ESL-TR-96/10-03

ESTIMATED SAVINGS FROM TURNING OFF UNNECESSARY ELECTRICAL LOADS DURING UNOCCUPIED PERIODS AT THE LANGFORD ARCHITECTURE CENTER

REPORT

Prepared by:

V. I. Soebarto
J. S. Haberl
L.O. Degelman

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ABSTRACT

This report presents the results of an on-off test conducted to determine the lighting load in the studios on the third and fourth floors of the Langford Architecture Center Building A and the savings that would be achieved by turning off the lights in those studios during unoccupied hours. Turning off the lights on the third and fourth floor studios would reduce the electricity cost by $4,757 per year and the associated heating and cooling costs by an additional $583 for a total savings of $5,340. If all unnecessary electrical loads could be turned off during the evening when not in use, as much as $34,200 per year could be saved at the Langford Architecture complex.

To achieve this saving, we first recommend that an energy awareness program be initiated. To implement this program, we suggest the following efforts: (1) conduct a more detailed analysis of all evening-time loads to determine which loads can be turned off without inconveniencing students or faculty/staff, (2) initiate a turn off program by hiring a student worker who would be responsible for turning off the lights in the studios and classrooms after midnight, (3) continue replacing the incandescent and 40W fluorescent fixtures with energy-efficient fixtures, (4) install high quality occupancy sensors in the studios and other rooms where cost justified. Finally, use the weekly monitoring by the Energy Systems Laboratory to track the progress and provide feedback to students and faculty/staff.

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BUILDING DESCRIPTION

The Langford Architecture Center consists of three buildings, A, B and C. Building A has four stories connected by an elevator and staircases in a large atrium. A small office is located on the fifth floor (rooftop). Clerestory lighting helps to illuminate the atrium during daylight hours. This building consists of studios, classrooms, offices, computer labs, and a library. Building C also has four stories connected by an elevator and staircases. It consists of classrooms, studios, offices, auditoriums, and a psychophysiology lab. Building B is a two-story building that has a center section with two large, open bay workshops attached on either end. On the second floor of the middle section is a storage area partly converted into an office for architecture graduate students. A sky-dome is located on the roof of this building, functioning as an architectural daylight simulator. The floor area of building A is approximately 102,105 sq.ft. The total floor area of building B and C is 69,914 sq.ft.

Lighting and receptacles

In general, the offices in building A and C are occupied from 8:00 a.m. to 5:30 p.m. Some classrooms are occupied until 10:00 p.m. for evening lectures. During workdays and Saturdays in the Fall and Spring semesters, the computer labs are occupied from 8:00 a.m. to midnight. On Sundays the labs are opened from noon to midnight. The studios in Building A are randomly occupied from 8:00 a.m. to midnight depending upon whether or not projects are due. However, regardless of the occupancy schedules, the lights in the studios and some classrooms in Building A and C are on 24 hours per day. Some professors also leave the lights and computers on in their offices continuously. The lighting of the corridors, lobby, and atrium are also on 24 hours per day. In building B, the lighting is often turned-off when the rooms are unoccupied.

The computers in the computer labs are on only during operating hours. However, most computers in the Visualization Lab and Electronic Design Studio as well as the servers are on continuously. Some computers in the professor's offices are also on 24 hours per day. Other receptacle loads in building A are the vending machines, which are on continuously; copy machines, printers, coffee makers, and microwave ovens, that are usually turned off during the unoccupied hours or remain in an idle condition when unused. In building B, the machines in the workshop are turned on only when they are in use.

HVAC systems

These three buildings use chilled water for space cooling and hot water for space heating provided by the Main Campus Central Plant. There is one electrical Motor Control Center (MCC) serving buildings A and B, and one MCC serving building C. Building A is served by 10 AHUs, each has a 30 hp (rated) supply fan motor and 7.5 hp (rated) return fan motor. It would appear that all the HVAC systems in building A are in need of repair. Observations conducted on July 3, 1996 revealed that the supply air duct of AHU-10 was torn in the middle, allowing a very large amount of cool air to flow into the mechanical room where it serves no purpose.

The office space on the roof is served by an air-cooled, package 10-ton rooftop unit. There are also two separate chillers (25 tons each or approximately 30 kW) which serve the Leibert cooling system in the Visualization Lab in Building A. The capacity of each chiller was estimated from the nameplate data (TRANE #CGADC304AAADWG) and from the whole-building measurements.

Energy monitoring

The electricity use and thermal energy use of the three buildings are monitored by the Energy Systems Laboratory (ESL) as part of the campus-wide monitoring study initiated in the Spring of 1995 by President Ray Bowen. The monitoring includes: the whole-building electrical use (WBE) for each building separately, the MCC for building A and B, the MCC for building C, the chilled water and hot water consumption (in gallons of flow and BTU) for building A, and the chilled water and hot water consumption (in gallons of flow and BTU) for buildings B and C. The chiller serving the Visualization

Lab is included in the WBE monitored data for building A. The ESL monitoring diagrams, weekly plots, and monthly energy consumption report are presented in Appendix A.

Energy Conservation Measures (ECMs)

The Langford Architecture Center was audited as part of the LoanSTAR program by an auditing firm hired by the Texas State Energy Conservation Office. The retrofit strategies (Energy Conservation Measures or ECMs) proposed by the energy auditor are as shown in Table 1.

TABLE 1. PROPOSED ENERGY CONSERVATION MEASURES (ECMs) FOR THE LANGFORD ARCHITECTURE CENTER

ECM	Description	Cost	Annual Savings	Payback (yr)	Status
1	Photocell Project: Install photocells to turn off hallway lights during the day time.	$1,062	$148	7.2	Not completed
2	Lamp Replacement: Replace existing incandescent lights in the corridors with compact fluorescent lights.	$3,484	$3,244	1.1	Completed
3	Studio Occupancy Sensors: Install 18 occupancy sensors to turn off the lights in the studios during unoccupied periods.	$7,702	$2,399	3.2	Not completed
4	VAV Modification: Replace the existing inlet vane VAV control with Variable Frequency Drive control.	$213,795	$55,809	3.8	Under construction
5	Variable CHW Pumping: Install Variable Frequency Drive and controls on the chilled water pump to obtain variable speed pumping.	$20,952	$6,863	3.1	Under construction
	TOTAL	$246,995	$68,463	3.6	--

ECM 4 and ECM 5 are being installed during Fall 1996 as part of the retrofit project for all campus buildings. ECM 2 was carried out by the Physical Plant. Recently, the 40W fluorescent lamps in all the studios are being replaced with 34W fluorescent lamps. However, no definite plan has been established to complete ECMs 1 and 3.

ON-OFF TEST

This section presents the results of the test to determine the lighting load in the studios in Building A. Section III presents the estimation of savings that could be achieved by turning off the lights in those studios during unoccupied periods. It also presents the target savings that could be achieved by controlling the use of the lights in other spaces in the building.

Conducting the test

A preliminary on-off test was conducted to measure the lighting load in the studios on the third and fourth floors of the Langford Architecture Building A. This test was conducted on May 4, 1996, by several students of the ARCH 333 class. Each studio (approximately 10,000 sq.ft.) occupies about 40% of the total area of each floor (approximately 40,000 sq.ft.). Thus, both studios occupy about 20% of the total floor area of building A. Both studios have indirect lighting. The fixtures utilize a single 40W fluorescent lamp.

In the tests, the lighting in the studio on each floor was divided into two sections (A and B). However, the lighting for both third and fourth floor computer labs were not included. The lights were then turned on and off using the light switches. Prior to the test, the data logger was set to monitor the tests at 1-minute intervals. The tests started with all lights turned on. The lights of the first group on the third floor were then turned off, followed by turning off the lights of the second group on the third floor. Next was to turn off the lights of the first group on the fourth floor, followed by turning off the light of the second group on that floor. During these tests, other electrical equipment such as the air handling units, the chillers and the computers remained operational because the area maintenance personnel would not allow the equipment to be turned off. Five minutes were allowed to elapse between switching modes. However, it was then noticed that there were some "spikes" in the data, which were caused by the on/off switching of the chillers that served the Visualization Lab (Figure 1). The existence of these spikes made it difficult to determine the load in each step. Therefore, the logger was then set to record the electrical use for an additional 10 minutes before turning on the lights of the other section.

Analyzing the results

To determine the lighting load in each section (i.e. group A and B on the third floor and group A and B on the fourth floor), some adjustments were made by assuming that the spikes were not present (i.e., shave the spikes). The lighting load in each studio was then estimated by calculating the difference of the electrical load between one step to the next (Figure 2).

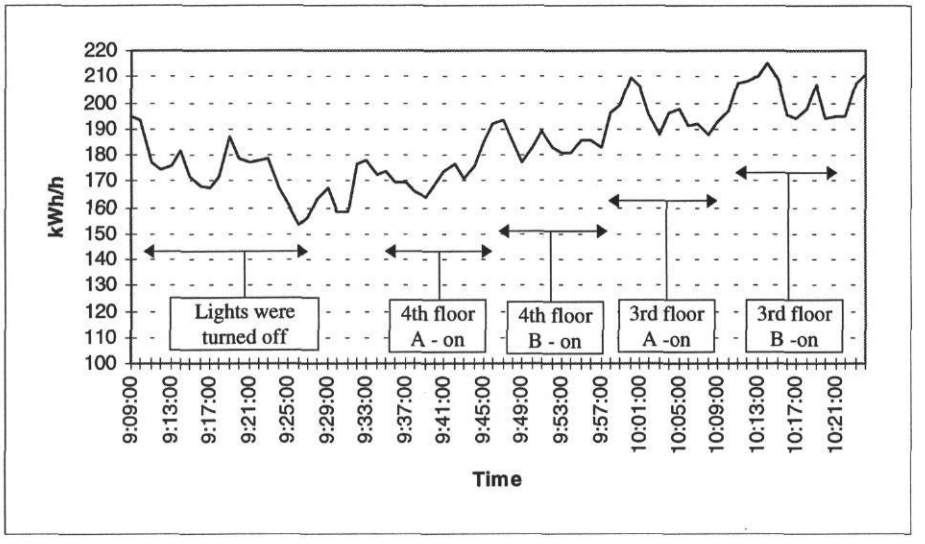


FIGURE 1. UNADJUSTED ON-OFF TEST RESULTS.

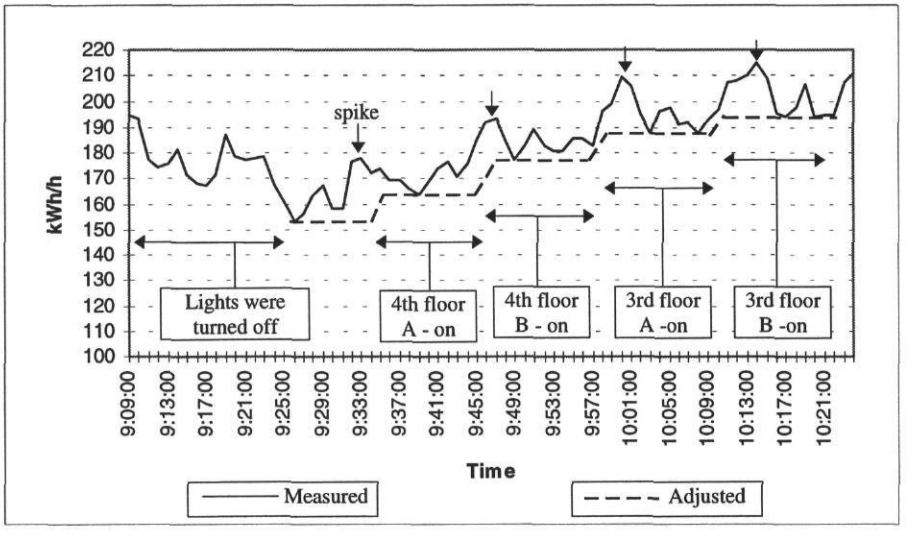


FIGURE 2. ADJUSTING THE ON-OFF TEST RESULTS.

The results were also compared to the values obtained by manually counting the number of fixtures that were turned on in each studio, multiplied by the wattage of each fixtures (40 Watt), and taking into account an estimated ballast factor (1.2). Both methods yielded similar results as shown in Table 2. The lighting load of the third and fourth floors studio was about 18 kW and 21 kW respectively, or about 1.8 W/sq.ft. and 2.1 W/sq.ft. correspondingly.

TABLE 2. COMPARISON OF ON-OFF TEST RESULTS AND ESTIMATION FROM OBSERVATION

Group	On-off test results kW	Estimated from observation		% difference
		# of light	kW	
4th Floor Group A	10	190	9.12	-9
4th Floor Group B	12	247	11.8	-2
3rd Floor Group A	9	195	9.4	4
3rd Floor Group B	8	172	8.3	4
TOTAL	**39 kW**	804	**38.6 kW**	**1 %**

ESTIMATION OF SAVINGS

Savings from turning off the lights of the two studios

The on-off test results were used to estimate the electricity savings that could be achieved if the lights in the above spaces were turned off during the unoccupied periods. Currently, the lights in these studios are on 24-hours per day. Thus, during the unoccupied periods, the building wastes about 39 kW for the lights of the two studios (or 2 Watts/ sq.ft.). During the summertime there is also a cooling load associated with these lights. In the winter these lights add heat to the space.

The LoanSTAR weekly monitored data showed that building A uses a total of 300 kW at nights and during the unoccupied periods (Figure 3). This 300 kW includes approximately 110 kW of MCC (see Figure 3), and approximately 25-50 kW for the two chillers for the Visualization Lab. This leaves about 140 kW for the lights and receptacles. Thus, during the unoccupied periods the lights of the third

and fourth floor studios used about 13% of the total electrical consumption or 30% of the electrical use for lights and receptacles in Building A.

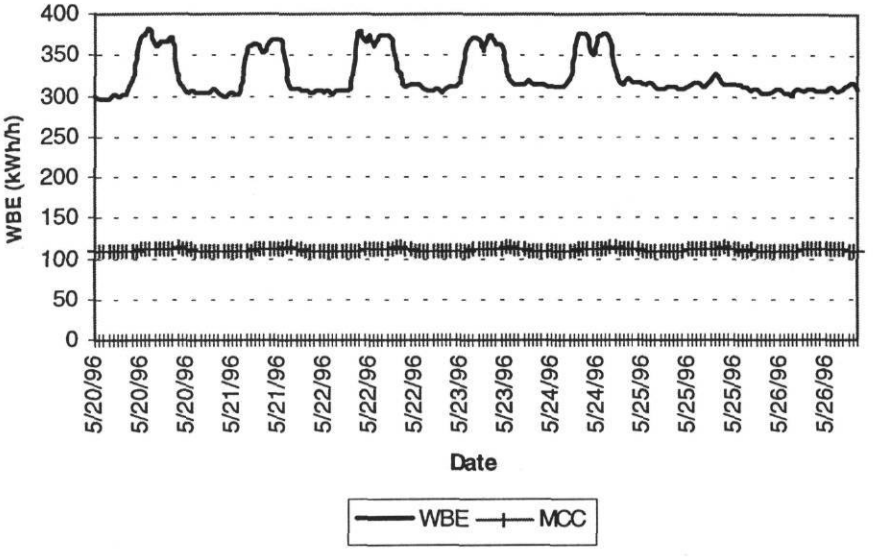


FIGURE 3. ONE WEEK OF HOURLY WHOLE-BUILDING ELECTRICITY USE IN BUILDING A.

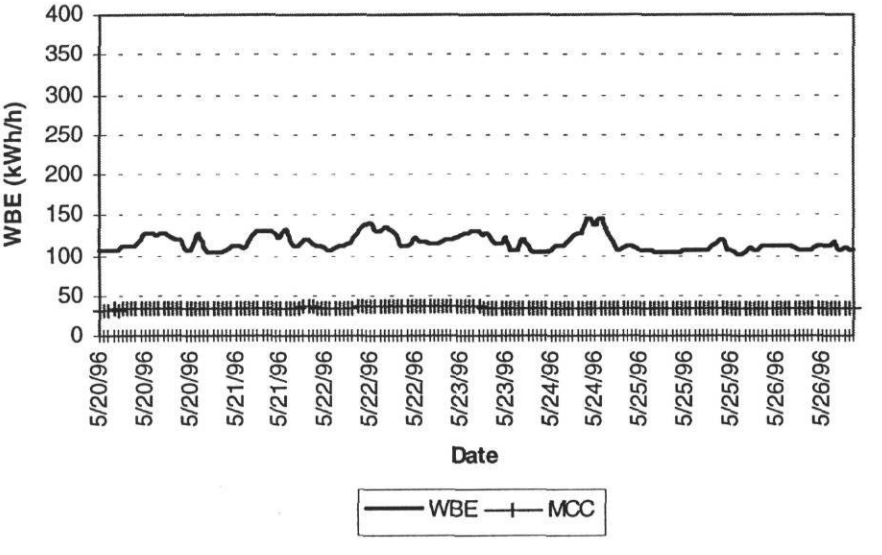


FIGURE 4. ONE WEEK OF HOURLY WHOLE-BUILDING ELECTRICITY USE IN BUILDING B AND C.

