Aloha Systems

# Evaluation, Measurement, and Verification (EM&V) Report

## California State University Chancellor's Office
## 2002-2003 Energy Efficiency Program
## CPUC Non-Utility Program #311BC-02

## Revised Final Version

An Analysis Prepared for:

Eli W. Kollman
Energy Division
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102-3298

**May 5, 2004**

Dr. Mark S. Shirilau
Robert A. Prodonovich
Amichai Kotev

**14801 Comet Street ✠ Irvine, California 92604-2464 ✠ (949) 851-2221 Fax (949) 851-5008**
Villa Grande, California ✠ Austin, Texas ✠ Ellenburg Center, New York
CA Prof Engr E-11818 ✠ NY PE 080236 ✠ TX PE 88014 ✠ CA Contractor 541443 ✠ CA Locksmith LCO 3045
**www.alohasys.com**

# Table of Contents


**1. Summary ..... 1**

Project Description ..... 1

Project Locations ..... 2

EM&V Process ..... 3

Benefits Achieved by Interactive EM&V ..... 4

Problems Identified and Corrected through EM&V ..... 4

Savings of Individual Units ..... 5

Individual Unit Annual Energy Savings Estimates ..... 6

Individual Unit Demand Reduction Estimates ..... 8

Ex-Ante Savings Calculations ..... 10

Summary of Project by Equipment Size ..... 10

Summary of Project Energy Savings (kWh/year) by Equipment Size ..... 10

Summary of Project Demand Reduction (kW) by Equipment Size ..... 12

Program Summary of Ex-Ante Estimates ..... 12

Ex-Post Savings Calculations ..... 13

Campus Annual Energy Savings Estimates ..... 14

Campus Total Demand Reduction Estimates ..... 15

Customer Satisfaction Survey ..... 16

Conclusions ..... 17

**2. Summary CSU Dominguez Hills ..... DH-1**

**3. Summary CSU Fullerton ..... F-1**

**4. Summary CSU Long Beach ..... LB-1**

**5. Summary CSPU Pomona ..... Pom-1**

**6. Summary CSU San Bernardino ..... SB-1**

**7. Summary CSU San Diego ..... SD-1**

**8. Summary CSU San Marcos ..... SM-1**

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# Evaluation, Measurement, and Verification Report

## Project Description

The California State University (CSU) Chancellor's Office Energy Efficiency Program sponsored through the California Public Utilities Commission's Third Party Local Program consists of installation of lighting control systems in various CSU facilities. The control system to be installed is the EnergySaver manufactured by Electric City of Elk Grove Village, Illinois. This lighting controller saves energy by reducing the power demand of existing lighting systems. This device does not affect the operating hours of the lights. It works with all types of existing fixtures, including fluorescent and high-intensity discharge (HID) lights with either magnetic or electronic ballasts.[1] Fixture changes are not part of the project.

The project as approved by the California Public Utilities Commission (CPUC) includes installations in both the Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) service territories. The following table summarizes the energy savings in kWh per year:

| | S C E | S D G & E | Total |
|---|---|---|---|
| Original Proposal | 1,316,140 | 654,700 | **1,970,840** |
| Revised Proposal | 1,252,776 | 538,866 | **1,791,642** |
| Ex-Ante Verified | 1,261,741 | 513,583 | **1,775,324** |
| Ex-Post Measured | 848,639 | 432,937 | **1,281,576** |
| After Relocations | 1,246,356 | 579,971 | **1,826,327** |

The project was modified slightly and revised during its course. We verified full completion of the project and compliance with the plan. The *ex-ante* savings estimate differs very slightly (1%) only because of minor changes in actual unit sizes installed in a few locations. The ex-post energy savings calculations show reduced savings due to equipment installation in inappropriate locations. This problem has been discussed extensively with CSU personnel, and the university has obtained agreement from its contractor to relocate these units. When that relocation is completed we anticipate the true energy savings will actually exceed the revised proposal's estimate.

[1] The EnergySaver does not work with "adaptable" or "universal-voltage" electronic ballasts. This problem was encountered at Cal State San Marcos and is described in more depth in the detailed report section for that campus.

## Project Locations

The project was installed on the seven campuses of the California State University system that are within the SCE and SDG&E service territories:

California State University at Dominguez Hills
1000 East Victoria Street
Carson, CA 90747
SCE Account 3-013-3419-19

California State University at Fullerton
800 N. State College Boulevard
Fullerton, CA 92834
SCE Account 3-010-0065-02

California State University at Long Beach
1250 Bellflower Boulevard
Long Beach, CA 90840
SCE Account 3-001-3609-74

California State Polytechnic University at Pomona
3801 W. Temple Avenue
Pomona, CA 91768
SCE Account 3-000-0082-69

California State University at San Bernardino
5500 University Parkway
San Bernardino, CA 92407
SCE Account 3-012-3219-26

California State University at San Diego
5500 Campanile Drive
San Diego, CA 92182
SDG&E Account 5606-502-242

California State University at San Marcos
333 S. Twin Oaks Valley Rd.
San Marcos CA 92096
SDG&E Account 5477-270-317

## EM&V Process

The evaluation measurement and verification process involved four components:

- Verification of equipment installation and operation
- Measurement of power reduction
- Data collection for assessment of operating hours
- Calculation of energy savings.

