how much it is affected, the sales and usage September for the three machines was looked at side by side.

Sales and Energy Usage for Three Vending Machines (2005)				
Building	Sept. Sales (Cases)	Sept. Energy Usage (kWh)	Sales Comparison with Brandeis Hall	Energy Comparison with Brandeis Hall
Lutz Hall	11	216	50%	90%
Brandies Hall (Law School)	22	240	100%	100%
Davidson Hall	116	266	527%	110%

These are all the same model vending machine, except that Lutz Hall does not have a card reader, which was estimated at about 40W to 50W, or 18% to 23% of the total base power used. KPPC cautions against putting much weight on a comparison of one machine to the others, because there is some inconsistency between the data loggers.

These numbers simply indicate that, taking the machine in Brandeis Hall to be the reference case, energy usage is impacted by a little over 10% in the worst case scenario, where there were more than five times the sales. Since the differences in sales from September to October were small in comparison, even discounting the card readers, the effect of sales is considered to be small

4.4 Traffic Comparisons

The following table shows the percentage of time during the month of October the VendingMisers allowed the machines to be active. These numbers indicate the level of traffic seen by the occupancy sensors as opposed to the amount to actual sales. Maximum traffic was determined from the data collected during the VendingMiser-installed period of the test by calculating the percentage of samples where an average of two Watts or more was measured during the sample interval.

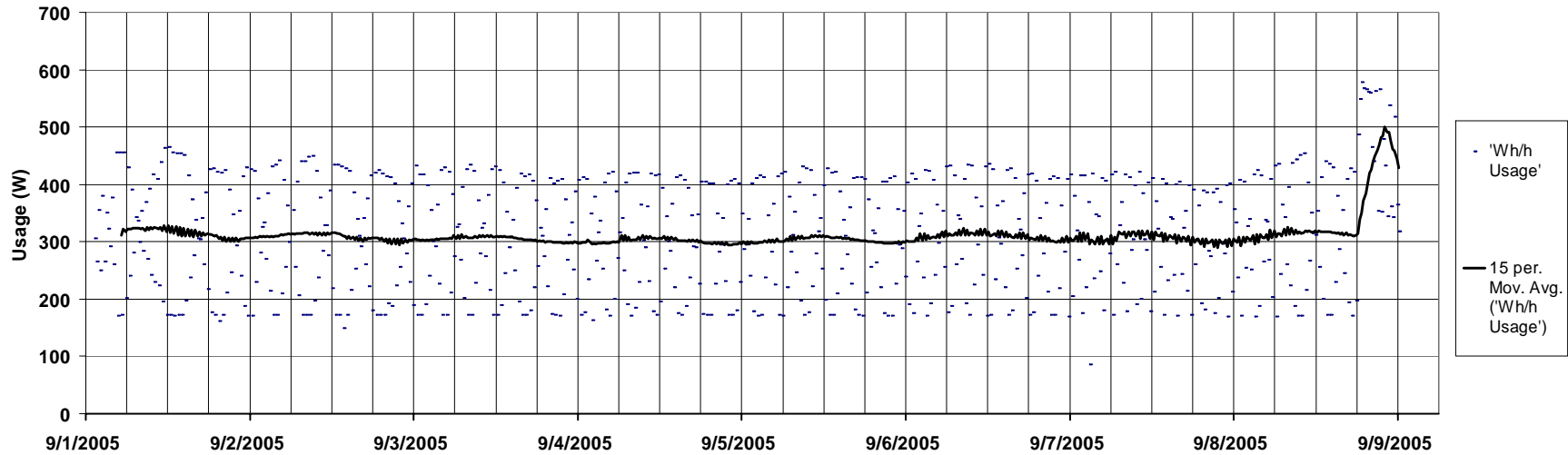
Maximum Daily Traffic	
Machine Location	Maximum Traffic
Lutz Hall	23%
Brandeis Hall	56%
Davidson Hall	64%

5.0 SUMMARY

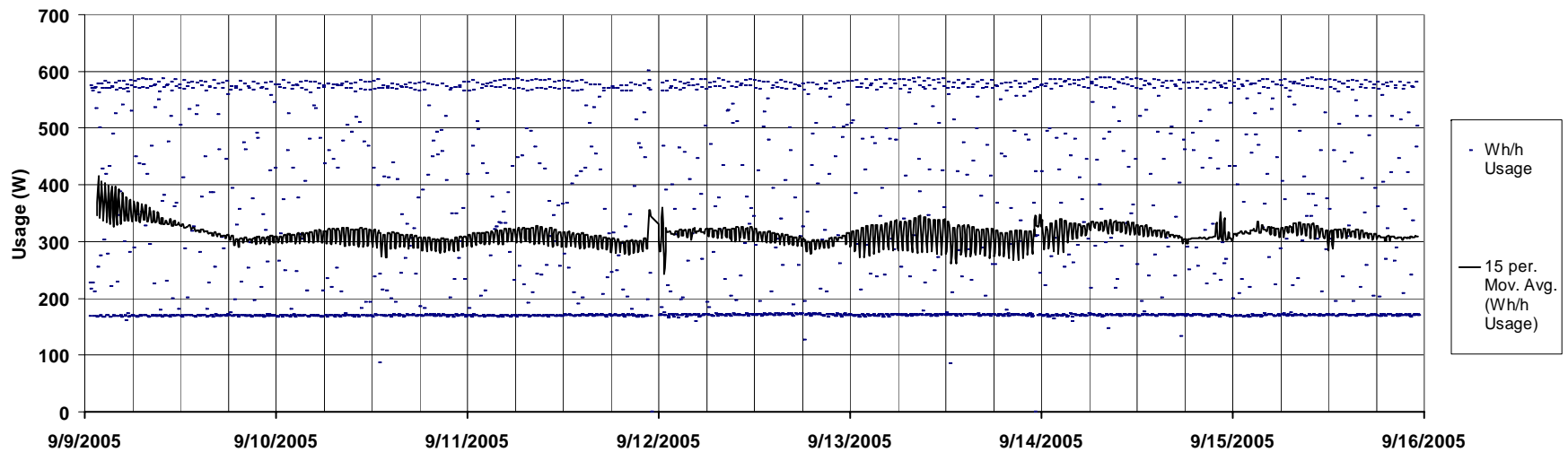
Energy savings between 28% and 63%, depending on the amount of traffic in the area, was achieved by installing VendingMisers on three machines at UofL. Sales data shows significantly more sales before the Misers were installed but sales data from the previous year show that a sharp decrease in sales may be caused by cooler weather. At best this data must be taken as inconclusive. Temperature logging inside the machine with the least usage indicate that the VendingMisers affect the temperature inside the machines by about 3°C. During the course of October 2005, there were no indications that the VendingMisers caused damage to the electronics in the machines and significant indications that the VendingMiser caused the compressor to cycle less often, which will cause a decrease in wear and tear on the machines.