Assuming that the studios were unoccupied from 10:00 p.m. to 8:00 a.m. (10 hours/day) on the workdays and from 10:00 p.m. to 12:00 noon (14 hours/day) on the weekends, the savings that could be achieved by turning off the lights of the studios during the unoccupied periods are estimated as follow:

Estimated lighting energy saving:

= 39 kW x 10 hrs/day x 261 workdays/year +
39 kW x 14 hrs/day x 104 weekends/year
= 158,574 kWh/year

Estimated annual energy cost savings from reduction in electricity use due to reduced lighting energy for the studios in Building A:

= $0.03/kWh(**) x 158,574 kWh
= **$4,757.**

The reduction on the electrical load is estimated to result in a 1 Btu to 0.7 Btu reduction of the chilled water use (for space cooling during the cooling season) and a 1 Btu to 0.7 Btu addition of hot water use (for space heating during the heating season). This is based on the assumption that the electrical lighting gives 70% of its heat to the space which then becomes an HVAC load. The estimated total savings are:

Estimated annual chilled water savings (8 months of the year will be in a cooling mode):

= 8/12 x 0.7 x 158,574 kWh x 3,413 Btu/kWh
= 253 MMBtu.

Estimated annual chilled water cost saving:

= 253 MMBtu x $4.67/MMBtu of chilled water (**)
= **$1,181.**

Estimated reduction of savings from additional hot water use (4 months of the year):

= 4/12 x 0.7 x 158,574 kWh x 3,413 Btu/kWh
= 126 MMBtu.

Estimated annual additional cost:

= 126 MMBtu x $4.75/MMBtu of hot water (**)

= **$598.**

Total annual cost savings (electric cost savings + cooling cost savings - heating costs):

= $4,757 + $1,181 - $598

= **$5,340.**

Note: (**) The unit costs $0.03/kWh for electricity, $4.67/MMBtu for chilled water, and $4.75/MMBtu for hot water, represent the unit costs used by the Energy Systems Laboratory to report the LoanSTAR savings for the Texas A&M campus. There would be no savings due to electric peak demand reductions since the campus co-generates electricity.

Estimated savings from turning off other unnecessary lights

In the previous section, only the lights of the studios were taken into account. From a brief observation of the entire building conducted in the evening of June 3, 1996, it was learned that there were many more unnecessary lights that were on during the unoccupied periods besides the lights in the studios (e.g. the lights of some faculty offices, classrooms, and the atrium). Thus, more savings could be achieved by turning off these lights during the unoccupied periods. From the observation, it was learned that the lights in the following unoccupied rooms were on:

Building A:

- First floor: corridor, entry hall, Rm. 105, rest rooms.
- Second floor: hall, rest rooms.
- Third floor: studio, class rooms (318, 302), four offices, rest rooms.
- Fourth floor: studio, classrooms (403, 404, 445), three offices, rest rooms.

Building C:

- First floor: corridor, rest room.
- Second floor: corridor, rest room, studios (204, 206).

- Third floor: corridor, rest room, studios (304, 306), classroom (307).
- Fourth floor: corridor.

Table 3 presents the estimated electricity savings that could be achieved if most of the lights of the rooms above were to be turned off during the unoccupied hours. Since lighting in the corridors is necessary, only one half of the lights in this space were considered to be turned off. Also, no bathroom lights were included in this table.

TABLE 3. ESTIMATION OF ENERGY SAVINGS FROM TURNING OFF UNNECESSARY LIGHTS IN BUILDING A AND C.

Room	Number of lights	Estimated load (kW)	Percentage to be turned off	Estimated saving (kW)
Building A (*):				
First floor: Rm. 105 A	12 (40 W)	0.6	100%	0.6
Corridor	30 (40 W)	1.4	50%	0.7
Third floor: Studio	367 (40W)	17.6	100%	17.6
Rm. 318	32 (40 W)	1.5	100%	1.5
Rm. 302	36 (40 W)	1.7	100%	1.7
4 Offices	48 (40 W)	2.3	100%	2.3
Fourth floor: Studio	437 (40 W)	22	100%	22
Rm. 403	36 (40 W)	1.7	100%	1.7
Rm. 402	28 (40W)	1.3	100%	1.3
Rm. 445	28 (40W)	1.3	100%	1.3
3 Offices	36 (40 W)	1.7	100%	1.7
Total Building A:		**53.1**		**52.4**
Building C:				
First floor: Corridor	108 (40 W)	5.2	50%	2.6
Second floor: Corridor	40 (40 W)	1.9	50%	0.8
Studio 204	154 (34 / 40W)	6.8	100%	6.8
Studio 206	154 (34 / 40W)	6.8	100%	6.8
Third floor: Corridor	34 (40 W)	1.6	50%	0.8
Studio 304	154 (34 / 40W)	6.8	100%	6.8
Studio 306	154 (34 / 40W)	6.8	100%	6.8
Class 307	40 (40 W)	1.9	100%	1.9
Total Building C:		**37.8**		**33.3**
TOTAL		**90.9**		**85.7**

(*) the lights on the entry halls and around the atrium are not included.

Currently, the total whole-building electricity use during unoccupied periods is about 410 kW or 2.4 Watt/sq.ft. (Figure 5). With a reduction of 85.7 kW from turning off the lights as shown in Table 3, the hourly whole-building electricity use would become 324.3 kW or about 1.9 Watt/sq.ft. Previous retrofit projects conducted by the Energy Systems Laboratory at the University of Texas at Austin campus showed that the electrical use during unoccupied periods in similar buildings could be reduced to about 0.5 to 1.0 Watt/sq.ft. Thus, if the same savings were to be achieved at the Langford Architecture Center, the electrical use in all three buildings during unoccupied periods could be further reduced to 172 kW (or 1.0 Watt/sq.ft.). This means that currently there are about 150 kW of other unnecessary loads that could potentially be turned off during unoccupied periods.

To achieve this goal, additional on-off tests for the entire complex should be conducted. Also, all receptacle loads and computer systems should be investigated to determine which systems can be turned off during unoccupied periods. Then, to minimize the energy use during unoccupied periods several strategies may be applied, including: (1) manually turning off the lights and other unnecessary loads when the space is unoccupied, (2) using occupancy sensors that will only turn on the lights when the space is occupied, and (3) replacing the current fixtures with energy-efficient fixtures. Specifically in building C, we should also consider moving the location of the light switches of the studios to an accessible place, so that the lights can be easily controlled (the current location of all light switches is in the hallway corridor in front of either the men's or women's rest room).

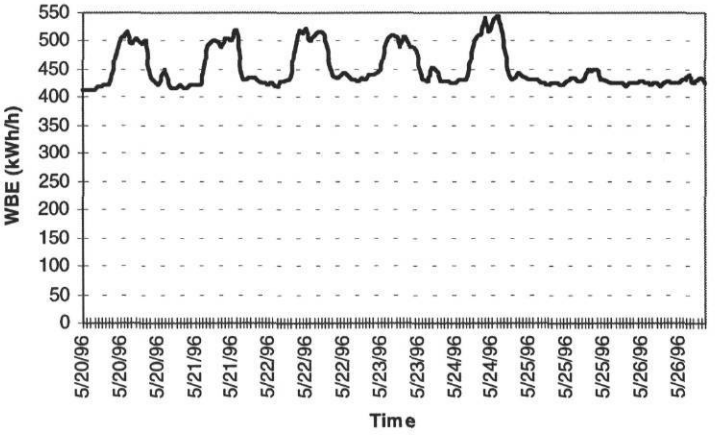


FIGURE 5. ONE WEEK OF HOURLY WHOLE-BUILDING ELECTRICITY USE OF ALL THREE BUILDINGS.

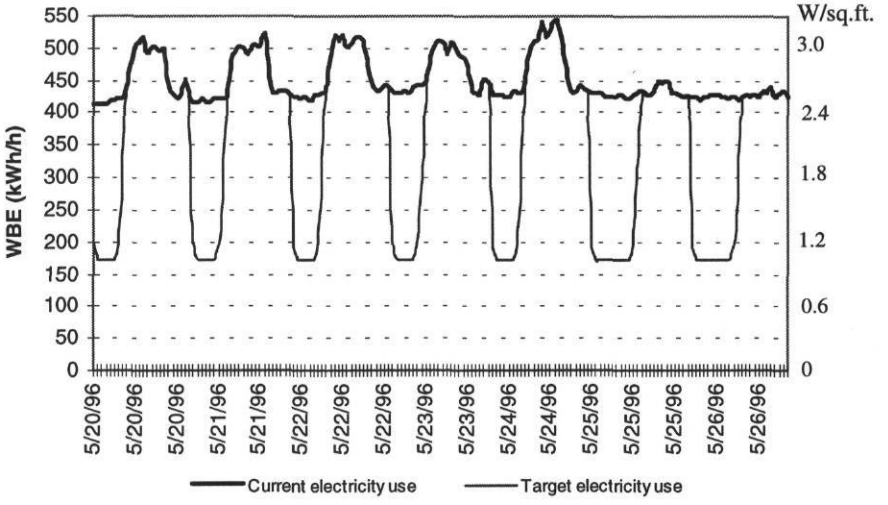


FIGURE 6. TARGET OF WEEKLY ELECTRICITY USE

Target of future savings

If the electricity use during unoccupied periods were to be reduced to about 1 Watt/sq.ft. during the evening (or to about 172 kW) as shown in Figure 6, the current electricity use could be reduced by about 230 to 250 kW (410 kW - 172 kW). The estimated savings are as follow:

Estimated annual total electricity saving:

= 250 kW x 10 hrs/day x 261 workdays/year +

250 kW x 14 hrs/day x 104 weekends/year

= 1,016,500 kWh

Estimated annual electricity cost savings from the lighting reduction alone would be:

= $0.03/kWh x 1,016,500 kWh

= **$30,495**

Similar to the previous calculations, the reduction of the electrical load is estimated to result in a 1 Btu to 0.7 Btu reduction of the chilled water use (for space cooling during the cooling season) and a 1 Btu to 0.7 Btu addition of hot water use (for space heating during the heating season). The estimated savings are:

Estimated annual chilled water savings (8 months of the year will be in a cooling mode):

= 8/12 x 0.7 x 1,016,500 kWh x 3,413 Btu/kWh

= 1,619 MMBtu.

Estimated annual chilled water cost saving:

= 1,619 MMBtu x $4.67/MMBtu of chilled water (**)

= **$7,561**

Estimated increase in hot water use (4 months of the year):

= 4/12 x 0.7 x 1,016,500 kWh x 3,413 Btu/kWh

= 810 MMBtu

Estimated annual additional cost:

= 810 MMBtu x $4.75/MMBtu of hot water (**)

= **$3,848**

Total annual cost savings (electric cost savings + cooling cost savings - heating costs):

= $30,495 + $7,561 - $3,848

= **$34,208**

SUMMARY AND RECOMMENDATIONS

A total potential saving of about $34,200 per year could be achieved if the use of lighting and receptacles in the Langford Architecture buildings could be minimized during unoccupied periods[1]. To achieve this saving, we first recommend that an energy awareness program be initiated, perhaps with a potential reward mechanism (like a certificate and picture with Dean Wendler). To implement this program, we suggest the following efforts:

(1) Conduct a more detailed analysis of all evening-time loads to determine which loads can be turned off without inconveniencing students or faculty/staff.

(2) After the analysis has been conducted, initiate a trial turn off program. This could be done by hiring a student worker who would turn off the lights in the studios and classrooms after midnight. A similar effort has been conducted by the College of Engineering for the last ten years where a student worker is hired to turn off the lights of the university-controlled classrooms in the Zachry Engineering Center every night around 10:30 to 11:00 p.m.

(3) Continue replacing the incandescent and 40W fluorescent fixtures with energy-efficient fixtures.

(4) For a long-term effort, we recommend that high quality occupancy sensors should be installed.

(5) Finally, use the weekly monitoring by the Energy Systems Laboratory in a graphical format to track the progress. This could be posted in a prominent place, and possibly, on the Architecture WWW home page to provide feedback to students and faculty staff.

[1] This saving is approximately equal to the annual salaries of three graduate assistants.

ACKNOWLEDGMENTS

The on-off test of the lighting in the studios of the Langford Architecture Building A was conducted by two undergraduate students from Department of Architecture, Roberto Samaniego and John Urbin. We would also like to thank Dr. David Claridge and Dr. Mingsheng Liu for their inputs to this report.

APPENDIX A

Monitoring Diagrams, Example of Weekly Plots, and ESL Monthly Energy Consumption Report for Langford Architecture Buildings A and B / C

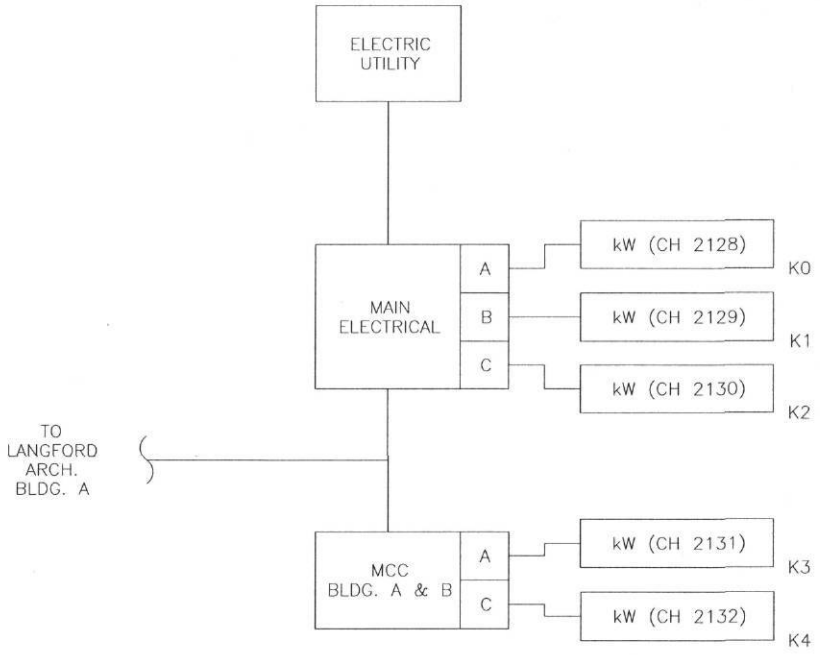
APPENDIX

Monitoring Diagrams, Example of Weekly Plots, and ESL Monthly Energy Consumption Report for Langford Architecture Buildings A and B / C