In addition to the above components that enable us to assess ex-post energy savings, the EM&V process also provided the following valuable benefits that increased the energy savings, reliability, and safety of the systems:

- Discovery of equipment malfunctions
- Discovery and repair or reporting of improper or dangerous installations
- Recommendations for improved operation for increased savings.

The EnergySaver devices change the power demand of lighting systems but do not change operating hours. Therefore there was not a need to collect pre- and post-installation operating times. After the equipment was installed, we visited each campus twice. During the first visit we installed dataloggers on each of the EnergySaver units to collect 5-minute current readings. These data were converted into load profiles showing the average weekday and weekend operation of the lighting systems. From these load profiles we calculated annual operating times. If needed, adjustments were made to address any differences between the annual campus schedule and the three- to four-week monitoring period. In general, these differences were minor because the campuses operate on a year-round basis and most of the installation sites – parking lots, libraries, and gymnasiums – tend to be open and used on weekends and during break periods.

We also collected true power readings from each of the units. This was done both in its operating mode and with the system set to full-voltage operation. (The EnergySaver reduces energy consumption by reducing the voltage delivered to the existing ballasts and light fixtures.) These readings were usually done during the installation of the dataloggers. On systems where we discovered operational errors or equipment problems, we also took readings at the time of logger removal. The second reading verified that the manufacturer had made the necessary repairs and also provided more accurate readings because some of the malfunctions reduced the unit's energy-saving ability.

The demand reduction of the unit is determined by subtracting the typical operating demand from the demand when the system is bypassed into full-voltage operation. This demand reduction value is then multiplied by the effective full-load (but reduced voltage) operating time of the lights.[2] This results in the annual energy savings

[2] The "full-load operating time" of the lights is the equivalent period of time the lights would run at full load and consume the same amount of energy they consumed with the recorded load profile. In some instances this is the same as the time when the lights are on because they are either all on or all off. In

produced by the unit. These calculations were made on a unit-by-unit basis and then added together on a campus-by-campus basis.

The details of the metering installation, the demand reduction, and energy savings calculations are provided in the chapters of this report dedicated to each individual campus.

## Benefits Achieved by Interactive EM&V

Aloha Systems practices "interactive EM&V." In the course of our evaluation process, we work directly with the implementer, contractor, and in this particular case, even the equipment manufacturer. Because we are licensed electrical contractors as well as engineers and evaluation professionals, we sometimes even correct problems directly on the site, particularly if they are safety related.

Because of our EM&V inspections, the savings capability of the installed systems was increased by 210,715 kWh per year. This amount is included in the measured savings total because the problems have been corrected. An *additional* 147,034 kWh per year will be achieved once the San Marcos campus carries out its plan to move the units that are presently connected to adjustable (universal-voltage) ballasts, and 379,717 kWh per year can be achieved once the Fullerton campus relocates the units in its sports facilities.

The following table details the problems we noted and the savings that correcting these problems achieved. This clearly identifies the value of the EM&V process not just in evaluation, but also in quality control.

**Problems Identified and Corrected through EM&V**

| Unit | Correction Made | Annual Energy Savings Protected |
|---|---|---|
| DH-5 | Board problem prevented proper voltage reduction. Aloha reported to Electric City and correction increased power savings from 4.42 kW to 6.82 kW. | 10,512 kWh |
| DH-6 | Board problems prevented proper voltage reduction. Aloha reported to Electric City and correction increased power savings from 1.17 kW to 4.95 kW. | 20,669 kWh |

other cases this amount of time is less than the period of time when *any* light is used because there are times when only a portion of the light is used. The power reduction capability of the EnergySaver unit was demonstrated to be nearly linear with its load, so the energy saved is accurately calculated by multiplying the full-load demand reduction of the EnergySaver unit by the equivalent full-load operating time of the lighting system.

| Problems Identified and Corrected through EM&V | | |
|---|---|---|
| **Unit** | **Correction Made** | **Annual Energy Savings Protected** |
| FU-3.1<br>FU-3.2<br>FU-3.3 | Had been placed in permanent bypass mode because of start-up problem on Units FU-4A and FU-4B. | 38,470 kWh |
| FU-4A<br>FU-4B<br>FU-5 | Had been placed in permanent bypass mode because of start-up problems. Aloha traced and identified cause of problem and reported to Electric City for correction. | 24,928 kWh |
| FU-3.1 | Incoming power wire was arcing. Aloha staff shut down unit and repaired the unit on site. | Safety improved, but no energy savings effect. |
| FU-6 | Had been placed in permanent bypass mode because of start-up problem on Units FU-4A and FU-4B. | 14,690 kWh |
| SD-2B | Datalogger identified that this unit was not reducing power on Tuesdays. Installation contractor was notified to correct programming error. (9.4 kW at 22.94 h/day) | 11,218 kWh |
| SD-3 | Unit had been set in bypass mode and campus staff were unaware of this. | 90,228 kWh |
| SM-3A<br>SM-3B | Units were not saving energy because of adjustable ballasts. Savings of 147,034 will be added if these units are moved to a similar location with regular ballasts. | Savings not counted in total because unit re-installation has not yet taken place. |
| **Total** | **Energy Savings Protected by EM&V Work** | **210,715 kWh** |