APPENDIX A – Energy Usage Profiles for Lutz Hall Test Machine

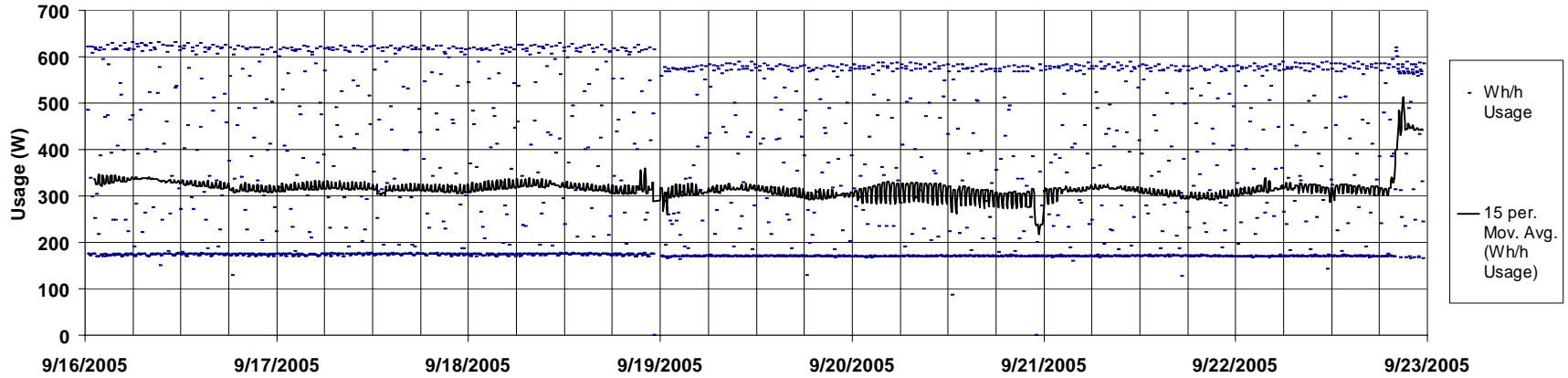
Power Usage of Vending Machine in Lutz Hall For 9/01/2005 to 9/09/2005



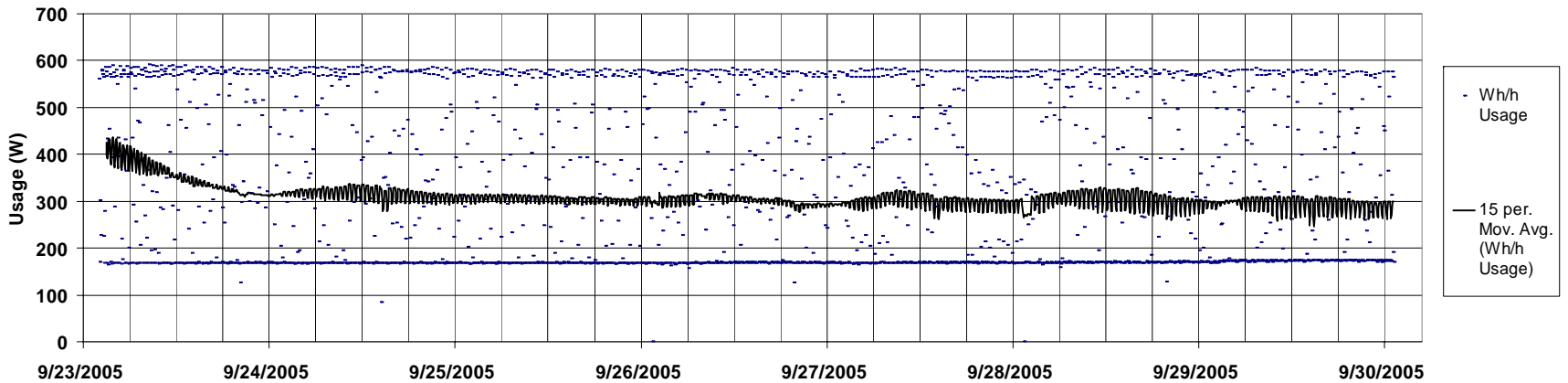
Power Usage of Vending Machine in Lutz Hall For 9/09/2005 to 9/16/2005



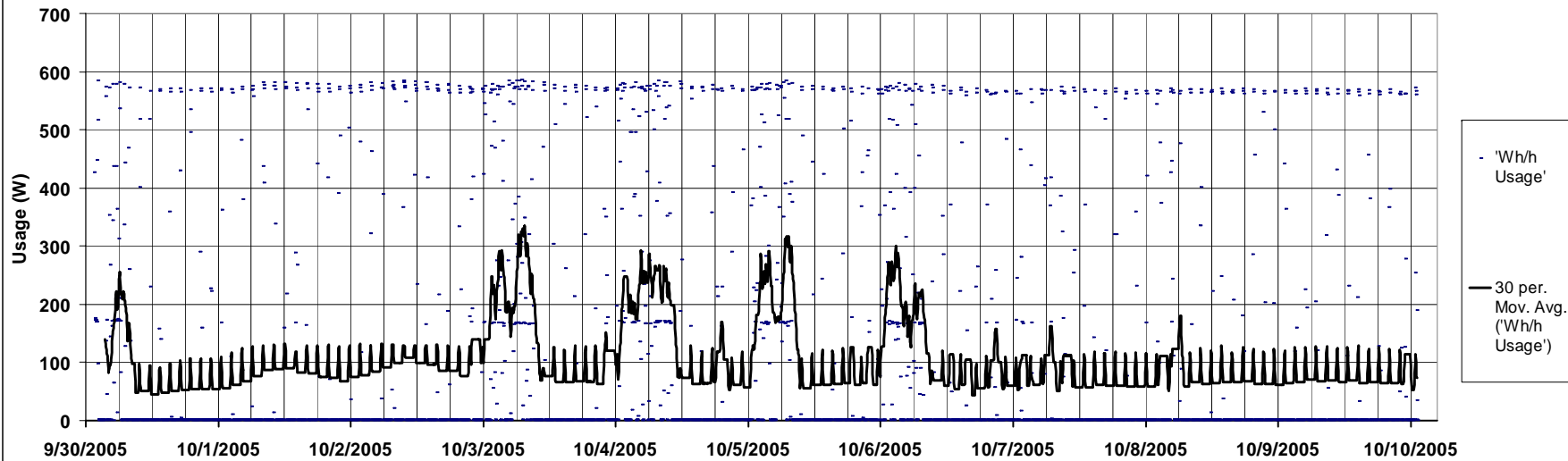
Power Usage of Vending Machine in Lutz Hall For 9/16/2005 to 9/23/2005