TEXAS A&M UNIVERSITY
LANGFORD ARCHITECTURE
BUILDING A
ELECTRICAL MONITORING DIAGRAM

LEGEND

K=kWh channel
A=Analog channel
D=Digital channel

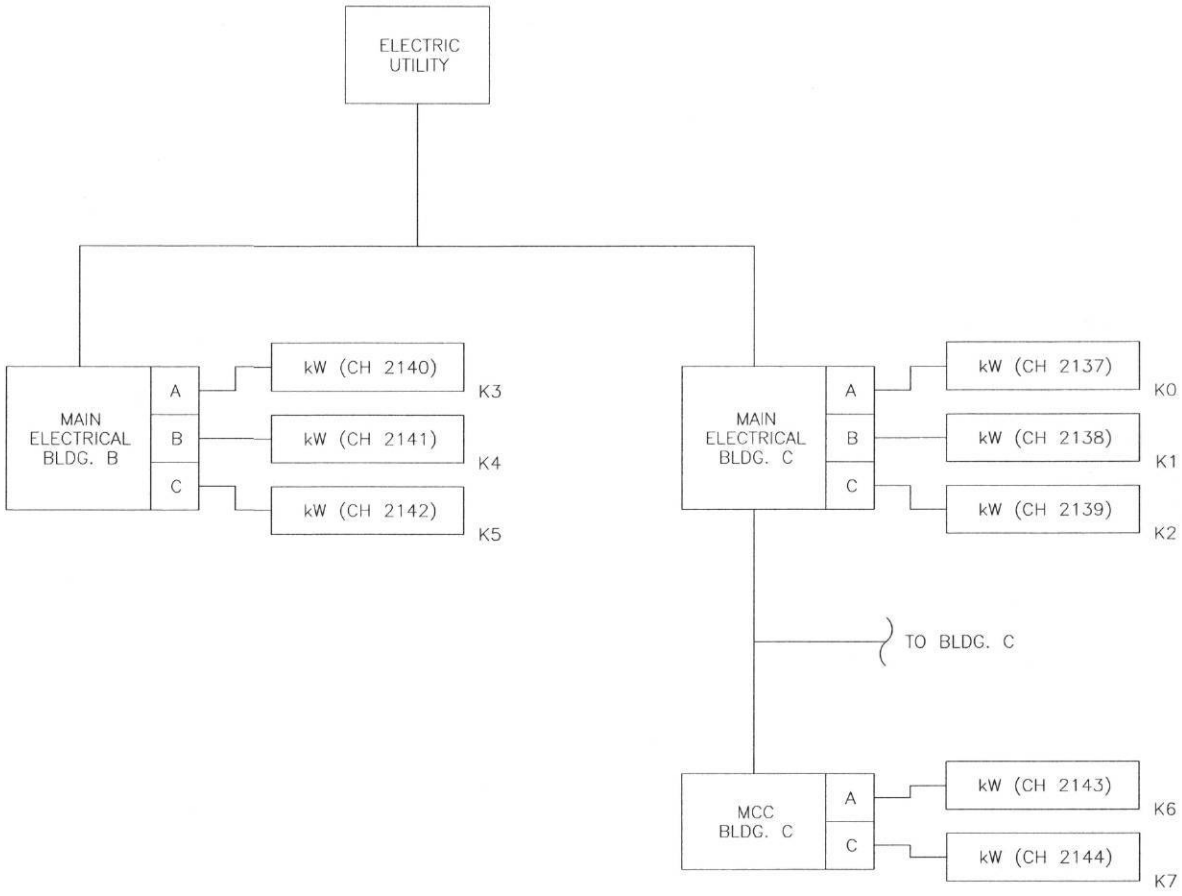


LANGFORD ARCH. BLDG. A – SITE 494

TEXAS A&M UNIVERSITY
LANGFORD ARCHITECTURE
BUILDINGS B & C
ELECTRICAL MONITORING DIAGRAM

LEGEND

K=kWh channel
A=Analog channel
D=Digital channel

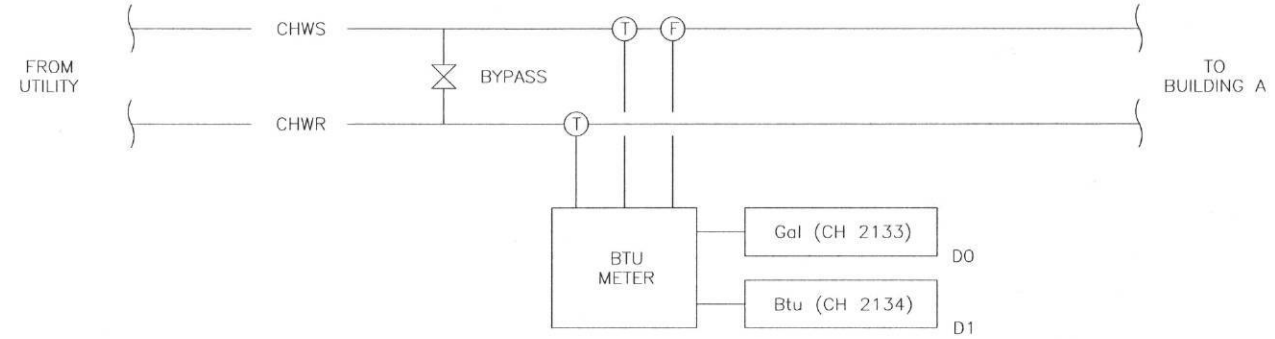


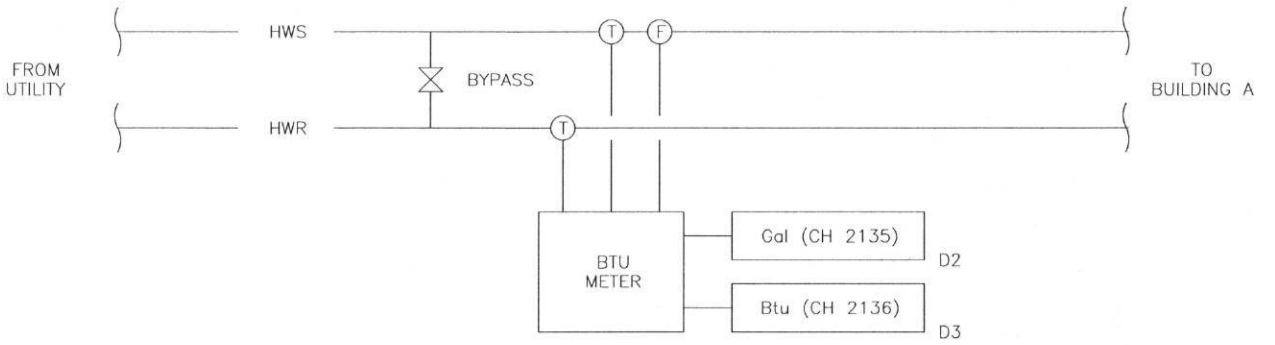
LANGFORD ARCH. BLDG. B & C – SITE 495

THERMAL MONITORING DIAGRAM
LANGFORD ARCHITECTURE
BUILDING A

LEGEND

F=FLOW
K=KWH CHANNEL
A=ANALOG CHANNEL
D=DIGITAL CHANNEL
CHWS=CHILLED WATER SUPPLY
CHWR=CHILLED WATER RETURN
HWS=HOT WATER SUPPLY
HWR=HOT WATER RETURN

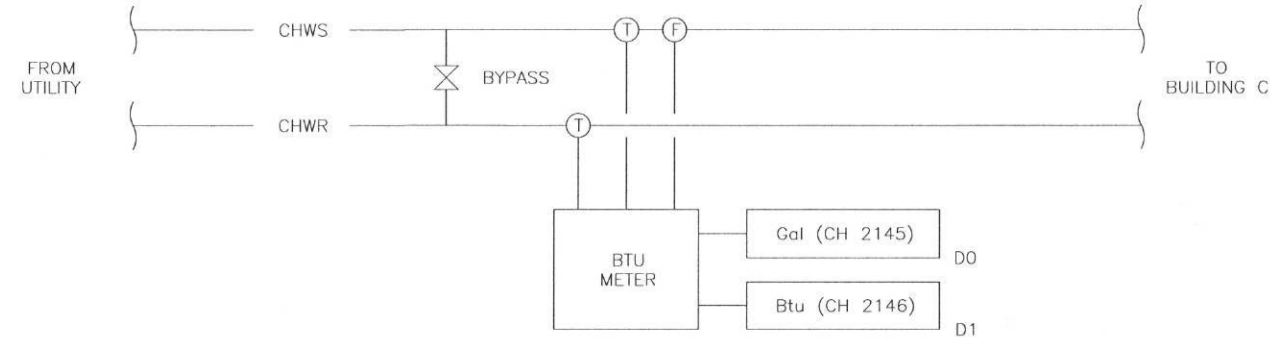


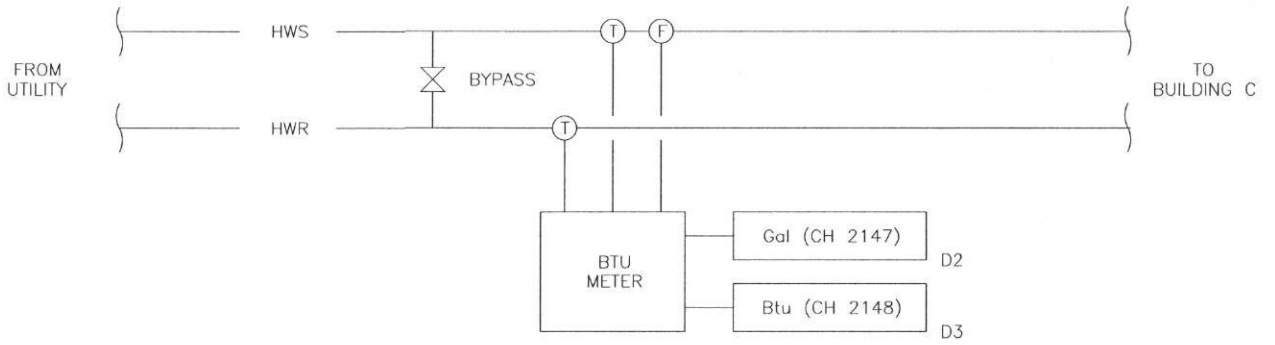


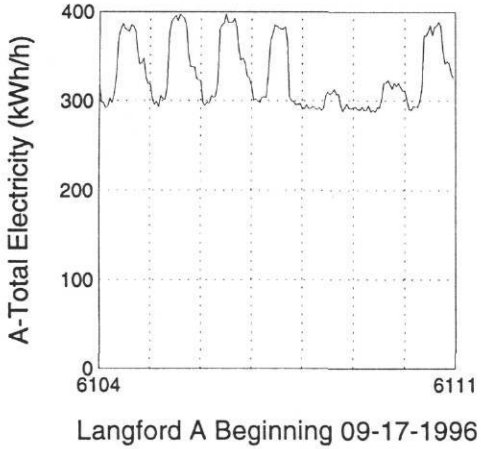
THERMAL MONITORING DIAGRAM
LANGFORD ARCHITECTURE
BUILDING C

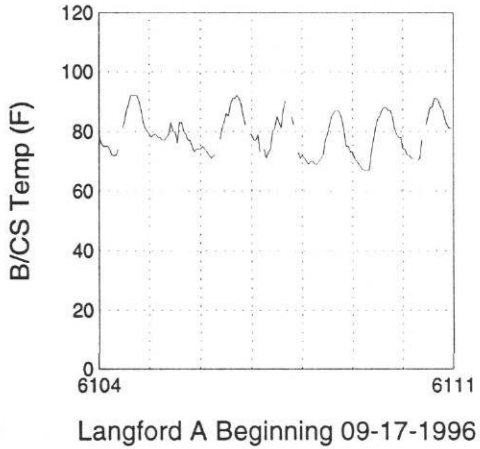
LEGEND

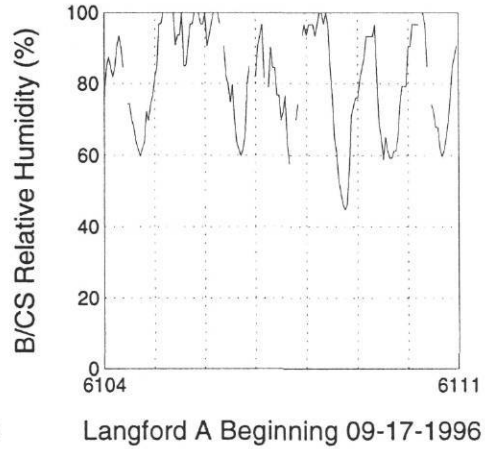
F=FLOW
K=KWH CHANNEL
A=ANALOG CHANNEL
D=DIGITAL CHANNEL
CHWS=CHILLED WATER SUPPLY
CHWR=CHILLED WATER RETURN
HWS=HOT WATER SUPPLY
HWR=HOT WATER RETURN

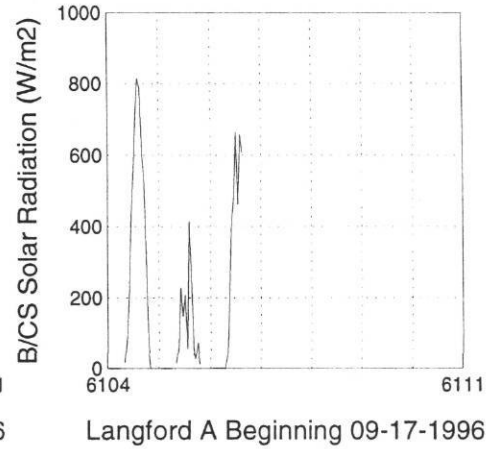


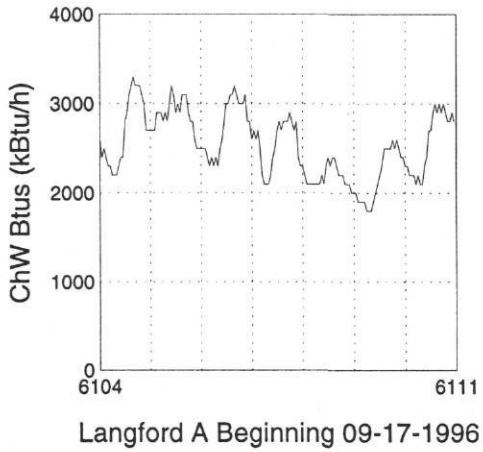


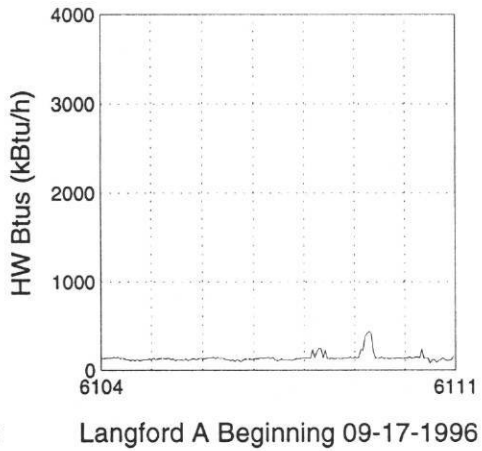

A-Total Electricity (kWh/h)
0
100
200
300
400
6104
6111
Langford A Beginning 09-17-1996

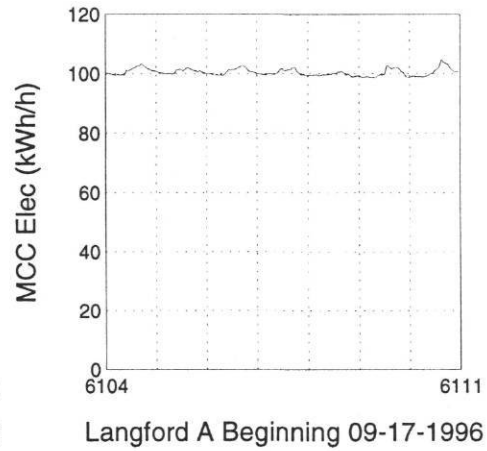

B/CS Temp (F)
0
20
40
60
80
100
120
6104
6111
Langford A Beginning 09-17-1996

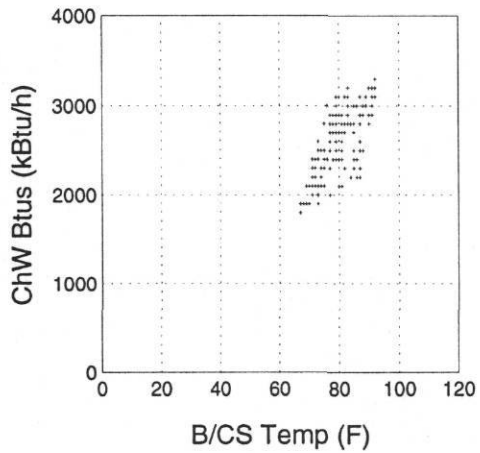

B/CS Relative Humidity (%)
0
20
40
60
80
100
6104
6111
Langford A Beginning 09-17-1996

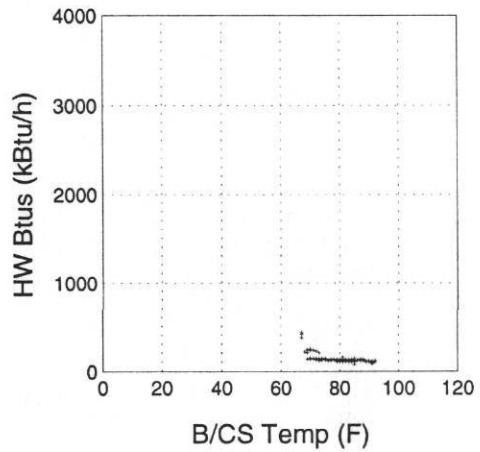

B/CS Solar Radiation (W/m2)
0
200
400
600
800
1000
6104
6111
Langford A Beginning 09-17-1996