## Savings of Individual Units

We measured 100% of the installed units. The following table provides a detailed listing of each unit along with its *ex-ante* savings estimate and *ex-post* savings estimate. The *ex-ante* savings estimates are simply based upon the size of the unit and the stipulated per-unit savings in the program spreadsheet submitted to the CPUC. The *ex-post* savings estimates are derived from our metering. Their calculation is detailed in the chapters discussing each individual campus.

| Individual Unit Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Campus | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| DH-1 | 40 | Library Floor 2 | 24,638 | 9,944 |
| DH-2 | 60 | Library Floor 3 | 29,120 | 22,165 |
| DH-3 | 40 | Library Floor 4 | 24,638 | 22,336 |
| DH-4 | 60 | Roadway/Walkway | 29,120 | 29,888 |
| DH-5 | 40 | Parking Lot #1 | 24,638 | 29,872 |
| DH-6 | 60 | Gym Floor | 29,120 | 27,067 |
| **Total** | | **Dominguez Hills Campus** | **161,274** | **141,272** |
| FU-1 | 60 | Library 6th Floor | 29,120 | 20,807 |
| FU-2 | 120 | Library | 58,240 | 63,068 |
| FU-3.1 | 200 | Football Field | 91,520 | 11,232 |
| FU-3.2 | 200 | Football Field | 91,520 | 13,900 |
| FU-3.3 | 200 | Football Field | 91,520 | 13,338 |
| FU-4a | 100 | Baseball Field | 49,920 | 6,768 |
| FU-4b | 100 | Baseball Field | 49,920 | 6,542 |
| FU-5 | 150 | Baseball Field | 74,880 | 11,618 |
| FU-6 | 150 | Gymnasium | 74,880 | 14,690 |
| FU-7 | 40 | Parking Structure West Side | 24,638 | 13,565 |
| FU-8 | 150 | Library | 74,880 | 73,089 |
| FU-9 | 100 | Library | 49,920 | 55,180 |
| **Total** | | **Fullerton Campus** | **760,958** | **303,797*** |
| LB-1a | 100 | Parking Structure | 49,920 | 72,708 |
| LB-1b | 80 | Parking Structure | 49,275 | 135,711 |
| **Total** | | **Long Beach Campus** | **99,195** | **208,419** |
| Pom-1 | 100 | Gymnasium | 49,920 | 43,461 |
| Pom-2 | 60 | Outside Rose Garden | 29,120 | 3,627 |
| **Total** | | **Pomona Campus** | **79,040** | **47,088** |

| Individual Unit Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| SB-1 | 60 | Library Floors 2-3 | 29,120 | 30,406 |
| SB-2 | 60 | Library Floors 2-3 | 29,120 | 29,864 |
| SB-3 | 60 | Library Floors 4-5 | 29,120 | 40,705 |
| SB-4 | 40 | Library Downstairs Offices | 24,638 | 14,071 |
| SD-5 | 40 | Library Downstairs Offices | 24,638 | 17,344 |
| SB-6 | 40 | Gym Floor | 24,638 | 15,673 |
| **Total** | | **San Bernardino Campus** | **161,274** | **148,063** |
| **Total** | | **SCE Service Territory** | **1,261,741** | **848,639*** |
| SD-1 | 150 | Parking Structure #4 | 74,880 | 128,197 |
| SD-2a | 120 | Parking Structure #1 | 58,240 | 52,436 |
| SD-2b | 150 | Parking Structure #1 | 74,880 | 80,104 |
| SD-3 | 80 | Parking Structure #5 | 49,275 | 90,228 |
| SD-4 | 80 | Parking Structure #6 | 49,275 | 55,422 |
| **Total** | | **San Diego Campus** | **306,550** | **406,387** |
| SM-1 | 80 | Parking Lot B | 49,275 | 7,883 |
| SM-2 | 40 | Parking Structure #1 | 24,638 | 18,667 |
| SM-3a | 120 | Library | 58,240 | 0* |
| SM-3b | 150 | Library | 74,880 | 0* |
| **Total** | | **San Marcos Campus** | **207,033** | **26,550**** |
| **Total** | | **SDG&E Service Territory** | **513,583** | **432,937**** |
| **Total** | | **Project Total** | **1,775,324** | **1,281,576***** |
| **Total** | | **After Relocations** | | **1,826,327***** |