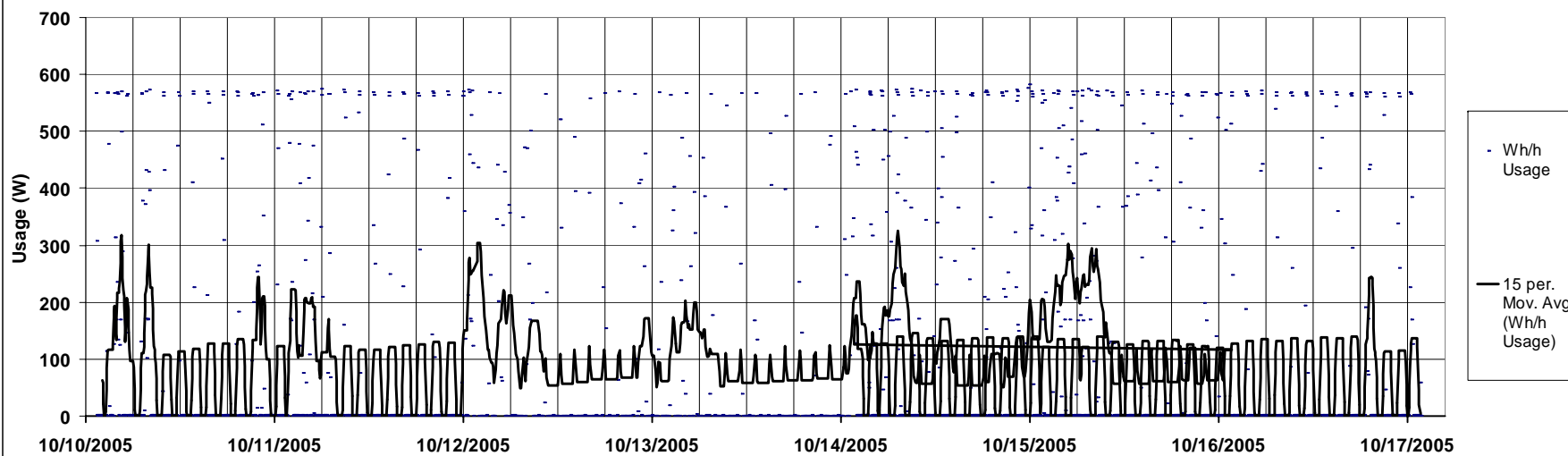
Power Usage of Vending Machine in Lutz Hall For 9/23/2005 to 9/30/2005



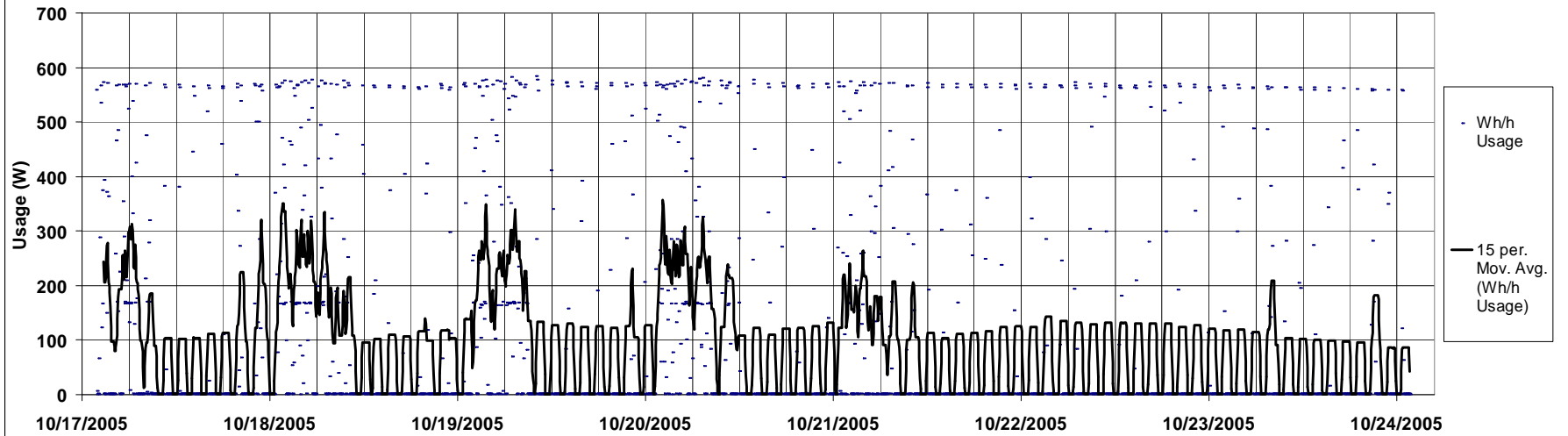
Power Usage of Vending Machine in Lutz Hall For 9/30/2005 to 10/10/2005



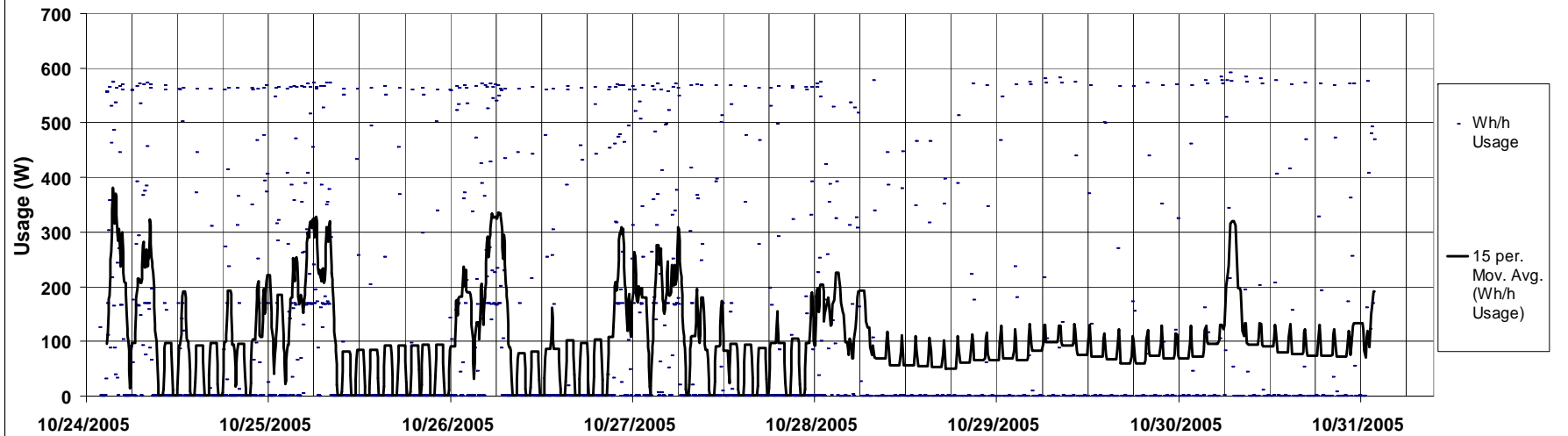
Power Usage of Vending Machine in Lutz Hall For 10/10/2005 to 10/17/2005