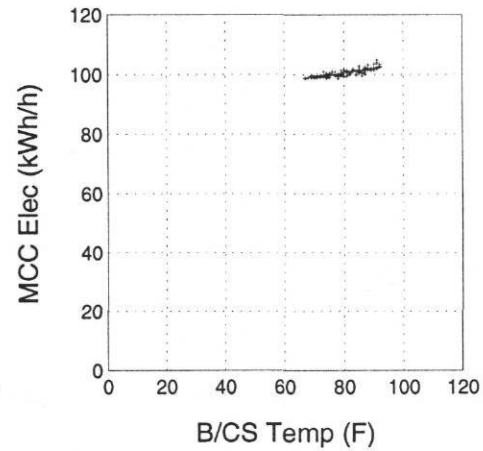

ChW Btus (kBtu/h)
0
1000
2000
3000
4000
6104
6111
Langford A Beginning 09-17-1996

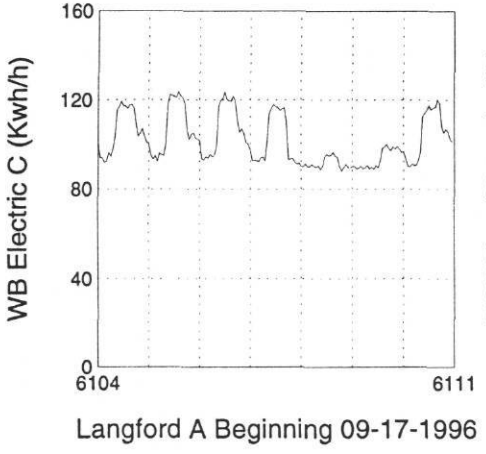

HW Btus (kBtu/h)
0
1000
2000
3000
4000
6104
6111
Langford A Beginning 09-17-1996

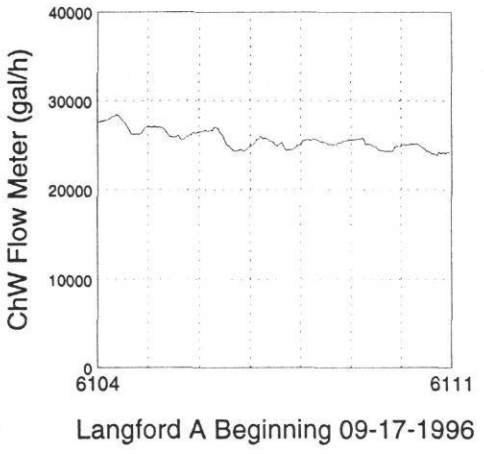

MCC Elec (kWh/h)
0
20
40
60
80
100
120
6104
6111
Langford A Beginning 09-17-1996

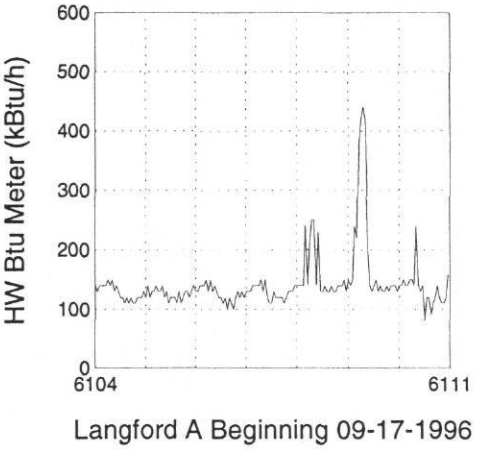

ChW Btus (kBtu/h)
0
1000
2000
3000
4000
0
20
40
60
80
100
120
B/CS Temp (F)

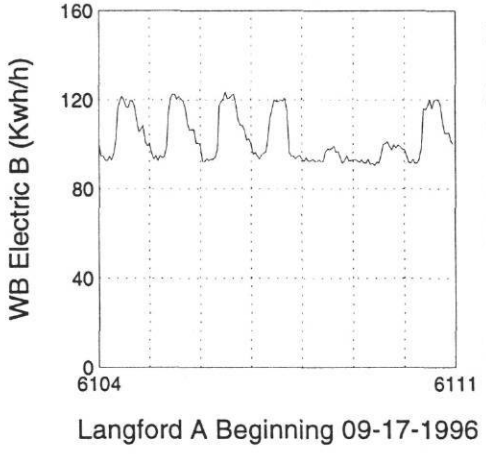

HW Btus (kBtu/h)
0
1000
2000
3000
4000
0
20
40
60
80
100
120
B/CS Temp (F)

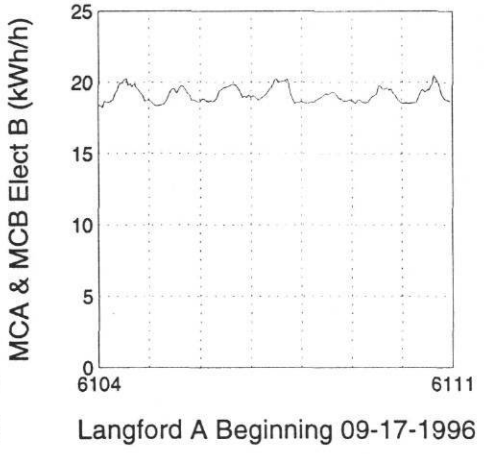

MCC Elec (kWh/h)
0
20
40
60
80
100
120
0
20
40
60
80
100
120
B/CS Temp (F)

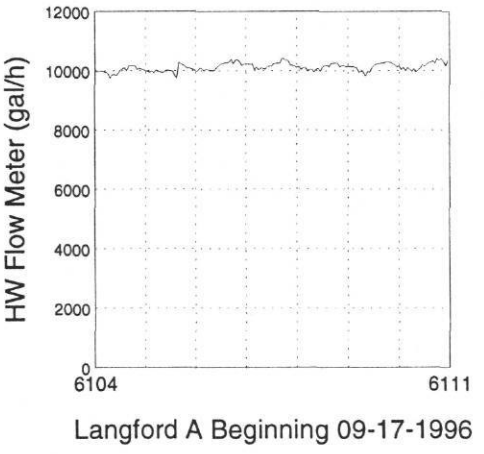

WB Electric C (Kwh/h)
160
120
80
40
0
6104
6111
Langford A Beginning 09-17-1996

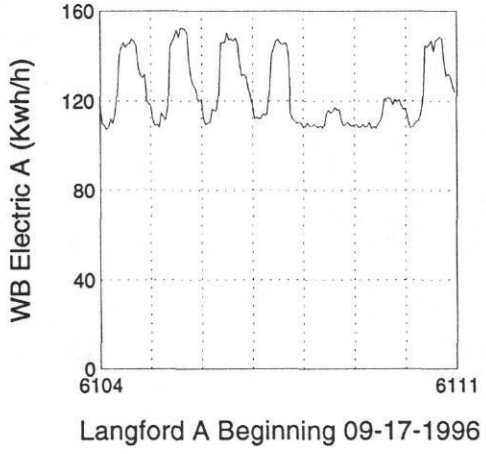

ChW Flow Meter (gal/h)
40000
30000
20000
10000
0
6104
6111
Langford A Beginning 09-17-1996

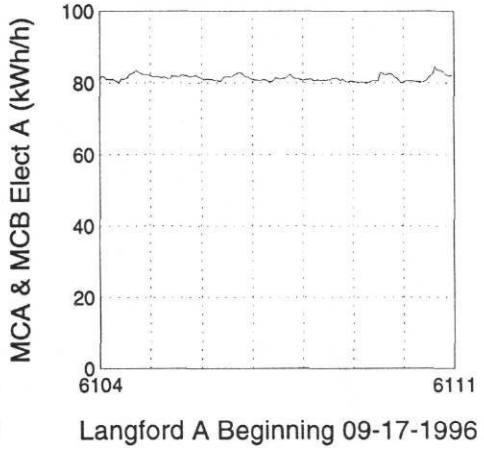

HW Btu Meter (kBtu/h)
600
500
400
300
200
100
0
6104
6111
Langford A Beginning 09-17-1996

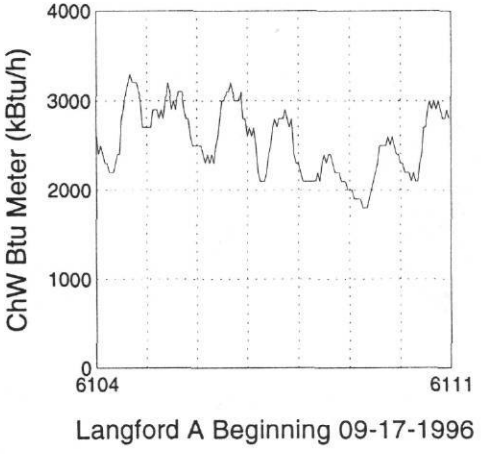

WB Electric B (Kwh/h)
160
120
80
40
0
6104
6111
Langford A Beginning 09-17-1996


MCA & MCB Elect B (kWh/h)
25
20
15
10
5
0
6104
6111
Langford A Beginning 09-17-1996

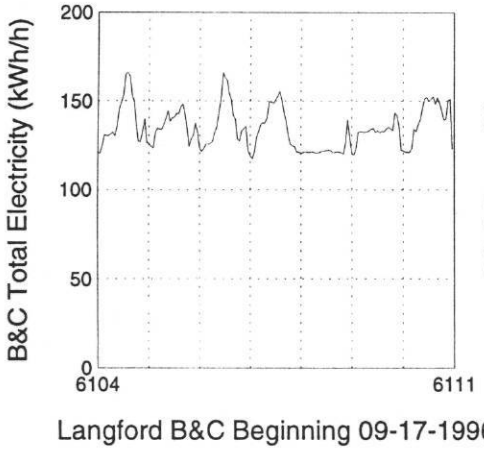

HW Flow Meter (gal/h)
12000
10000
8000
6000
4000
2000
0
6104
6111
Langford A Beginning 09-17-1996

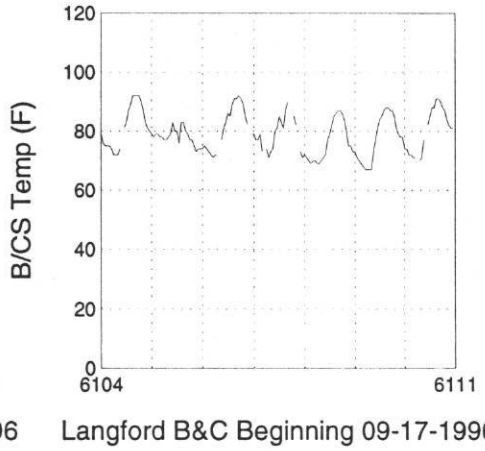

WB Electric A (Kwh/h)
160
120
80
40
0
6104
6111
Langford A Beginning 09-17-1996

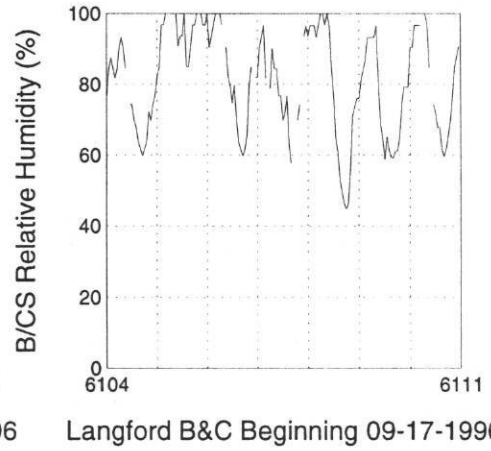

MCA & MCB Elect A (kWh/h)
100
80
60
40
20
0
6104
6111
Langford A Beginning 09-17-1996

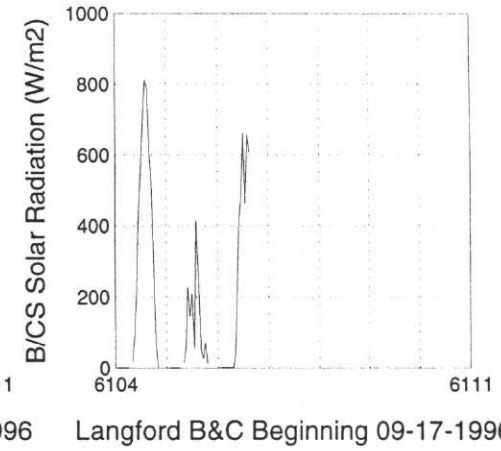

ChW Btu Meter (kBtu/h)
4000
3000
2000
1000
0
6104
6111
Langford A Beginning 09-17-1996