*The Fullerton total will become 701,514 if the campus staff relocates the seven sports-related units to facilities similar to the campus library. This will bring the SCE total up to 1,246,356

**The San Marcos total will become 173,584 if the campus carries out its plan to relocate the two library units to a similar facility that has regular ballasts. This will bring the SDG&E total up to 579,971

***The project total will be 1,826,327 if both the San Marcos and Fullerton relocations are implemented.

The following table provides a detailed listing of each unit along with its *ex-ante* demand reduction estimate and *ex-post* demand reduction estimate. We also provided an *ex-post* estimate of summer on-peak demand reduction.

| Individual Unit Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| EnergySaver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| DH-1 | 40 | 5.625 | 2.00 | 2.00 |
| DH-2 | 60 | 7.000 | 4.33 | 4.33 |
| DH-3 | 40 | 5.625 | 3.89 | 3.89 |
| DH-4 | 60 | 7.000 | 6.55 | 0.00 |
| DH-5 | 40 | 5.625 | 6.82 | 0.00 |
| DH-6 | 60 | 7.000 | 4.95 | 4.95 |
| **Dominguez Hl** | **Total** | **37.875** | **28.54** | **15.17** |
| FU-1 | 60 | 7.000 | 3.49 | 3.49 |
| FU-2 | 120 | 14.000 | 7.82 | 7.82 |
| FU-3.1 | 200 | 22.000 | 16.00 | 0.00 |
| FU-3.2 | 200 | 22.000 | 19.80 | 0.00 |
| FU-3.3 | 200 | 22.000 | 19.00 | 0.00 |
| FU-4a | 100 | 12.000 | 12.00 | 0.00 |
| FU-4b | 100 | 12.000 | 11.60 | 0.00 |
| FU-5 | 150 | 18.000 | 20.60 | 0.00 |
| FU-6 | 150 | 18.000 | 2.60 | 2.60 |
| FU-7 | 40 | 5.625 | 2.21 | 0.66 |
| FU-8 | 150 | 18.000 | 10.3 | 10.3 |
| FU-9 | 100 | 12.000 | 9.55 | 9.55 |
| **Fullerton** | **Total** | **182.625** | **134.97** | **34.42** |
| LB-1a | 100 | 12.00 | 8.30 | 8.30 |
| LB-1b | 80 | 11.25 | 17.01 | 12.49 |
| **Long Beach** | **Total** | **23.25** | **25.31** | **20.79** |

| Individual Unit Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Pom-1 | 100 | 12.00 | 8.52 | 8.52 |
| Pom-2 | 60 | 7.00 | 0.84 | 0.00 |
| **Pomona** | **Total** | **19.00** | **9.36** | **8.52** |
| SB-1 | 60 | 7.00 | 6.29 | 6.29 |
| SB-2 | 60 | 7.00 | 5.85 | 5.85 |
| SB-3 | 60 | 7.00 | 7.67 | 7.67 |
| SB-4 | 40 | 5.00 | 2.94 | 2.94 |
| SD-5 | 40 | 5.00 | 3.02 | 3.02 |
| SB-6 | 40 | 5.00 | 3.44 | 3.44 |
| **S Bernardino** | **Total** | **36.00** | **29.21** | **29.21** |
| **SCE Serv Ter** | **Total** | **296.25** | **227.39** | **108.11** |
| SD-1 | 150 | 18.00 | 17.0 | 10.7 |
| SD-2a | 120 | 14.00 | 6.5 | 5.3 |
| SD-2b | 150 | 18.00 | 9.4 | 8.5 |
| SD-3 | 80 | 11.25 | 10.3 | 10.3 |
| SD-4 | 80 | 11.25 | 7.3 | 5.3 |
| **San Diego** | **Total** | **72.50** | **50.5** | **40.1** |
| SM-1 | 80 | 11.25 | 1.63 | 0.00 |
| SM-2 | 40 | 5.00 | 3.86 | 0.00 |
| SM-3a | 120 | 14.00 | 0.00* | 0.00* |
| SM-3b | 150 | 18.00 | 0.00* | 0.00* |
| **San Marcos** | **Total** | **48.25** | **5.49*** | **0.00*** |
| **SDG&E Ser T** | **Total** | **120.75** | **55.99** | **40.10** |
| **Project** | **Total** | **417.00** | **283.38** | **148.21** |

## *Ex-Ante* Savings Calculations

Official program evaluation is based upon *ex-ante* savings calculations. In the program approval process, per-unit energy savings and demand reduction figures are provided for each component energy efficiency measure of the program. The ex-ante savings are then determined by multiplying the actual number of units provided through the program by their respective per-unit savings estimates.

In the California State University program, the component energy efficiency measures were EnergySaver units of various current (amp) rating sizes. Demand reductions (kW) were determined and agreed upon for each unit. Hours of operation were also determined and agreed upon, and from these two values energy savings were calculated and agreed upon.