Power Usage of Vending Machine in Lutz Hall For 10/17/2005 to 10/24/2005

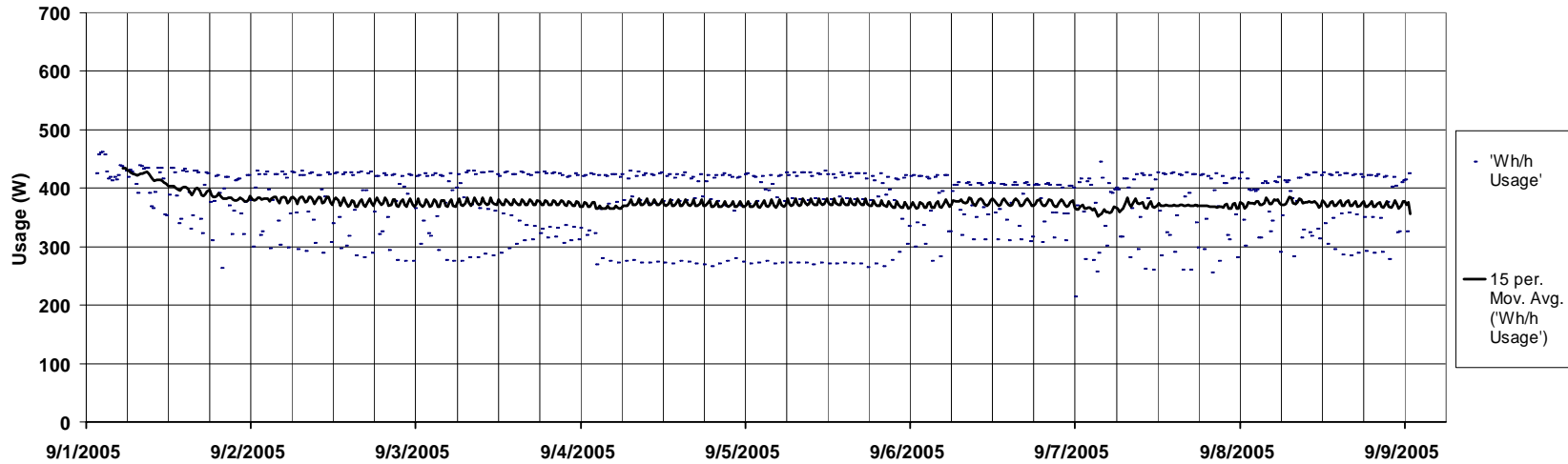


Power Usage of Vending Machine in Lutz Hall For 10/24/2005 to 10/31/2005

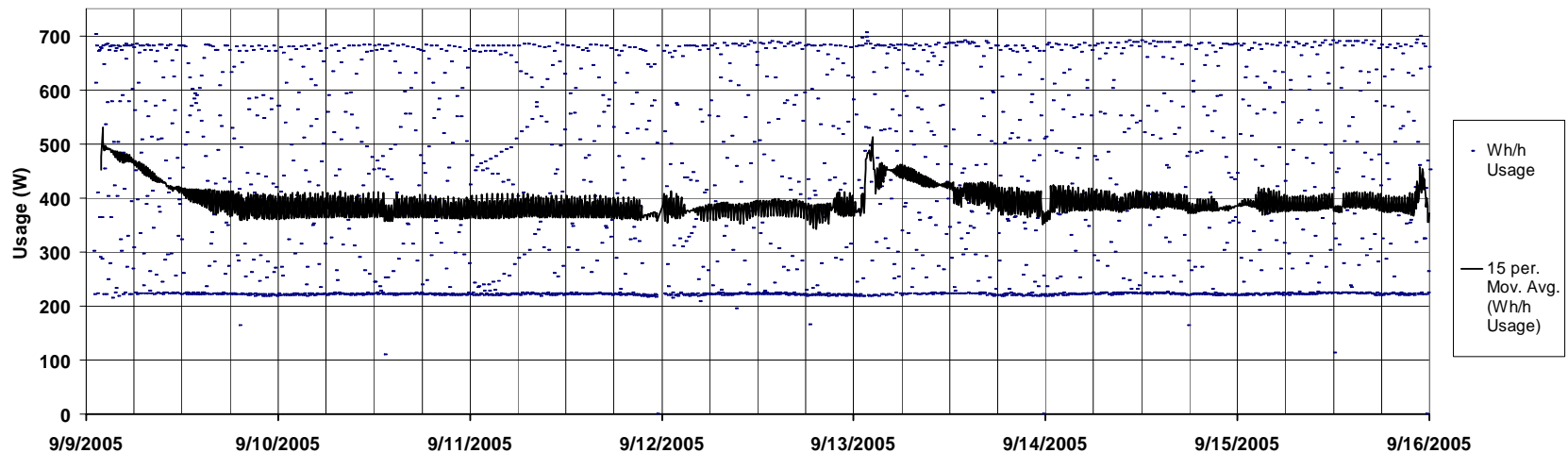


APPENDIX B – Energy Usage Profiles for Brandeis Hall Test Machine

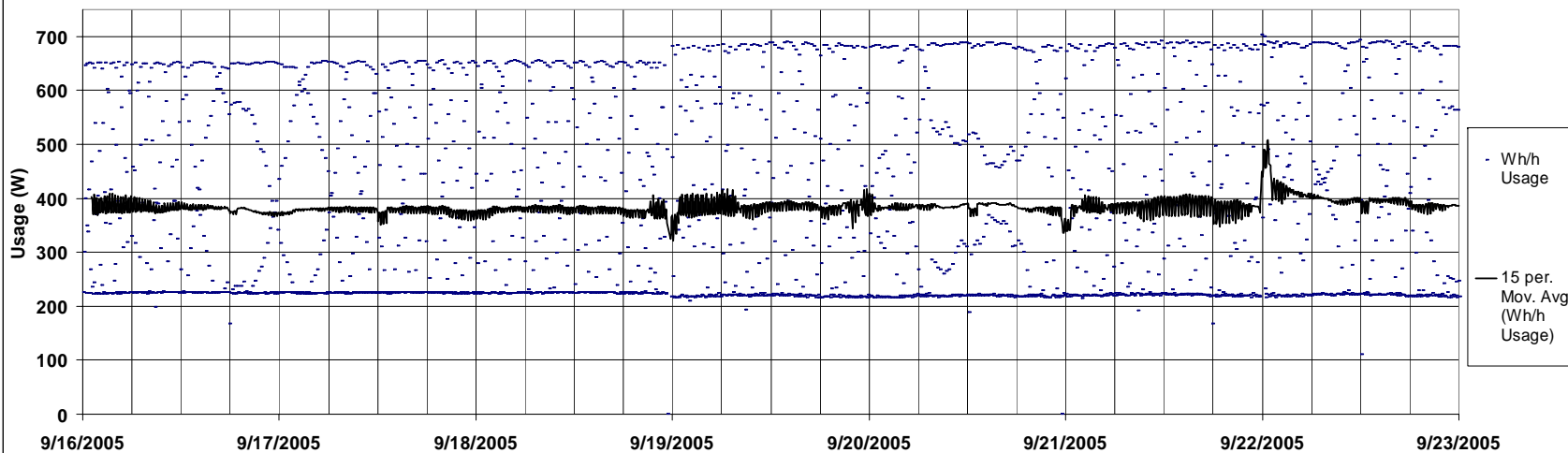
Power Usage of Vending Machine in Brandeis Hall For 9/01/2005 to 9/09/2005