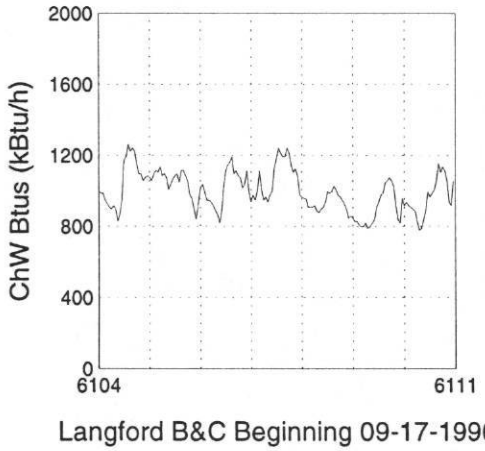
Site 495 Page 1

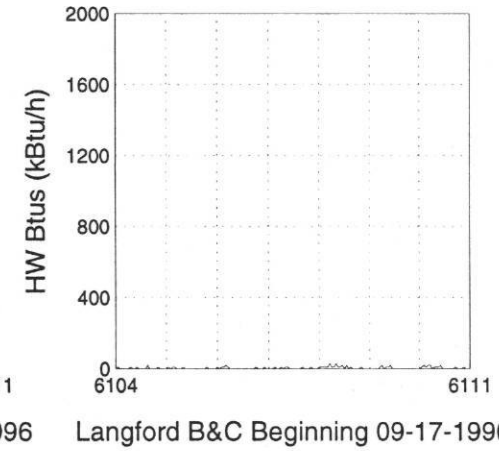


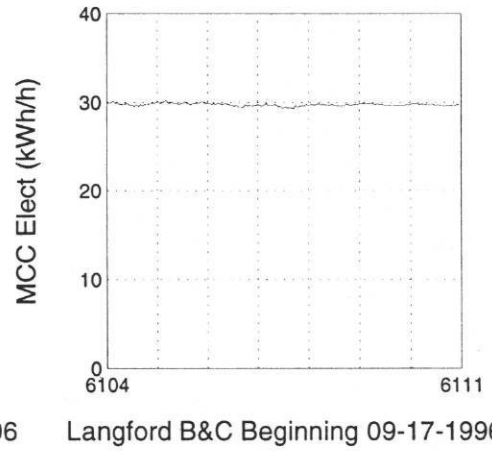


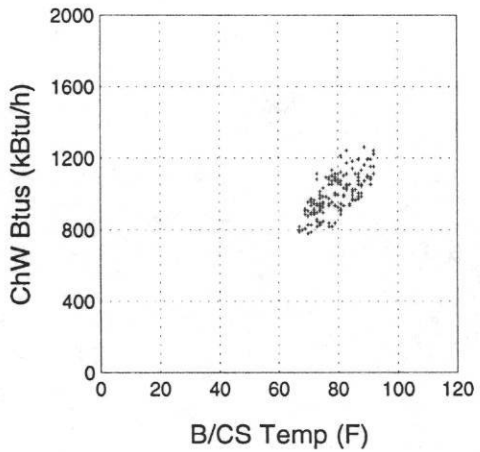


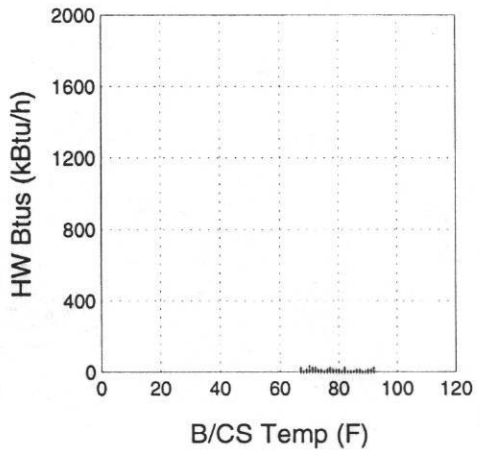


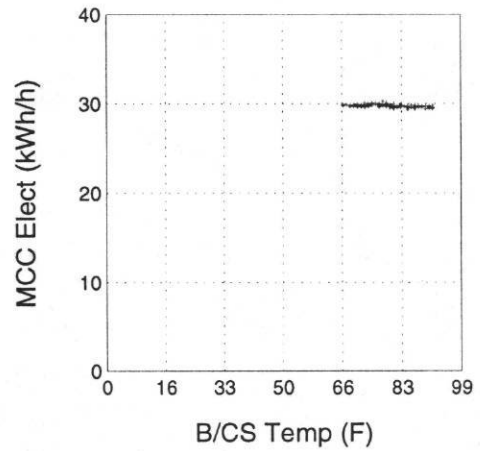


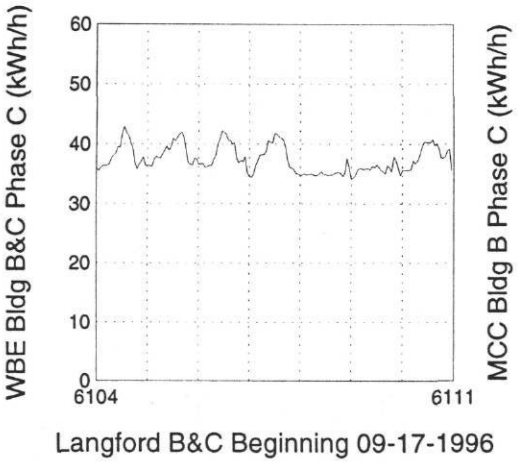


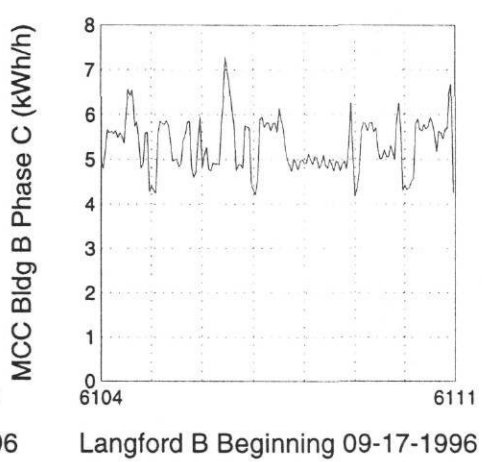


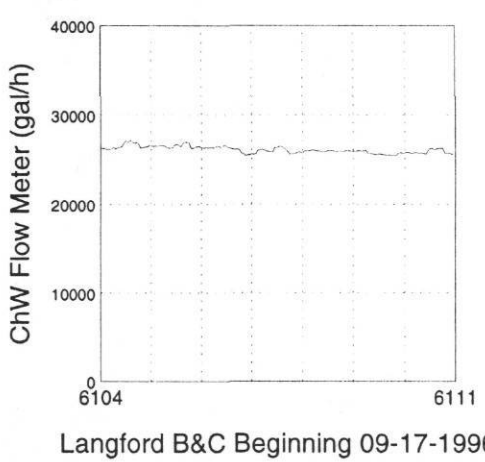


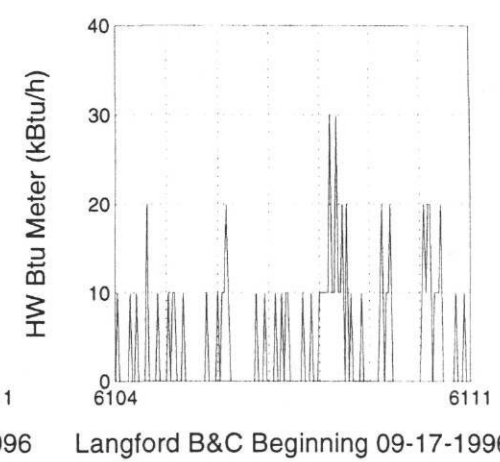


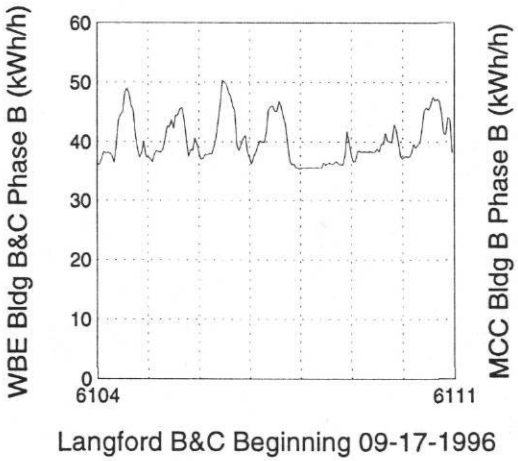


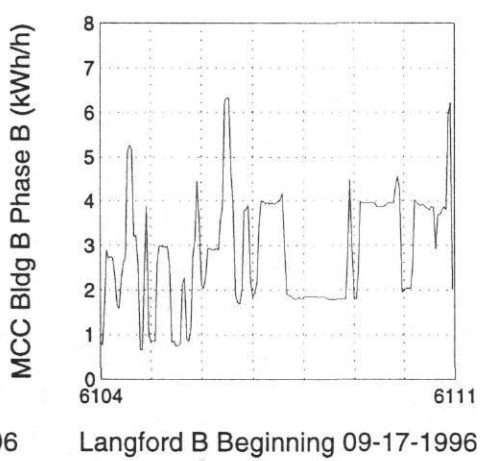

WBE Bldg B&C Phase C (kWh/h)
60
50
40
30
20
10
0
6104
6111
Langford B&C Beginning 09-17-1996

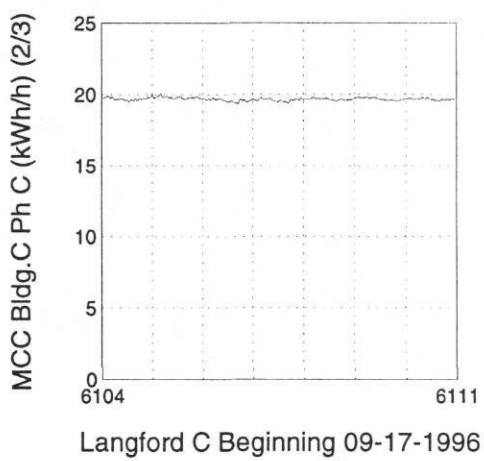

MCC Bldg B Phase C (kWh/h)
8
7
6
5
4
3
2
1
0
6104
6111
Langford B Beginning 09-17-1996

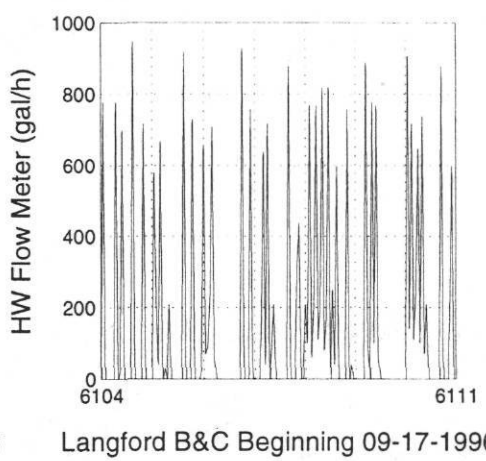

ChW Flow Meter (gal/h)
40000
30000
20000
10000
0
6104
6111
Langford B&C Beginning 09-17-1996

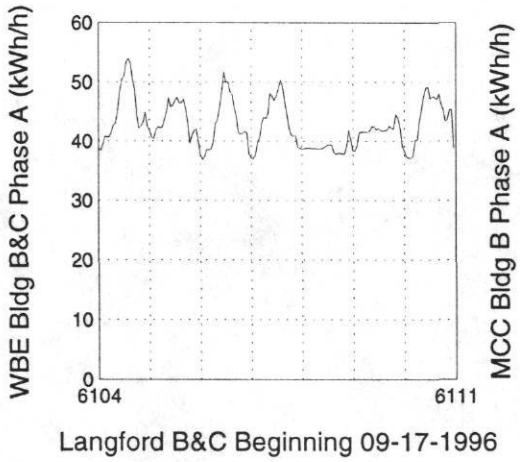

HW Btu Meter (kBtu/h)
40
30
20
10
0
6104
6111
Langford B&C Beginning 09-17-1996

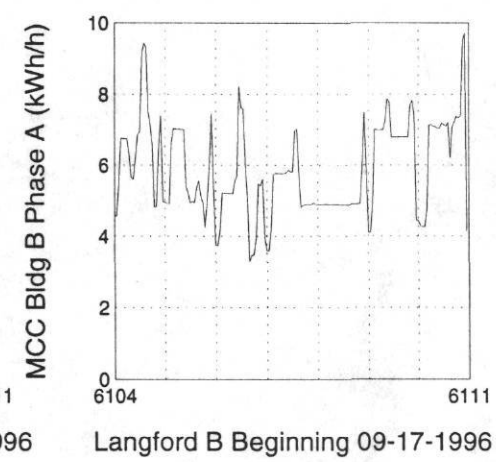

WBE Bldg B&C Phase B (kWh/h)
60
50
40
30
20
10
0
6104
6111
Langford B&C Beginning 09-17-1996

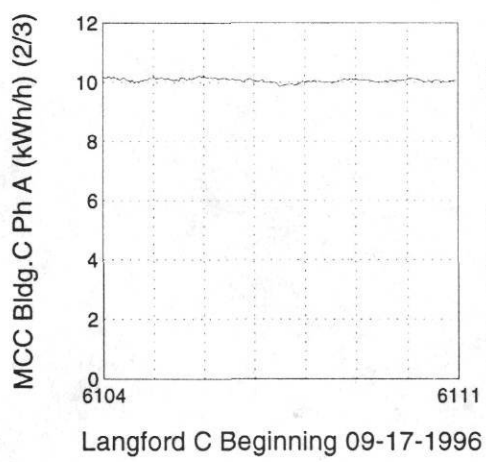

MCC Bldg B Phase B (kWh/h)
8
7
6
5
4
3
2
1
0
6104
6111
Langford B Beginning 09-17-1996

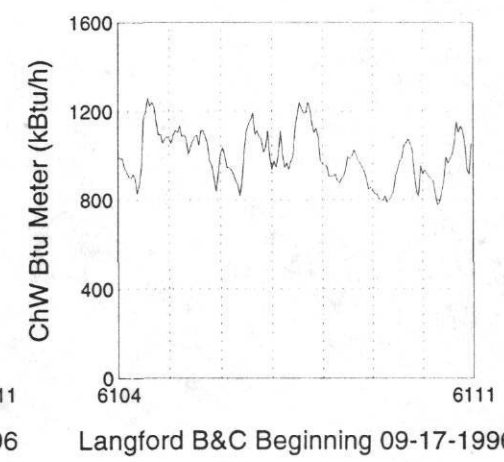

MCC Bldg.C Ph C (kWh/h) (2/3)
25
20
15
10
5
0
6104
6111
Langford C Beginning 09-17-1996


HW Flow Meter (gal/h)
1000
800
600
400
200
0
6104
6111
Langford B&C Beginning 09-17-1996


WBE Bldg B&C Phase A (kWh/h)
60
50
40
30
20
10
0
6104
6111
Langford B&C Beginning 09-17-1996


MCC Bldg B Phase A (kWh/h)
10
8
6
4
2
0
6104
6111
Langford B Beginning 09-17-1996


MCC Bldg.C Ph A (kWh/h) (2/3)
12
10
8
6
4
2
0
6104
6111
Langford C Beginning 09-17-1996


ChW Btu Meter (kBtu/h)
1600
1200
800
400
0
6104
6111
Langford B&C Beginning 09-17-1996

Langford Architecture A

Texas A&M University
102,105 square feet

Site Contact
Charles Darnell, Jr.
Physical Plant Administration
Texas A&M University
(409) 845–5318
Gene Stewart
(409) 845–5511

ESL Metering Contact
Namir Saman
053A WERC
Texas A&M University
College Station, TX 77843-3123
(409) 845–9213

Summary of Energy Consumption

	Measured Use	% hours reported	Unit Cost	Estimated Cost
Electricity	236815 kWh	100	$0.02788	$6602
Peak 60 Minute Demand	394 kW	100	-	-
Chilled Water	2035.8 MMBtu	100	$4.670	$9507
Hot Water	106.6 MMBtu	100	$4.750	$506

Peak 60 minute demand was recorded at 1500 Tuesday 06/25/96.
There were 720 hours in this month.

Monthly Savings

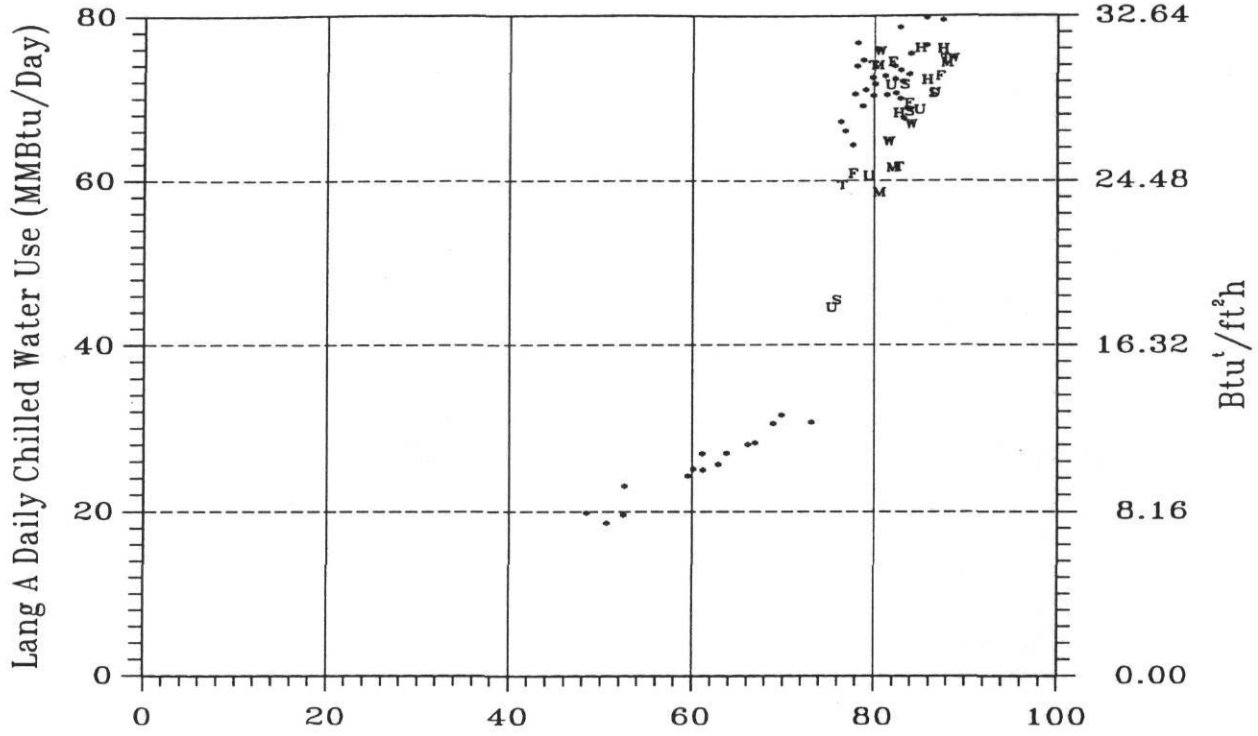
	Measured Savings	
Chilled Water (MMBtu)	207	$965
Cond./H.W./N.G. (MMBtu)	150	$713
Monthly Total		$1678
Total to Date	(1 month)	$1678

Comments

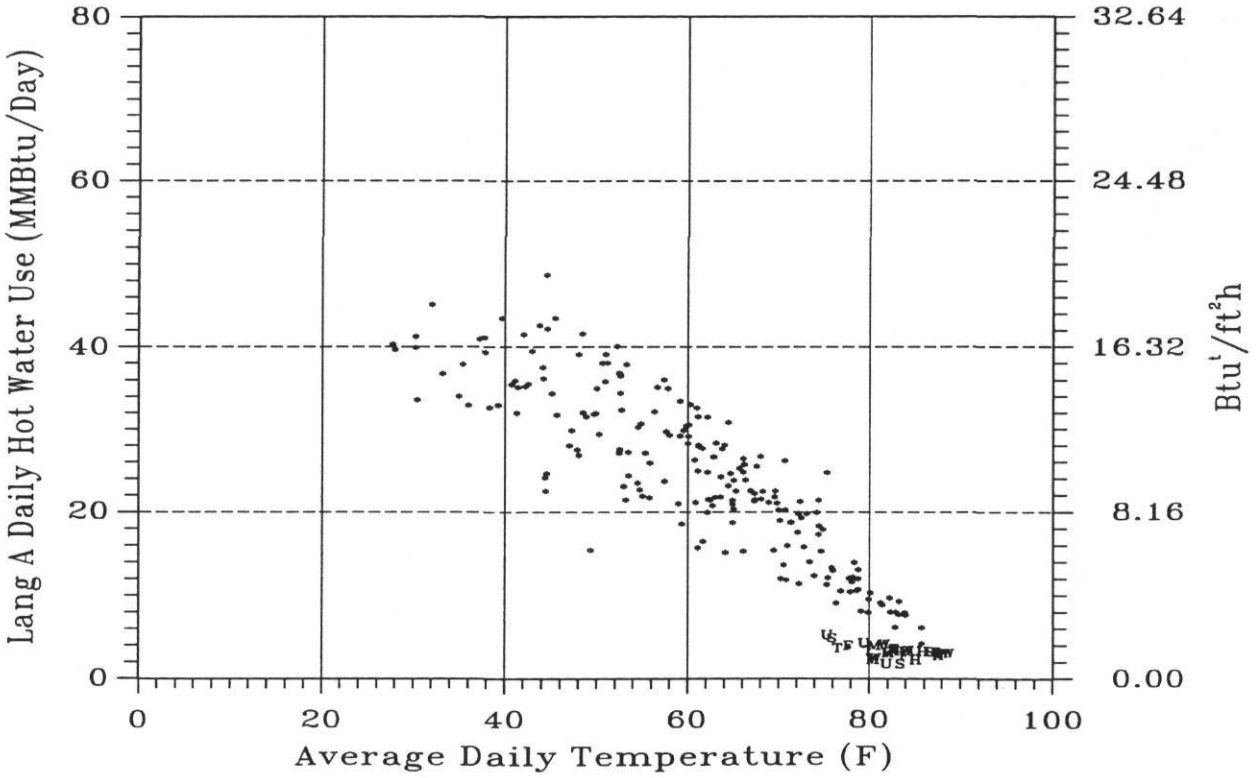
★ **The data in these reports represents the best available data at the time of publication.**