The following table provides the unit sizes, the stipulated demand reduction (kW), the stipulated annual operating hours, and the stipulated annual energy savings (kWh/year). The table also provides the original proposed quantity, the revised proposed quantity, and the actual quantity observed to be installed. The quantities are separated for the two utility service territories.

**Summary of Project by Equipment Size**

| Size | kW | hr/year | kWh | SCE Original | SCE Revised | SCE Actual | SDG&E Original | SDG&E Revised | SDG&E Actual |
|---|---|---|---|---|---|---|---|---|---|
| 40 | 5.625 | 4380 | 24,638 | | 7 | 7 | | 2 | 1 |
| 60 | 7.00 | 4160 | 29,120 | 5 | 8 | 8 | | | |
| 80 | 11.25 | 4380 | 49,275 | 4 | 2 | 1 | 4 | 2 | 3 |
| 100 | 12.00 | 4160 | 49,920 | 6 | 3 | 5 | | 1 | 0 |
| 120 | 14.00 | 4160 | 58,240 | 3 | 3 | 1 | 4 | 2 | 2 |
| 150 | 18.00 | 4160 | 74,880 | 3 | 2 | 3 | 3 | 3 | 3 |
| 200 | 22.00 | 4160 | 91,520 | 3 | 3 | 3 | | | |
| **Total** | | | | **24** | **28** | **28** | **11** | **10** | **9** |

The "original" quantities are the values contained in the implementation plan.[3] The term "original" does not refer to the original proposal submitted by the University, which was amended considerably upon approval by the CPUC. The "revised" quantities are the quantities listed on the recent quarterly report spreadsheets in Column "K" of the "Program Activities Worksheet." The May 24, 2002, implementation plan contained an estimate of how many units of each size that would be installed. As the program progressed, audits were conducted at each campus to determine how many units would be

[3] Murley, Clyde S., and Michael McCormick, *California State University Chancellor's Office Energy Efficiency Program Implementation Program Ref. 311BC-02*. (San Francisco, CA: Grueneich Resource Advocates, May 24, 2002.) Table 1, Page 4.

installed at each site and which size units were needed. This resulted in the revision of the plan that is reflected in the "revised" column. Additional modification was made prior to actual implementation, and this is reflected by the slight variation between the "revised" column that reflects the project goals and the "actual" column that reflects the equipment that is indeed installed and operating[4] on the campuses.

When the per-unit savings are multiplied by their respective numbers, we determine the *ex-ante* estimates of annual energy savings as follows:

**Summary of Project Energy Savings (kWh/year) by Equipment Size**

| Size | SCE Original | SCE Revised | SCE Actual | SDG&E Original | SDG&E Revised | SDG&E Actual |
|---|---|---|---|---|---|---|
| 40 | 0 | 172,466 | 172,466 | 0 | 49,276 | 24,638 |
| 60 | 145,600 | 232,960 | 232,960 | 0 | 0 | 0 |
| 80 | 197,100 | 98,550 | 49,275 | 197,100 | 98,550 | 147,825 |
| 100 | 299,520 | 149,760 | 249,600 | 0 | 49,920 | 0 |
| 120 | 174,720 | 174,720 | 58,240 | 232,960 | 116,480 | 116,480 |
| 150 | 224,640 | 149,760 | 224,640 | 224,640 | 224,640 | 224,640 |
| 200 | 274,560 | 274,560 | 274,560 | 0 | 0 | 0 |
| **Total** | **1,316,140** | **1,252,776** | **1,261,741** | **654,700** | **538,866** | **513,583** |

[4] "Operating" does not necessarily mean saving energy. This is particularly relevant with respect to the units in the library at CSU San Marcos. These two units are installed and they are operating. They reduce the voltage delivered to the lighting fixture ballasts as they are supposed to do. The adjustable universal-voltage ballasts compensate for this voltage reduction and prevent energy savings by increasing current draw. However, the very nature of *ex-ante* evaluation precludes such consideration. This failure to save energy, and the benefits of the possible remedies that campus personnel are considering, are discussed in the *ex-post* evaluation.

Likewise, the ex-ante estimates of demand reduction are as follows:

| Summary of Project Demand Reduction (kW) by Equipment Size | | | | | | |
|---|---|---|---|---|---|---|
| Size | SCE Original | SCE Revised | SCE Actual | SDG&E Original | SDG&E Revised | SDG&E Actual |
| 40 | 0.00 | 35.00 | 35.00 | 0.00 | 10.00 | 5.00 |
| 60 | 35.00 | 56.00 | 56.00 | 0.00 | 0.00 | 0.00 |
| 80 | 45.00 | 22.50 | 11.25 | 45.00 | 22.50 | 33.75 |
| 100 | 72.00 | 36.00 | 60.00 | 0.00 | 12.00 | 0.00 |
| 120 | 42.00 | 42.00 | 14.00 | 56.00 | 28.00 | 28.00 |
| 150 | 54.00 | 36.00 | 54.00 | 54.00 | 54.00 | 54.00 |
| 200 | 66.00 | 66.00 | 66.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **314.00** | **293.50** | **296.25** | **155.00** | **126.50** | **120.75** |