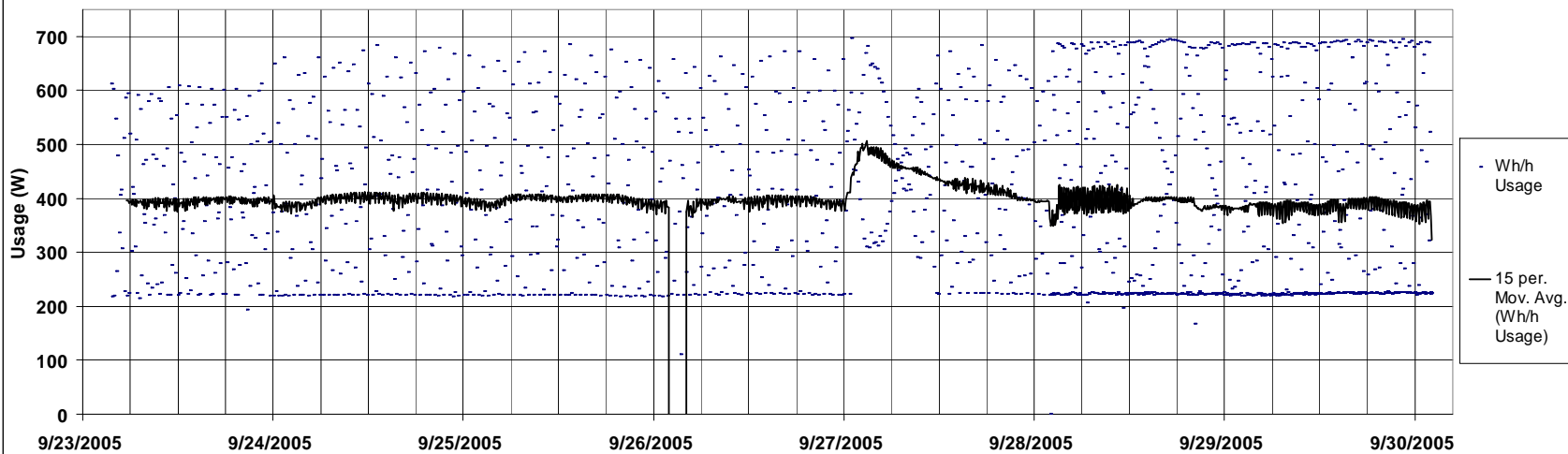
Power Usage of Vending Machine in Brandeis Hall For 9/09/2005 to 9/16/2005



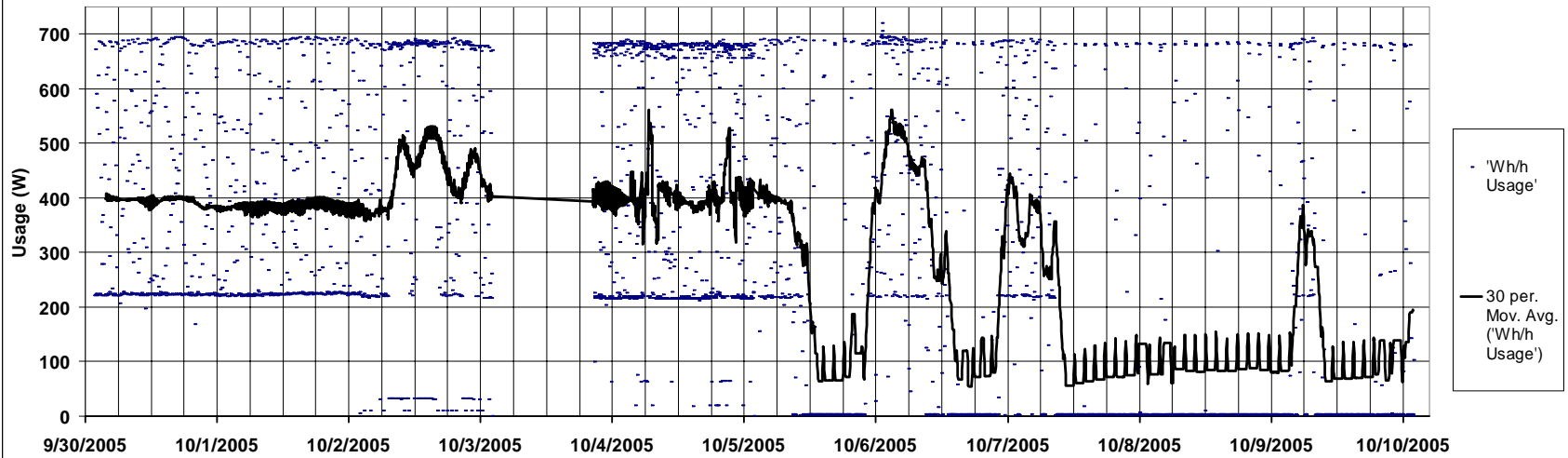
Power Usage of Vending Machine in Brandeis Hall For 9/16/2005 to 9/23/2005



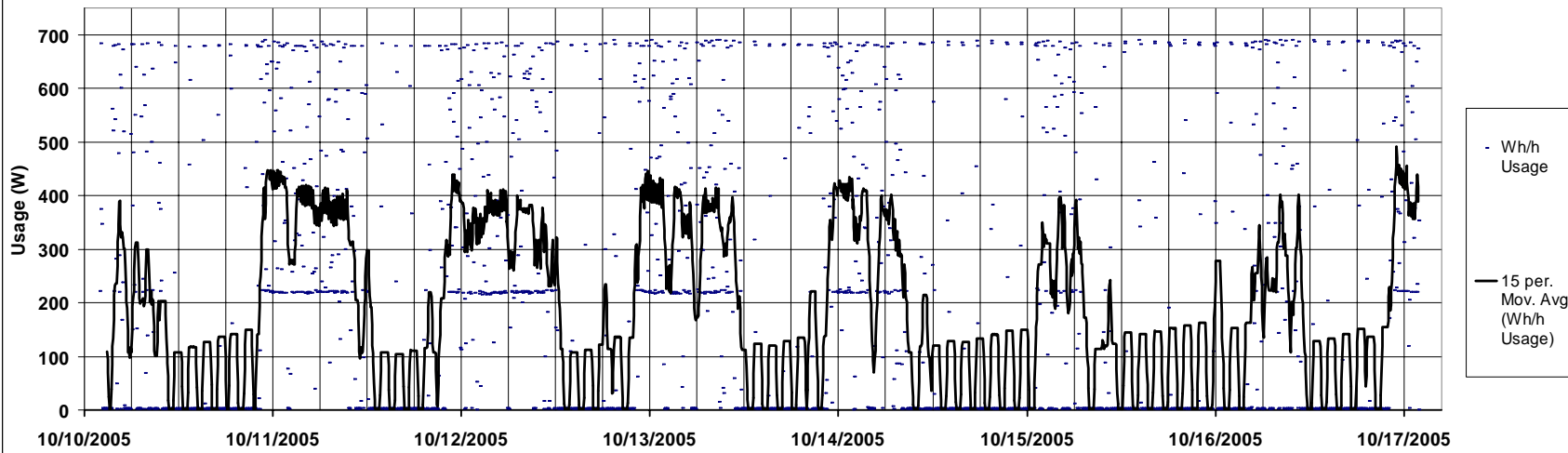
Power Usage of Vending Machine in Brandeis Hall For 9/23/2005 to 9/30/2005