★ **The drop in hot water energy consumption is due to the implementation of continuous commissioning measures.**

Jun 01 1995 – Jun 30 1996

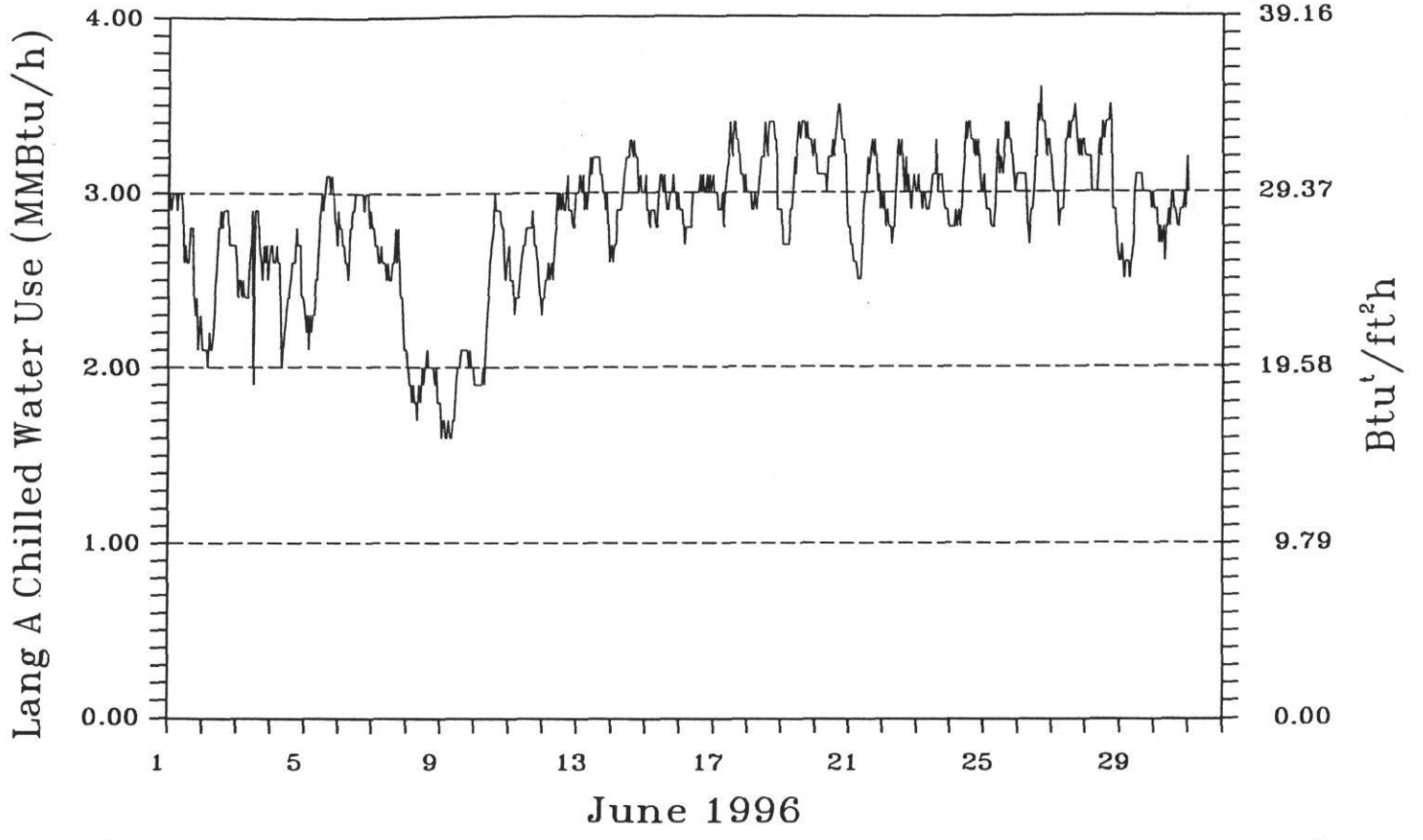


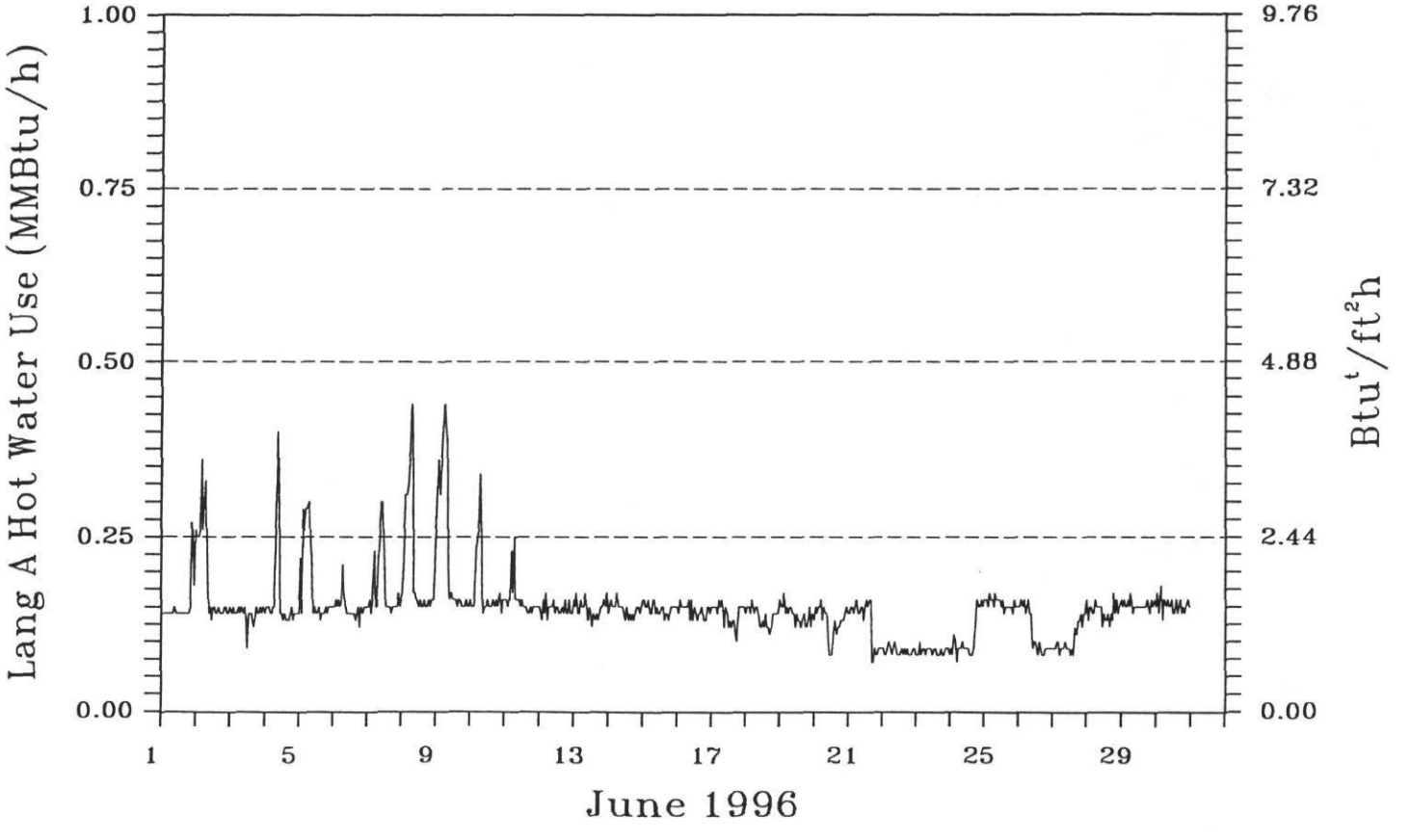
Jun 01 1995 – Jun 30 1996

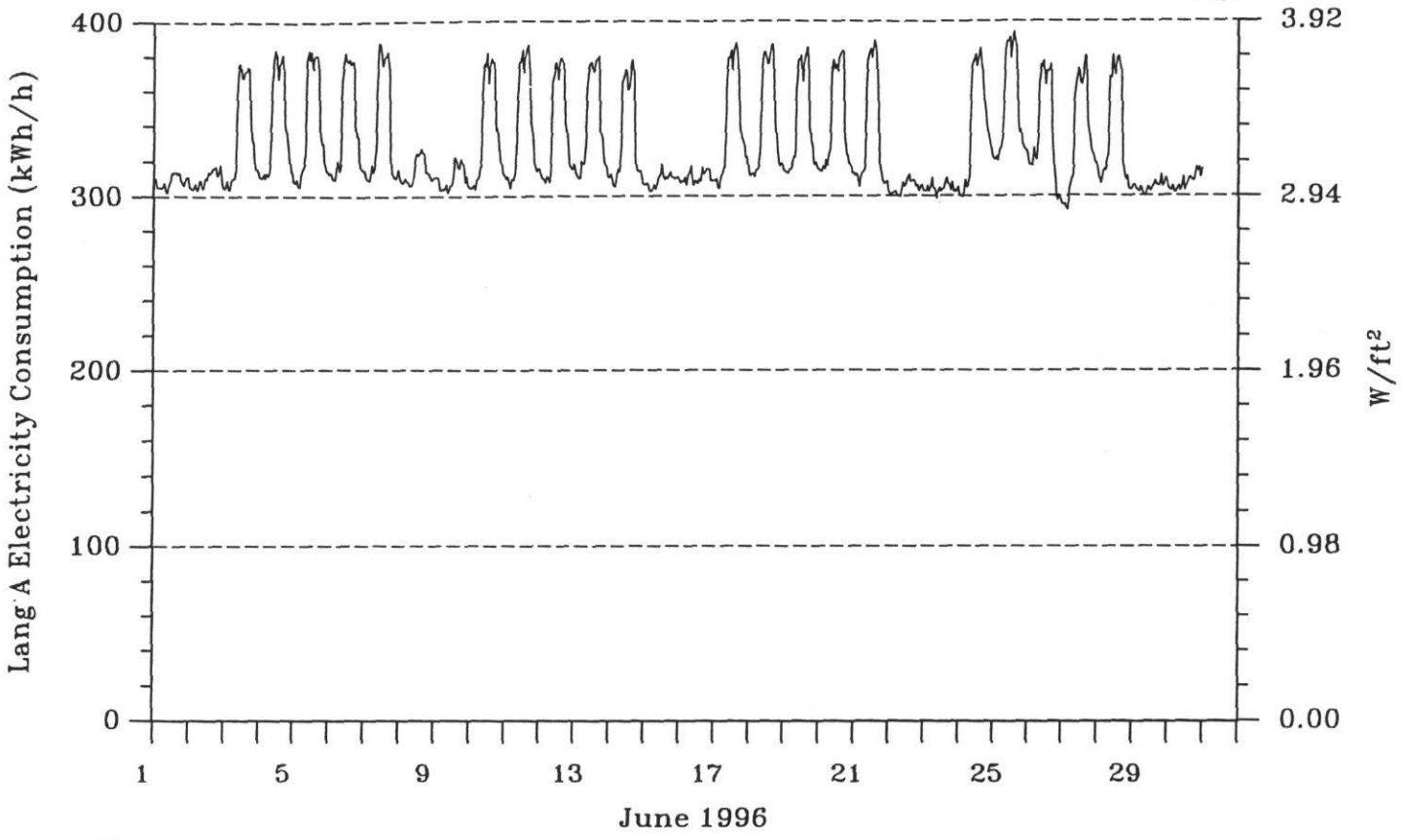


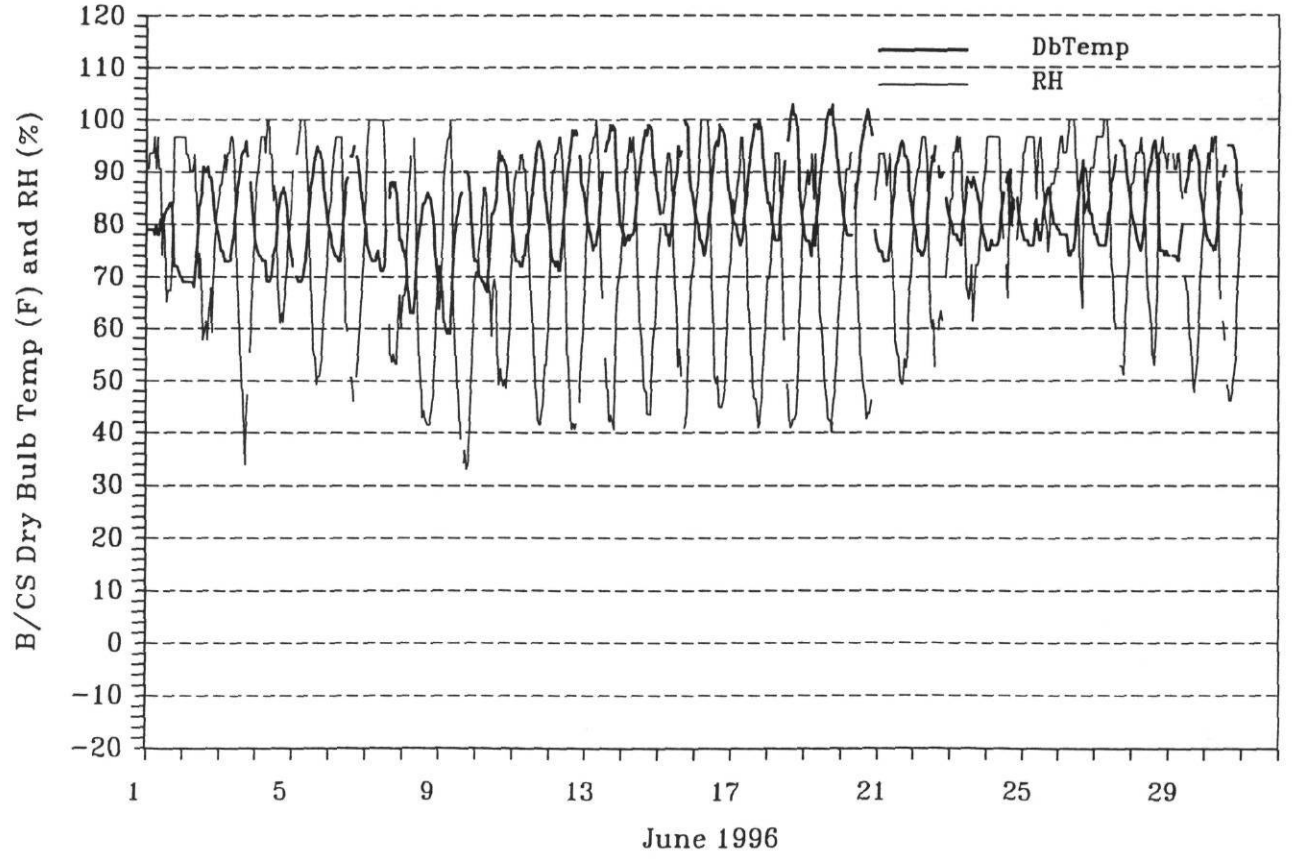
Data points for the current month are shown as letters.
Monday through Sunday are represented as M,T,W,H,F,S,U.

Points from this month last year are shown as +.
All other points are shown as *.