The following table provides a summary of these ex-ante evaluation findings:

| Program Summary of *Ex-Ante* Estimates | | | |
|---|---|---|---|
| **Energy Savings** | **Original** | **Revised** | **Actual** |
| SCE Service Territory | 1,316,140 | 1,216,201 | 1,225,166 |
| SDG&E Service Territory | 654,700 | 528,416 | 508,358 |
| **Program Total** | **1,970,840** | **1,744,617** | **1,733,524** |
| **Demand Savings** | **Original** | **Revised** | **Actual** |
| SCE Service Territory | 314.00 | 293.50 | 296.25 |
| SDG&E Service Territory | 155.00 | 126.50 | 120.75 |
| **Program Total** | **469.00** | **420.00** | **417.00** |

The program clearly met its installation goals. Although there were slight deviations from the revised program goals, the *ex-ante* energy savings estimate of 1,733,524 kWh/year is 99.4% of the anticipated savings. As the program evolved, more accurate deployment of equipment resulted in lower savings than had been estimated in the May 2002 implementation plan. The *ex-ante* savings are 88% of the 1,970,840 kWh/year estimated in that plan.

## ***Ex-Post* Savings Calculations**

*Ex-post* savings calculations provide a truer picture of the actual savings that will be achieved by the program. In addition to assessing whether the energy-efficiency measures specified in the plan were actually installed, the *ex-post* savings estimates verify and correct the assumptions made to estimate the program's potential prior to its installation.

The ex-post savings of this program were not as robust as the ex-ante estimates. There are three primary reasons. The first regards the loading of most of the EnergySaver units. The second regards the existence of adjustable "universal-voltage" ballasts in the very new library at Cal State San Marcos. The third regards the operating hours of a few of the units.

Most of the EnergySaver units were not loaded as fully as the original spreadsheet calculations assumed they would be. In some of the most severe cases this was because the unit operated at 120/208 volts, while the preliminary calculations assumed all of the units were 277/480-volt units. The power load, as well as the load reduction capability, of a unit is proportional to both the current and the voltage. In other cases, the lower loading was simply a matter of the lights actually connected to the unit.

The library at Cal State San Marcos is very new. Its lights contain adjustable "universal-voltage" ballasts that can operate with input voltages from 108 to 305 volts. They are basically designed to be interchangeable between 120-volt and 277-volt lighting systems. They electronically adjust input current in order to operate the lights at a given level regardless of the input voltage. Since the EnergySaver saves energy by reducing the voltage supplied to ballasts, these adjustable ballasts simply counteract the EnergySaver's efforts, resulting in no energy savings.

The preliminary calculations assumed a 12 hour per day operating period (4,160 or 4,380 hours per year). For the most part this was a very reasonable assumption. Many of the units operated considerably more than this amount. However, the largest of the units – the three 200-amp unit, one of the 150-amp units, and two of the 100-amp units – were on the sports fields of Cal State Fullerton. Sports fields are in general a very poor location for these EnergySaver devices because the lights do not operate for sufficient time. This was proven true at CSUF. This single fact alone accounted for a reduction of 385,882 kWh/year in estimated energy savings. This is 85% of the discrepancy between the program-wide ex-post savings and the program-wide ex-ante savings estimate. It is twice as significant as the failure to account for the adjustable universal-voltage ballasts in the Cal State San Marcos Library.

The following table provides a campus-by-campus delineation of the ex-ante and ex-post energy savings. The details of the ex-post calculations, together with the tables of power readings and the lighting load profiles for each EnergySaver unit, are provided in the chapters for each individual campus.

| Campus Annual Energy Savings Estimates | | |
|---|---|---|
| Campus | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| Dominguez Hills | 145,599 | 141,272 |
| Fullerton | 755,732 | 303,797* |
| Long Beach | 99,195 | 208,419 |
| Pomona | 79,040 | 47,088 |
| San Bernardino | 145,599 | 148,063 |
| **SCE Subtotal** | **1,225,165** | **848,639*** |
| San Diego | 306,550 | 406,387 |
| San Marcos | 201,808 | 26,550** |
| **SDG&E Subtotal** | **508,358** | **432,937**** |
| **Project Total** | **1,733,523** | **1,281,576***** |
| **Total After Relocations** | | **1,826,327***** |

*The Fullerton total will become 701,514 if the campus staff relocates the seven sports-related units to facilities similar to the campus library. This will bring the SCE total up to 1,246,356

**The San Marcos total will become 173,584 if the campus carries out its plan to relocate the two library units to a similar facility that has regular ballasts. This will bring the SDG&E total up to 579,971

***The project total will be 1,826,327 if both the San Marcos and Fullerton relocations are implemented.

The table on the following page provides a comparison of the *ex-ante* and *ex-post* demand reduction estimates. Two ex-post values are given – the connected load reduction and the summer on-peak demand reduction. The summer on-peak reduction is based upon the load profiles of the lights served by the individual units.