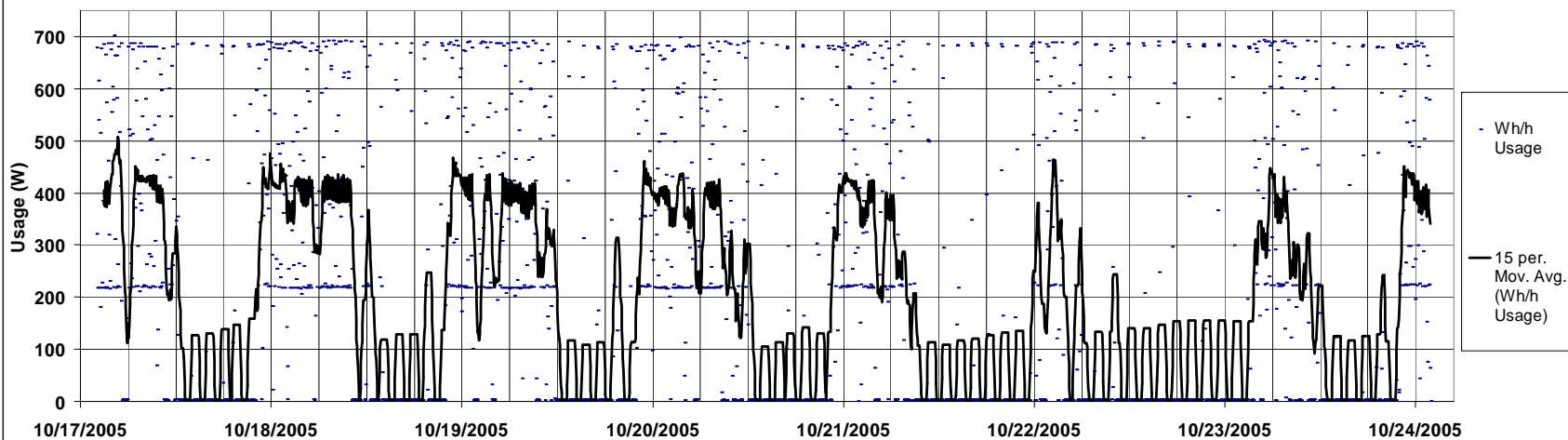
Power Usage of Vending Machine in Brandeis Hall For 9/30/2005 to 10/10/2005



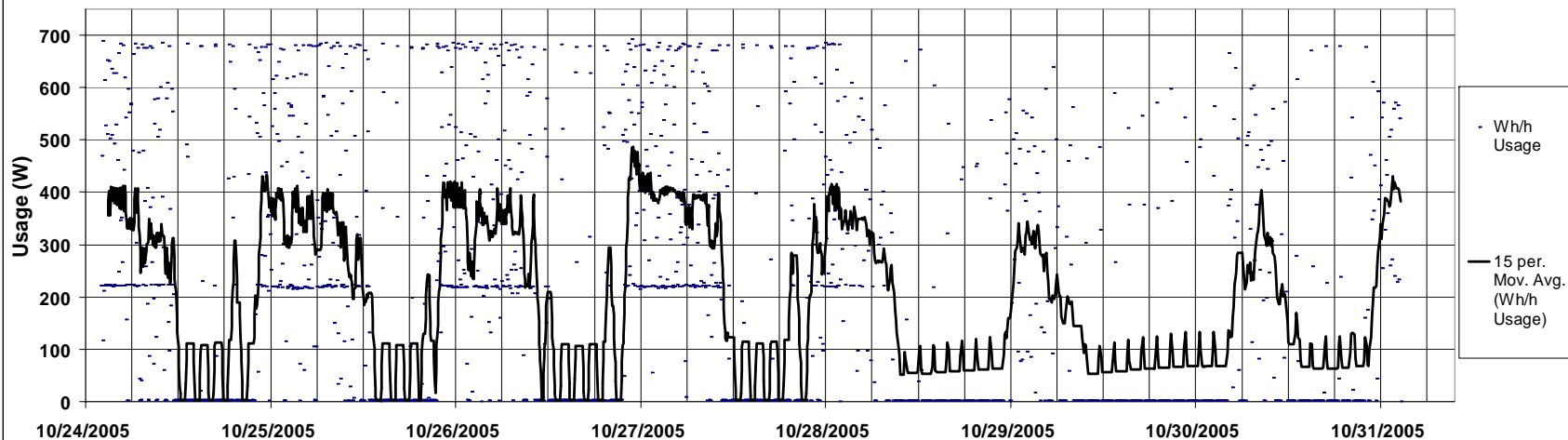
Power Usage of Vending Machine in Brandeis Hall For 10/10/2005 to 10/17/2005



Power Usage of Vending Machine in Brandeis Hall For 10/17/2005 to 10/24/2005



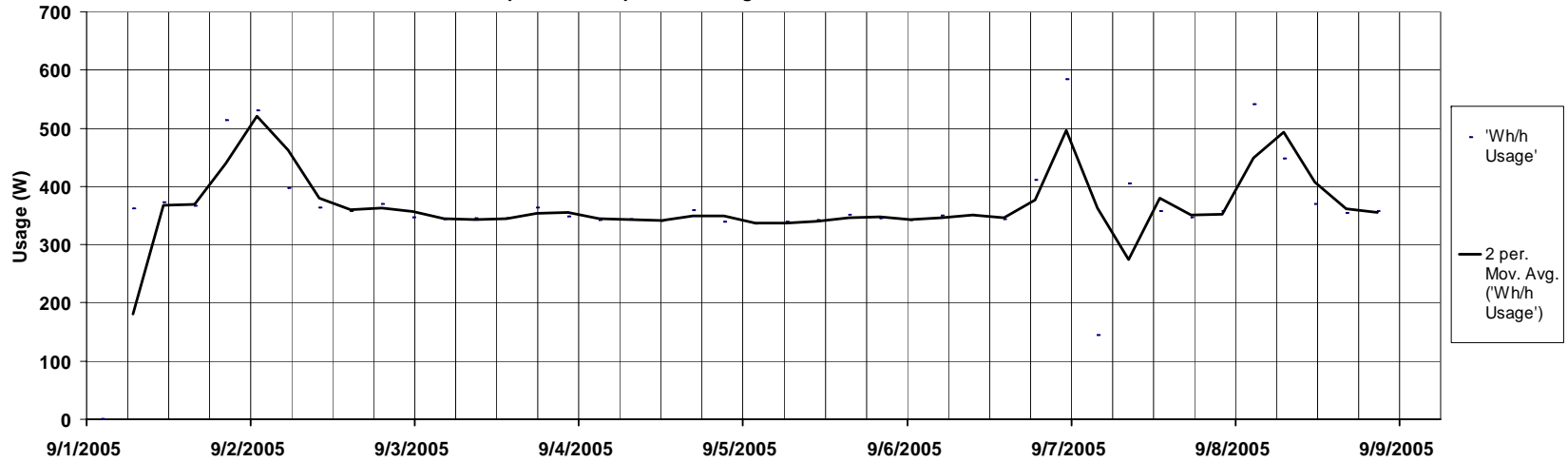
Power Usage of Vending Machine in Brandeis Hall For 10/24/2005 to 10/31/2005