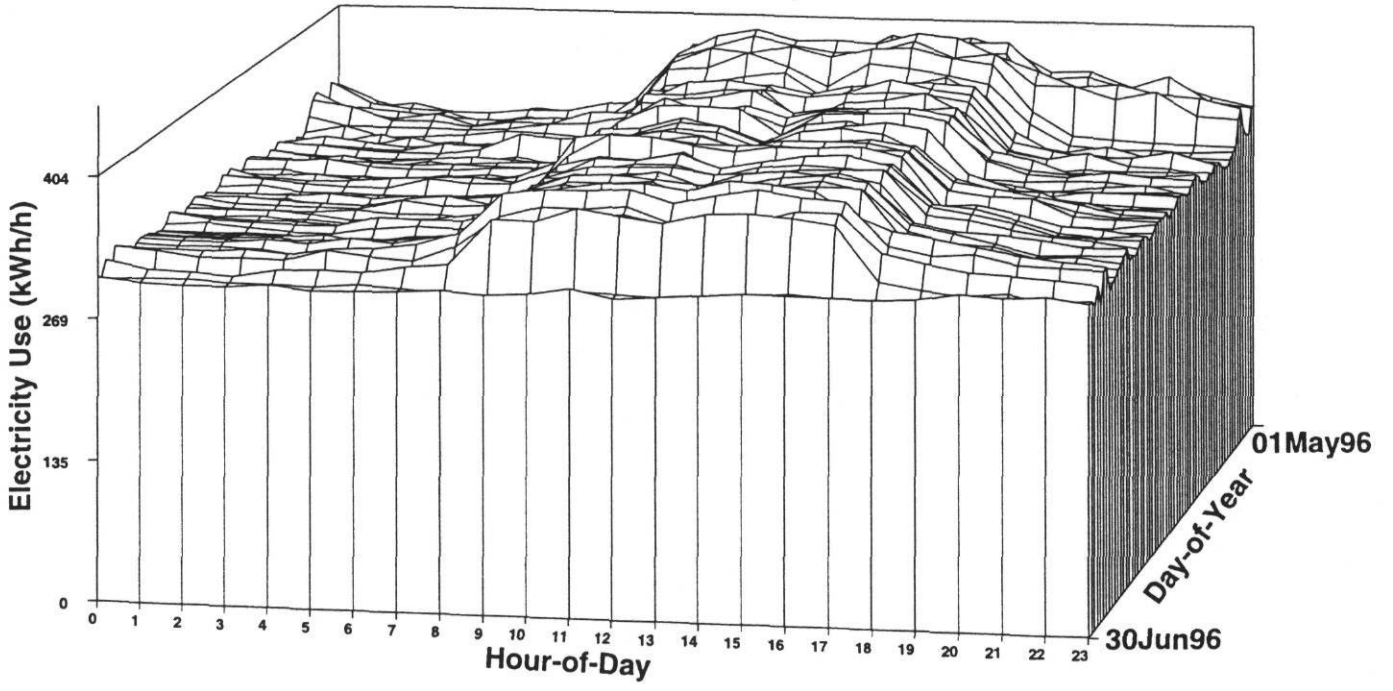

Lang A Chilled Water Use (MMBtu/h)
4.00
3.00
2.00
1.00
0.00
39.16
29.37
19.58
9.79
0.00
Btu^t/ft^2h
1
5
9
13
17
21
25
29
June 1996


Lang A Hot Water Use (MMBtu/h)
1.00
0.75
0.50
0.25
0.00
9.76
7.32
4.88
2.44
0.00
Btu^t/ft^2h
1
5
9
13
17
21
25
29
June 1996

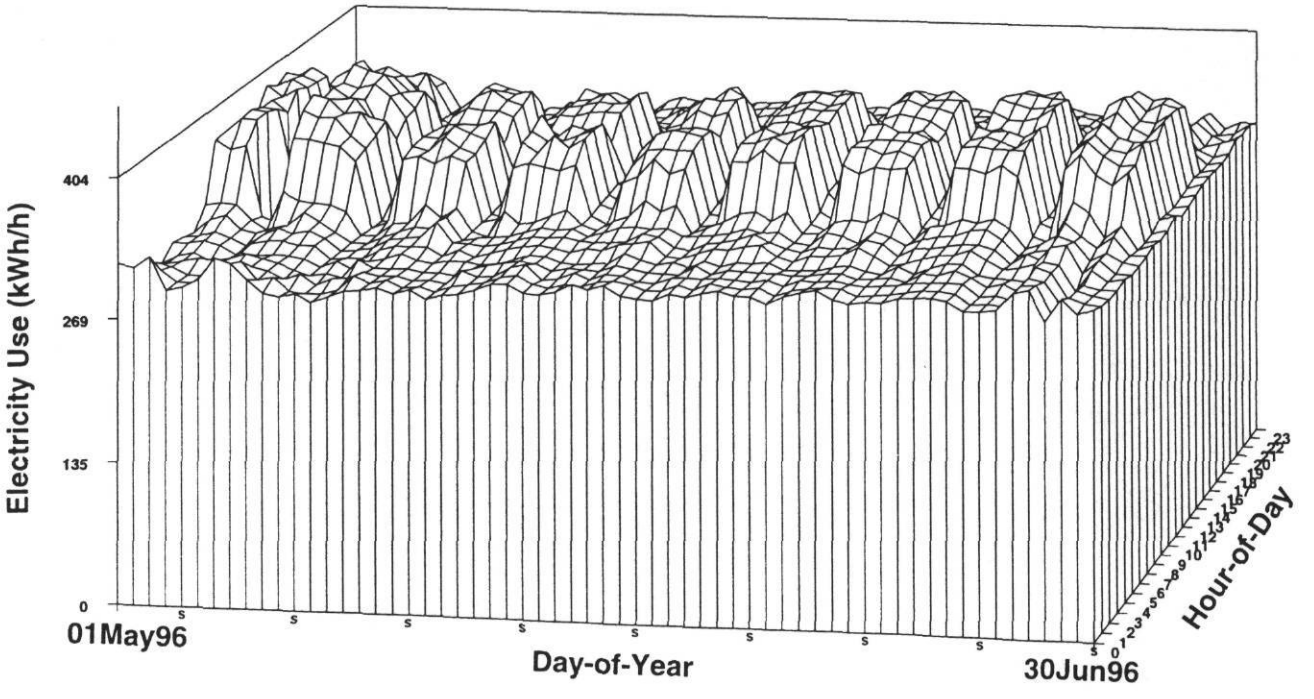

Lang A Electricity Consumption (kWh/h)
400
300
200
100
0
3.92
2.94
1.96
0.98
0.00
W/ft²
1
5
9
13
17
21
25
29
June 1996


B/CS Dry Bulb Temp (F) and RH (%)
DbTemp
RH
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
1
5
9
13
17
21
25
29
June 1996

Whole–Building Electric



Whole–Building Electric



Sundays are marked with an "S"

Langford Architecture B and C

Texas A&M University
69,950 square feet

Site Contact

Charles Darnell, Jr.
Physical Plant Administration
Texas A&M University
(409) 845–5318
Gene Stewart
(409) 845–5511

ESL Metering Contact

Namir Saman
053A WERC
Texas A&M University
College Station, TX 77843-3123
(409) 845–9213

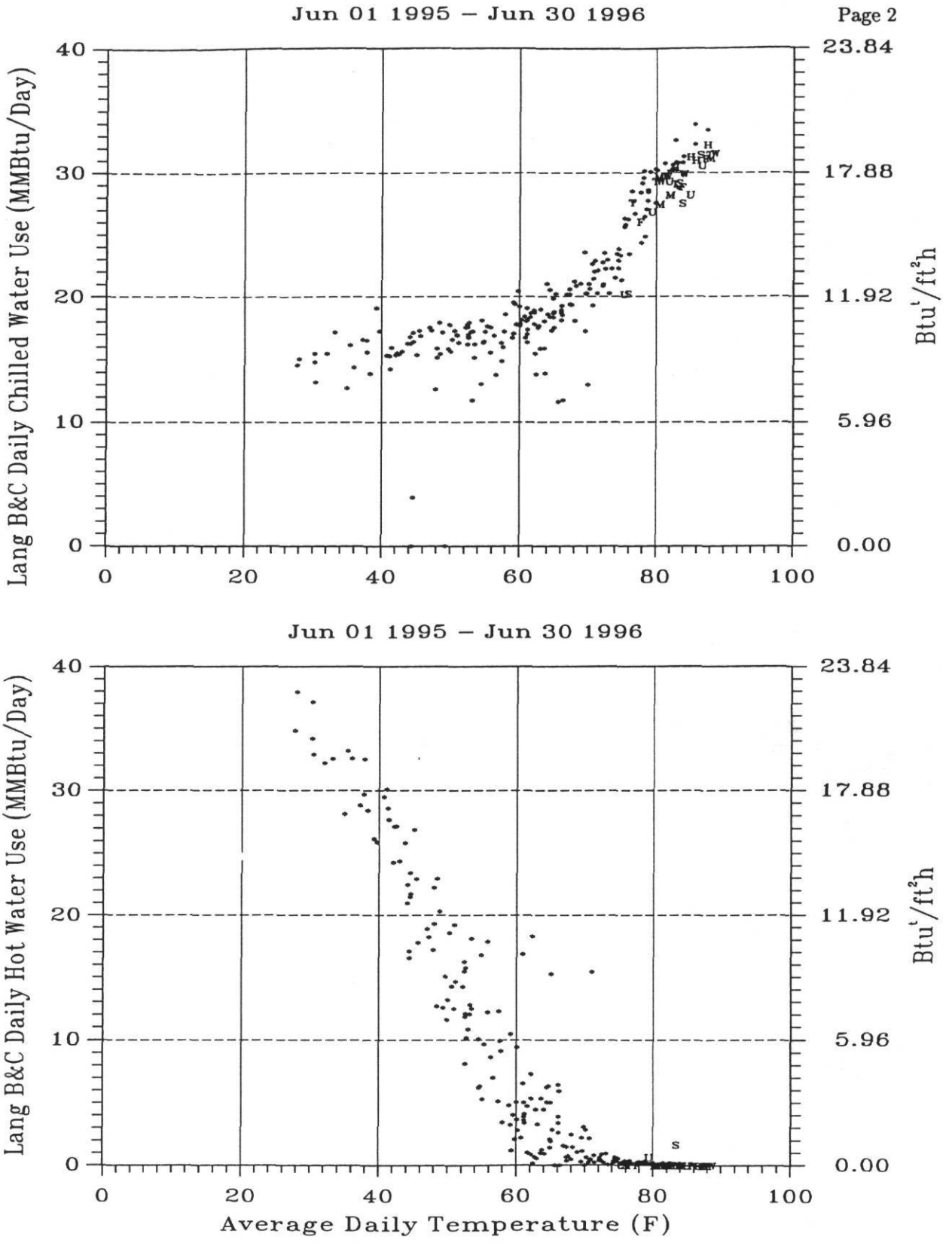
Summary of Energy Consumption

	Measured Use	% hours reported	Unit Cost	Estimated Cost
Electricity	91908 kWh	100	$0.02788	$2562
Peak 60 Minute Demand	175 kW	100	-	-
Chilled Water	871.3 MMBtu	100	$4.670	$4069
Hot Water	4.9 MMBtu	100	$4.750	$23

Peak 60 minute demand was recorded at 1400 Tuesday 06/25/96.
There were 720 hours in this month.

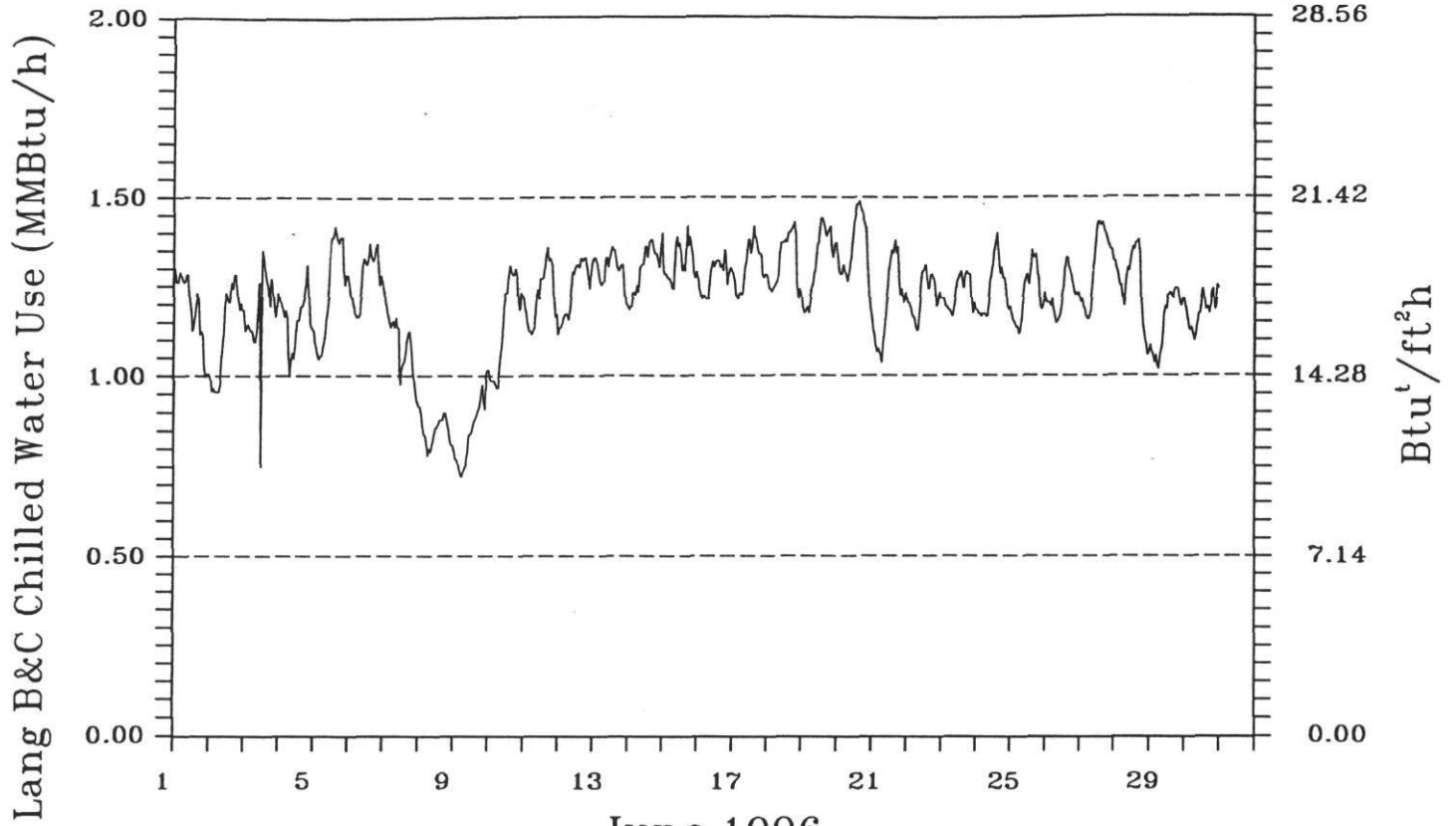
Comments

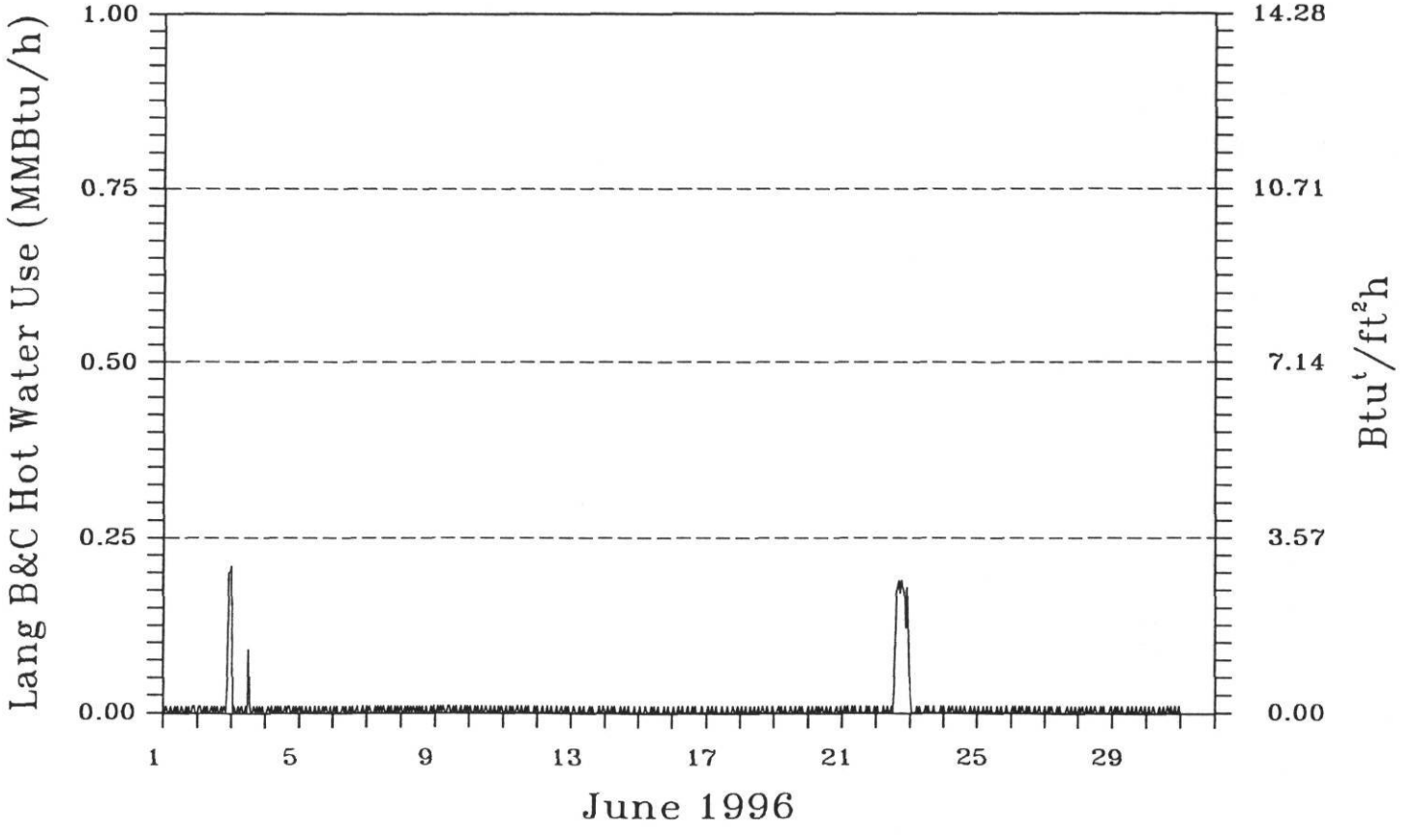
★ **The data in these reports represents the best available data at the time of publication.**