| Campus Total Demand Reduction Estimates | | | |
|---|---|---|---|
| Campus | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| Dominguez Hills | 36.00 | 28.54 | 15.17 |
| Fullerton | 182.00 | 134.97* | 34.42* |
| Long Beach | 23.25 | 25.31 | 20.79 |
| Pomona | 19.00 | 9.36 | 8.52 |
| San Bernardino | 36.00 | 29.21 | 29.21 |
| **SCE Subtotal** | **296.25** | **227.39** | **108.11** |
| San Diego | 72.50 | 50.5 | 40.1 |
| San Marcos | 48.25 | 5.49* | 0.00* |
| **SDG&E Subtotal** | **120.75** | **55.99** | **40.10** |
| **Project Total** | **417.00** | **283.38** | **148.21** |

*The Fullerton total summer on-peak total will increase significantly depending upon the load profile of the new installations, presumably by approximately 100 kW. The San Marcos total will become 31.29 kW if the campus carries out its plan to relocate the two library units to a similar facility that has regular ballasts. This will bring the SCE total up to 208 kW, the SDG&E total up to 82 kW and the project total up to 390 kW.

## Customer Satisfaction Survey

The program was sponsored and coordinated by the administrative office of the chancellor, and the "customers" are the facilities managers of the individual campuses. We conducted a brief survey of the campus staff and asked them to rate the program and the equipment.

Five of the seven submitted their responses. The respondents were asked to assign a value from 1 to 5 to each of the following, with 5 being "excellent" and 1 being "poor." The following table presents the average values:

| | |
|---|---|
| Lighting quality BEFORE installation | **3.4** |
| Lighting quality AFTER installation | **2.8** |
| Adequate training on the operation of the unit? | **2.4** |
| Installation contractor's work and professionalism | **2.8** |
| General overall satisfaction with the project | **2.6** |

In general the respondents felt that the EnergySaver reduced lighting quality. Two respondents rated the before and after quality the same, and three gave the "after" quality one point less than they gave the "before" quality. No respondent rated "after" quality higher than "before," and no respondent assigned a difference greater than one point. Lighting quality itself varied all the way from 5 to 1, depending on the campus.

The EnergySavers do reduce light output levels, though these are usually not noticeable to building occupants. It is important to note that the respondents in this survey were knowledgeable about this fact, and the survey does not reflect the opinions of students or staff in the areas. The one exception would be the athletic staff at Fullerton where the issue of technical lighting levels has arisen and is discussed in the Fullerton chapter. It is also important to note that lighting quality was only incrementally affected – bad lighting was sometimes perceived to be a little worse. It is not possible to determine from this survey to what extent the lighting quality opinions are shaped by expectations derived from experience with the equipment, the installation process and contractors, or the knowledge that lumen levels are factually reduced (information that the average person using the building would not have).

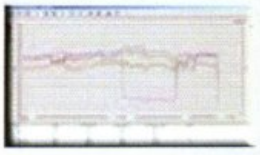
Training and operation of the units received the lowest overall rating. In general the units are designed to operate themselves. They can be programmed for a variety of schedules and light level reductions, but this is not commonly done, and the CSU units were set to operate consistently in a specific load reduction mode. The general sense is that the installing contractor could have taken more time helping the campus facilities electricians understand the system, its purpose, and how to use it.

## Conclusions

- The EnergySaver units were installed and are now operating properly.
- Some units at one campus remain in bypass mode due to real or perceived problems. Resolution of these problems is underway through a coordinated effort of the chancellor's office, the campus facilities personnel, and the equipment manufacturers and installers. Aloha Systems is being consulted in this process to assure that energy savings are enhanced in this process.
- Substantial problems that inhibited energy savings were discovered in some locations during the EM&V process. These problems were reported to CSU and/or Electric City personnel and they were promptly corrected.
- *Ex-ante* energy savings are 1,733,523 kWh/yr, which is 99.4% of the spreadsheet program goal (1,744,617) and 88% of the estimate in the May 2002 implementation plan (1,970,840).
- *Ex-post* energy savings are 1,281,576 kWh/yr, which is 73% of the spreadsheet program goal and 65% of the implementation plan estimate.
- *Ex-post* energy savings will rise to 1,826,327 kWh/yr if the Fullerton sports facility and San Marcos library units are relocated to a more suitable areas. This is 105% of the spreadsheet program goal and 93% of the original implementation plan estimate.
- *Ex-ante* demand reduction is 417 kW, which is 99% of the spreadsheet program goal (420 kW) and 89% of the implementation plan estimate (469 kW).
- *Ex-post* demand reduction is 283 kW, which is 67% of the spreadsheet program goal and 60% of the implementation plan estimate.
- *Ex-post* demand reduction will rise to 390 kW if the Fullerton and San Marcos units are relocated as planned. This is 94% of the spreadsheet program goal.
- The Electric City EnergySaver units are good applications when sufficiently loaded with lights that operate for sufficient periods of time. Good applications include libraries, gymnasiums, and outdoor lights that operate dusk-to-dawn. Parking lots that operate all or some of their lights on a 24-hour basis are particularly excellent applications.
- The EnergySaver units do not work with adjustable or "universal-voltage" ballasts and should not be installed in locations where such ballasts exist. Likewise, such ballasts should not be used to replace burned-out ballasts in locations served through an EnergySaver.
- There are some lighting quality issues with the EnergySaver units.
- The installation contractors could have taken more time explaining the units to the campus electricians, which in turn might have improved perception of the quality of units themselves.