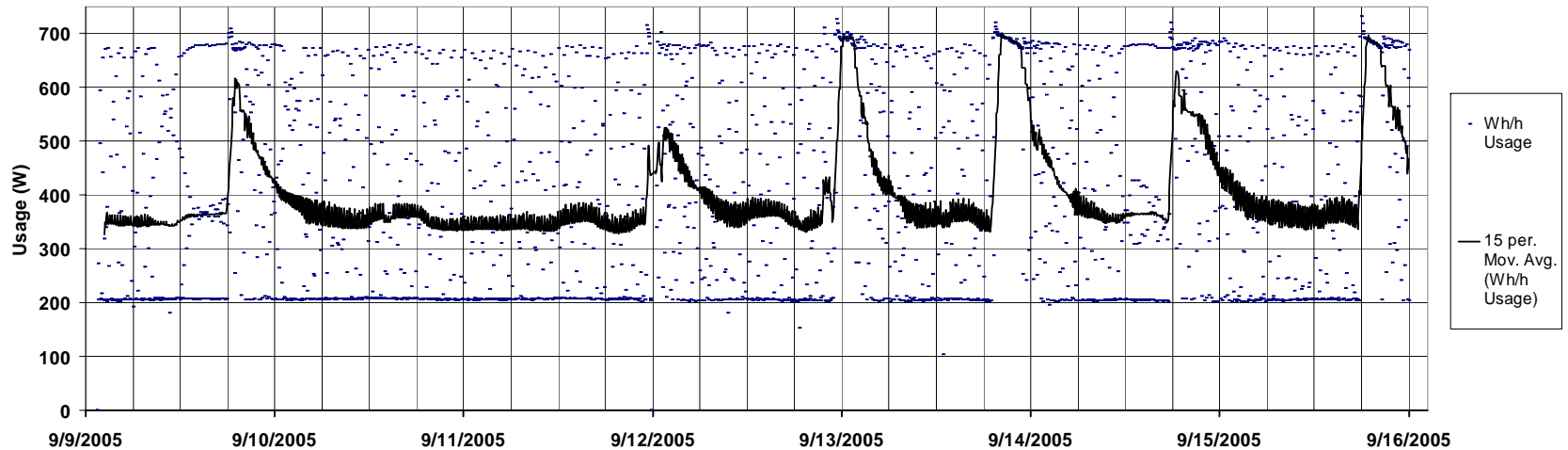
APPENDIX C – Energy Usage Profiles for Davidson Hall Test Machine

Power Usage of Vending Machine in Davidson Hall For 9/01/2005 to 9/09/2005

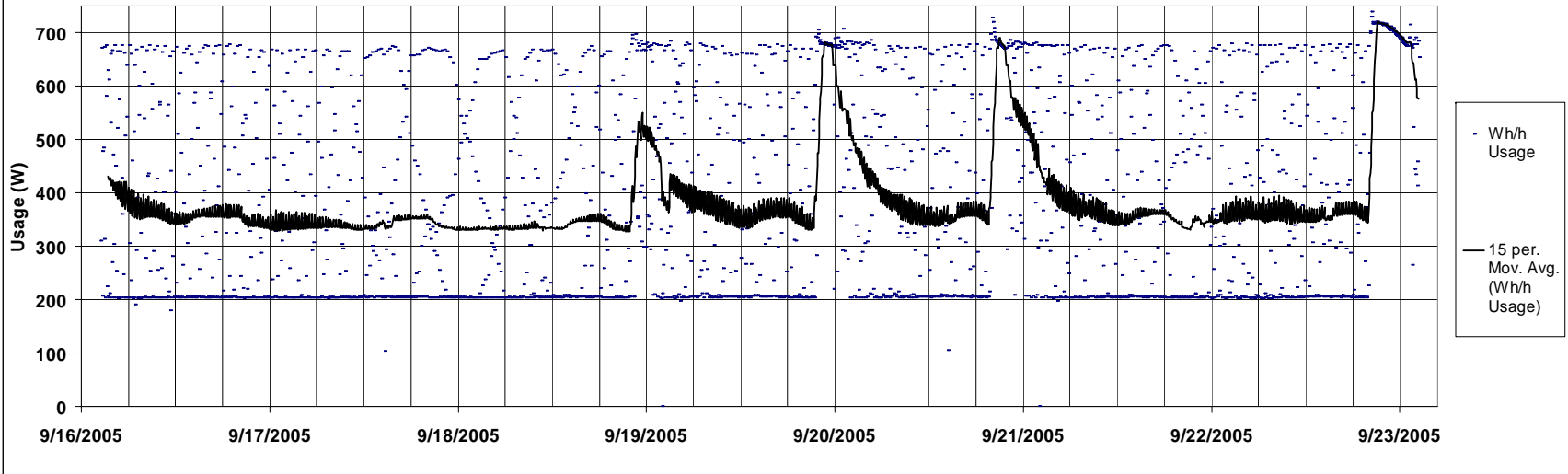
Sample time was pre-set at long interval. This was corrected after 9/09/05



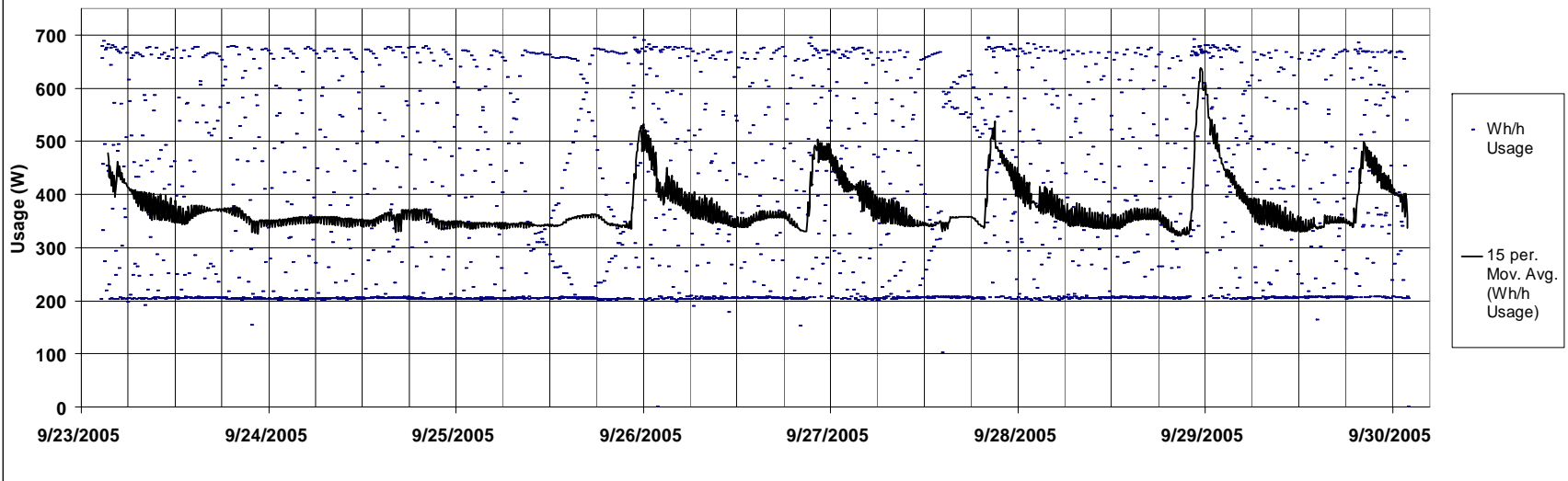
Power Usage of Vending Machine in Davidson Hall For 9/09/2005 to 9/16/2005