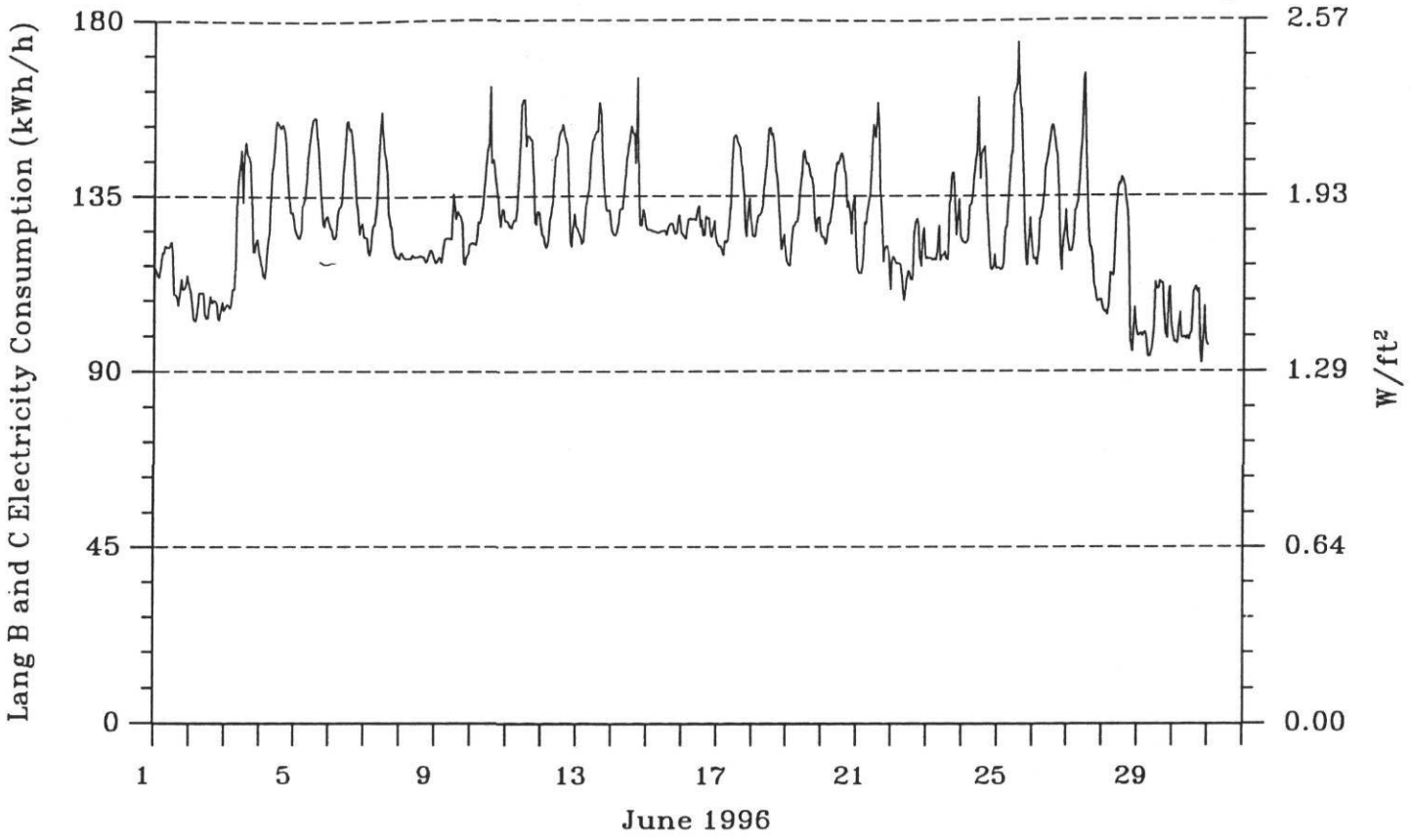


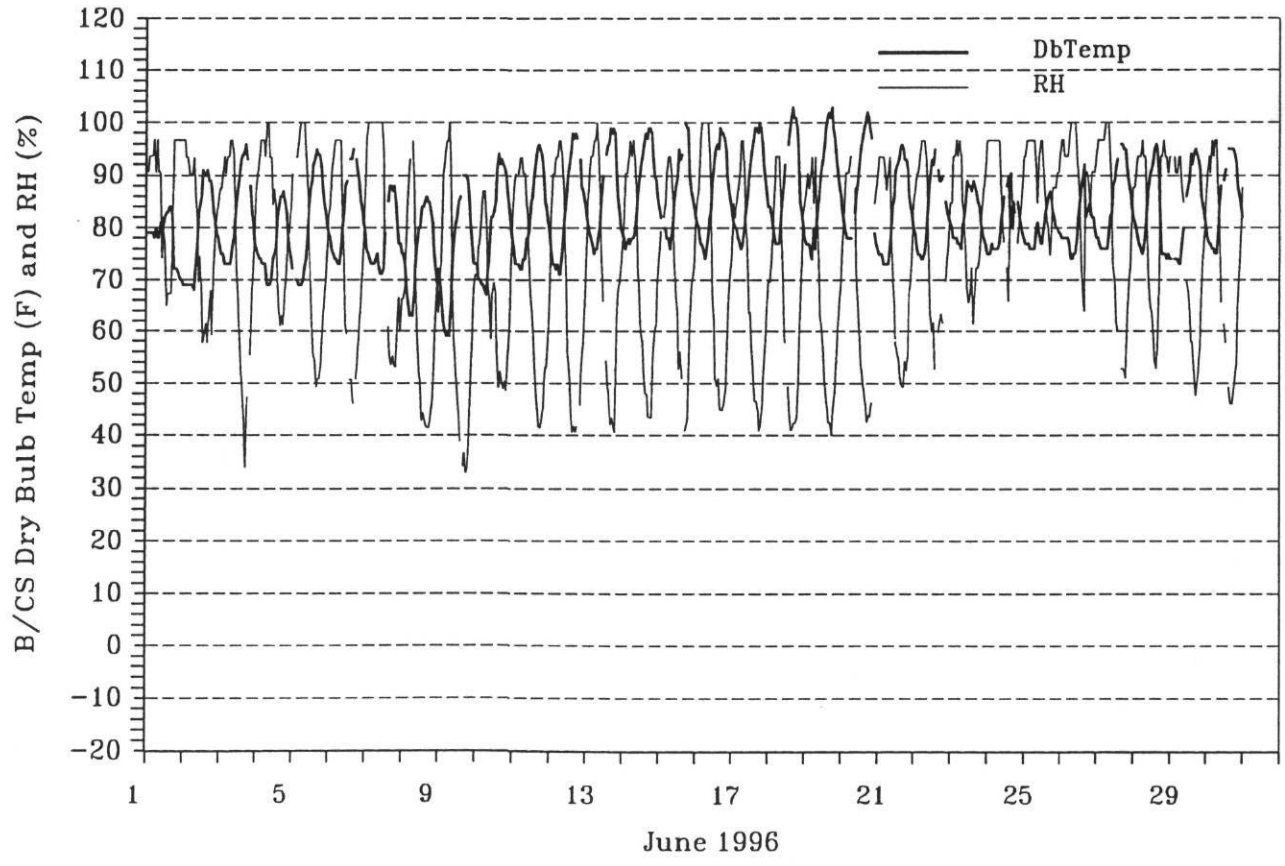
Data points for the current month are shown as letters.
Monday through Sunday are represented as M,T,W,H,F,S,U.

Points from this month last year are shown as +.
All other points are shown as *.

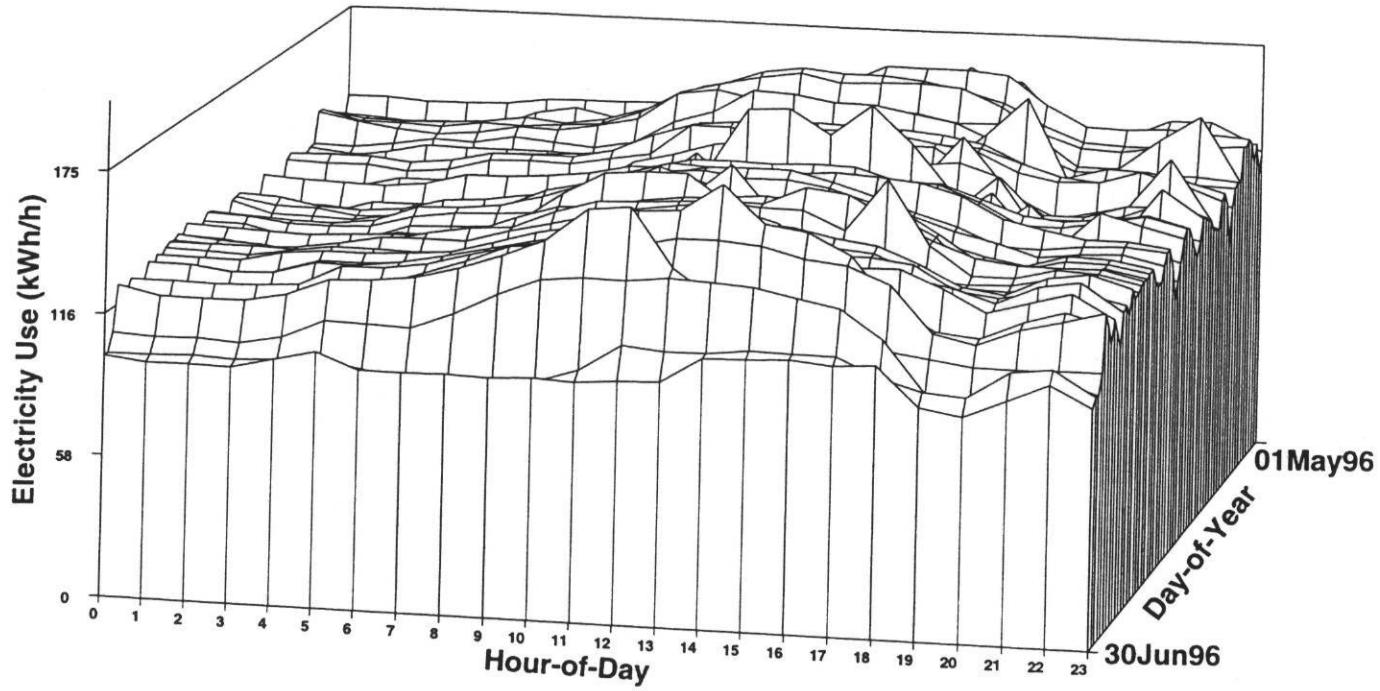

Lang B&C Chilled Water Use (MMBtu/h)
2.00
1.50
1.00
0.50
0.00
28.56
21.42
14.28
7.14
0.00
Btu/ft²h
1
5
9
13
17
21
25
29
June 1996


Lang B&C Hot Water Use (MMBtu/h)
1.00
0.75
0.50
0.25
0.00
14.28
10.71
7.14
3.57
0.00
Btu/ft²h
1
5
9
13
17
21
25
29
June 1996

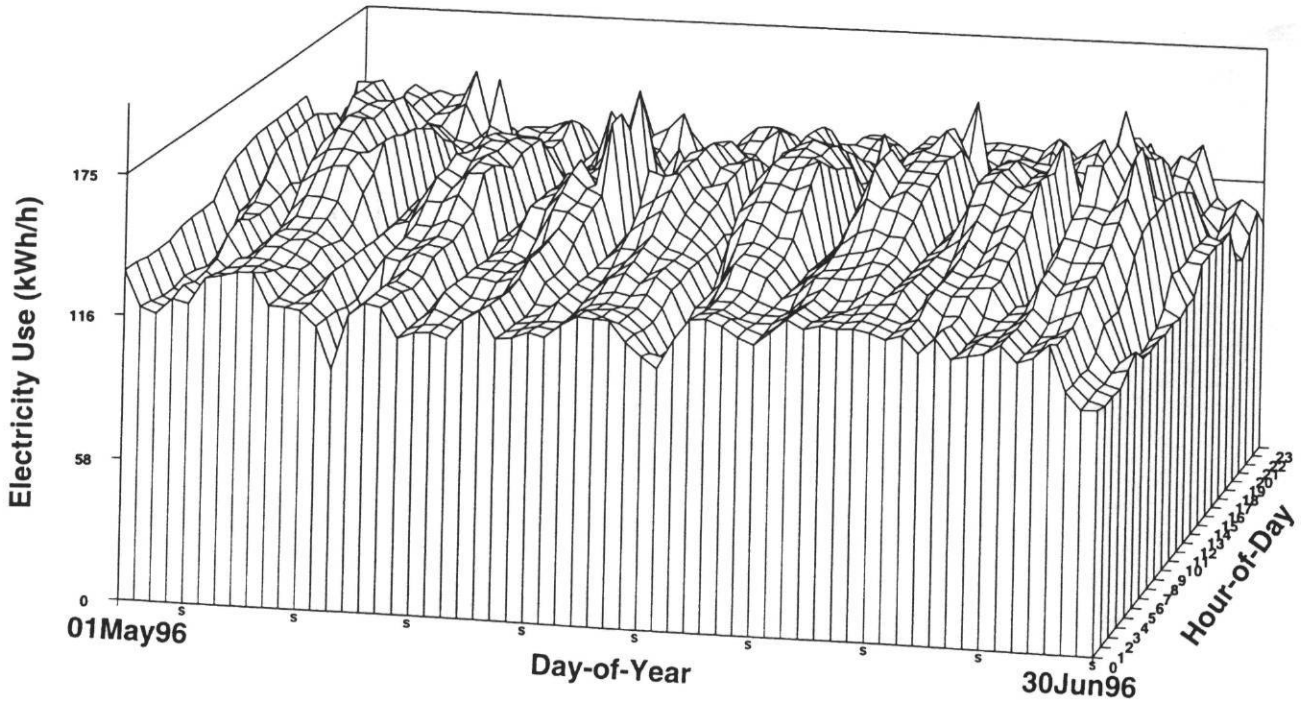

Lang B and C Electricity Consumption (kWh/h)
180
135
90
45
0
2.57
1.93
1.29
0.64
0.00
W/ft²
1
5
9
13
17
21
25
29
June 1996


B/CS Dry Bulb Temp (F) and RH (%)
DbTemp
RH
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
1
5
9
13
17
21
25
29
June 1996

Whole–Building Electric



Whole–Building Electric



Sundays are marked with an "S"