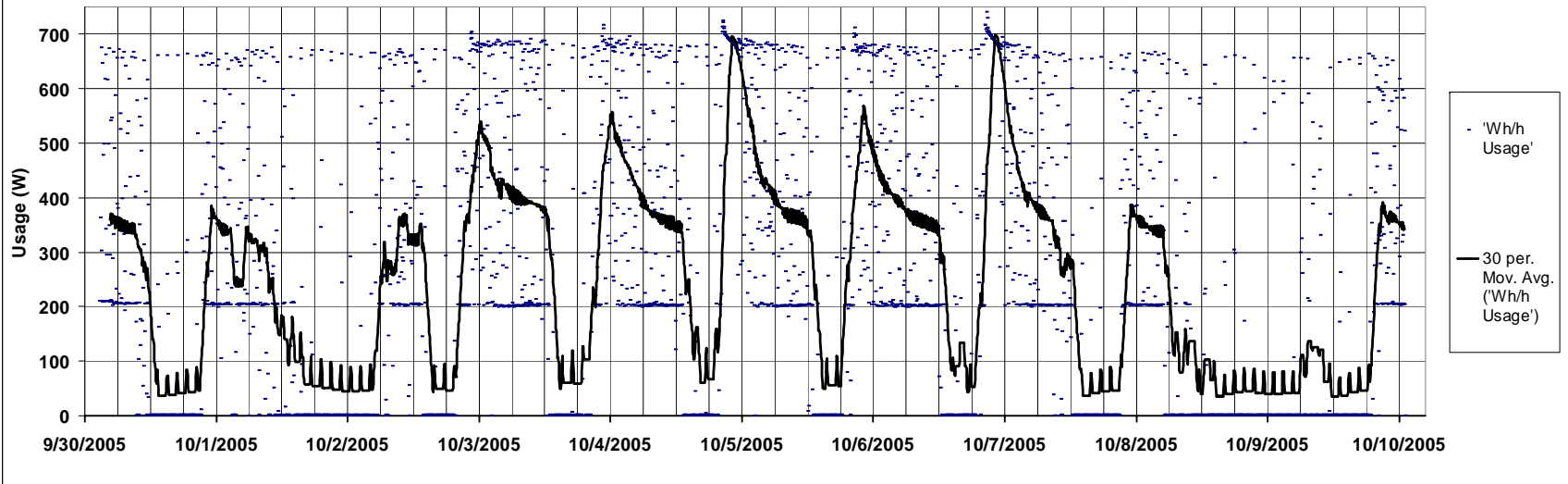
Power Usage of Vending Machine in Davidson Hall For 9/16/2005 to 9/23/2005



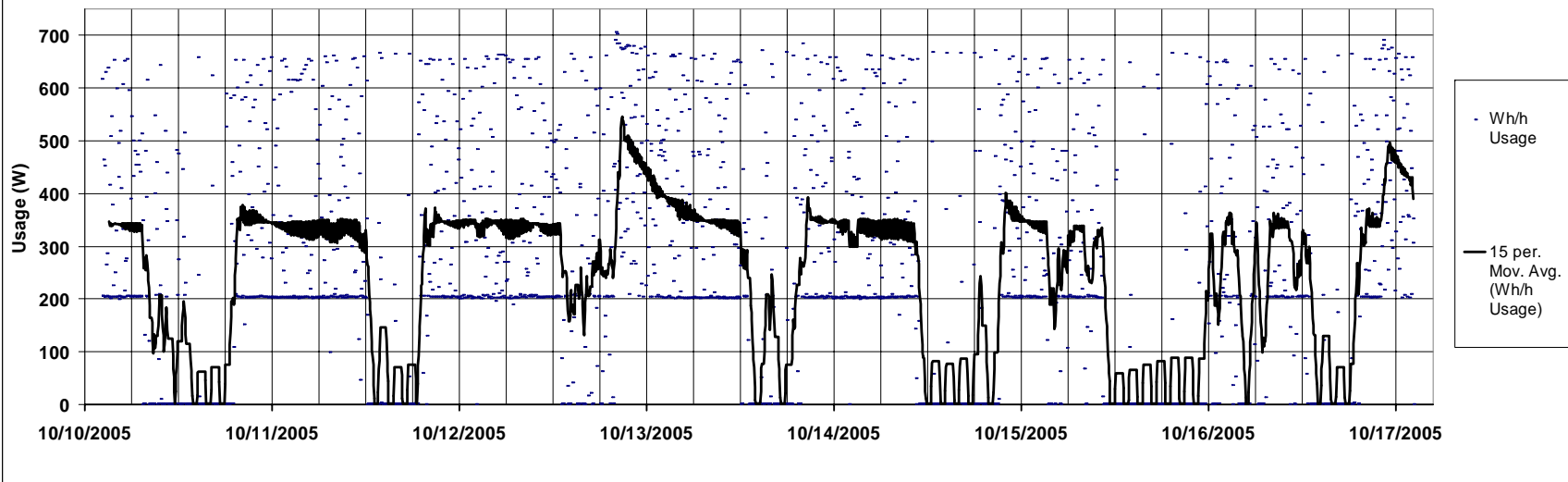
Power Usage of Vending Machine in Davidson Hall For 9/23/2005 to 9/30/2005



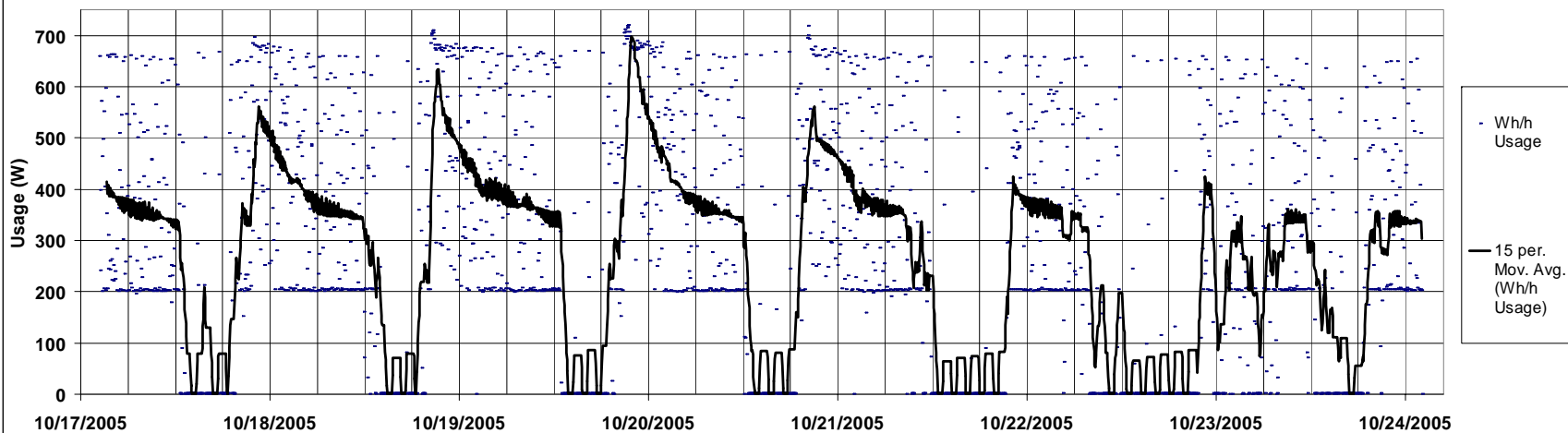
Power Usage of Vending Machine in Davidson Hall For 9/30/2005 to 10/10/2005



Power Usage of Vending Machine in Davidson Hall For 10/10/2005 to 10/17/2005



Power Usage of Vending Machine in Davidson Hall For 10/17/2005 to 10/24/2005



Power Usage of Vending Machine in Davidson Hall For 10/24/2005 to 10/31/2005