**Products & Services**

- EnergySaver™
- GlobalCommander®
- Virtual "Negawatt" Power Plan (VNPP®) *ELC's Demand Response System Offering for Utilities*
- Integrated Solutions -Building Automation



# Our Products Are Installed Throughout the U.S.& Around the World

**EnergySaver™ IS A RESOURCE-SAVING INVESTMENT FOR THE ENVIRONMENT: A MONEY SAVING INVESTMENT FOR YOUR BOTTOM LINE**

The EnergySaver™ is a patented, base load, variable demand-side energy management tool that reduces energy consumption by 15% to 35% in indoor and outdoor commercial, institutional and industrial lighting systems, while maintaining appropriate lighting levels for the user. Additional savings are realized through the extended service life of lamps and ballasts, along with reduced heat load on building air conditioning systems.

Fully programmable, the EnergySaver allows facility managers to maximize energy savings by combining load management, market-based pricing, and incentive programs offered by today's deregulated "open access" energy market. Because the EnergySaver hardware adds to the existing lighting panel without disturbing existing fixtures, ballasts or wiring, a large and expensive lighting system retrofit is unnecessary.

The EnergySaver is compatible with any open protocol based building automation system, including BACnet and Lonworks® systems, and can communicate over any type of network architecture, including:

- WAN
- LAN
- Ethernet
- Internet
- Power Line Carrier
- Fiber Optic
- Two-way Radio

For over seventeen years Europe has utilized the core EnergySaver technology to reduce the amount of electricity required to illuminate its streets. Now, Electric City Corporation has adapted the technology for multiple lighting applications. We control the power supplied to your indoor/outdoor lighting systems and provide the exact amount of power needed to maintain appropriate light levels.

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSU Dominguez Hills

## Energy Savings Summary

Six Energy Saver units were installed on the campus of the California State University at Dominguez Hills (CSUDH). Three of the units were installed to control lights in the library. One unit controls lights in the gym, one in a parking lot, and one for roadway lighting.

The following table delineates the savings estimates for each Energy Saver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the Energy Saver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are presented below.

| CSUDH Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Lights Controlled | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| DH-1 | 40 | Library Floor 2 | 24,638 | 9,944 |
| DH-2 | 60 | Library Floor 3 | 29,120 | 22,165 |
| DH-3 | 40 | Library Floor 4 | 24,638 | 22.336 |
| DH-4 | 60 | Roadway/Walkway | 29,120 | 29,888 |
| DH-5 | 40 | Parking Lot #1 | 24,638 | 29,872 |
| DH-6 | 60 | Gym Floor | 29,120 | 27,067 |
| **Total** | | **Dominguez Hills Campus** | **161,274** | **141,272** |

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak

(summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSUDH Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| DH-1 | 40 | 5.625 | 2.00 | 2.00 |
| DH-2 | 60 | 7.000 | 4.33 | 4.33 |
| DH-3 | 40 | 5.625 | 3.89 | 3.89 |
| DH-4 | 60 | 7.000 | 6.55 | 0.00 |
| DH-5 | 40 | 5.625 | 6.82 | 0.00 |
| DH-6 | 60 | 7.000 | 4.95 | 4.95 |
| **Total** | | **37.875** | **28.54** | **15.17** |

The estimated annual energy savings, 141,272 kWh/yr, is 12% less than the 161,274 kWh/yr reported in the CPUC project spreadsheet. The demand reduction estimate, however, is about 25% less. This is because of two factors with competing effects on savings. The lights in the library and gym tended to operate slightly longer than the operating hours assumed in the spreadsheet calculations (4160 or 4380 hours per year). On the other hand, the spreadsheet calculations assumed each Energy Saver system was loaded at a higher portion of its rated load than these units in fact were. Although the demand (and therefore the demand reduction) is lower, the somewhat extended operating hours produced energy savings slightly higher than originally estimated.

Following are descriptions of each of the Energy Saver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## DH-1. Library 2nd Floor

This 277/480-volt 40-amp unit is located in Room A219 of the library and controls lights on the second floor of the library. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral.

The input power was 8.53 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 10.53 kW, indicating that the power reduction was 2.00 kW, or 19.0% of the original load. The system operated at a 98% power factor in reduced-voltage mode and 95% power factor in full-voltage mode.

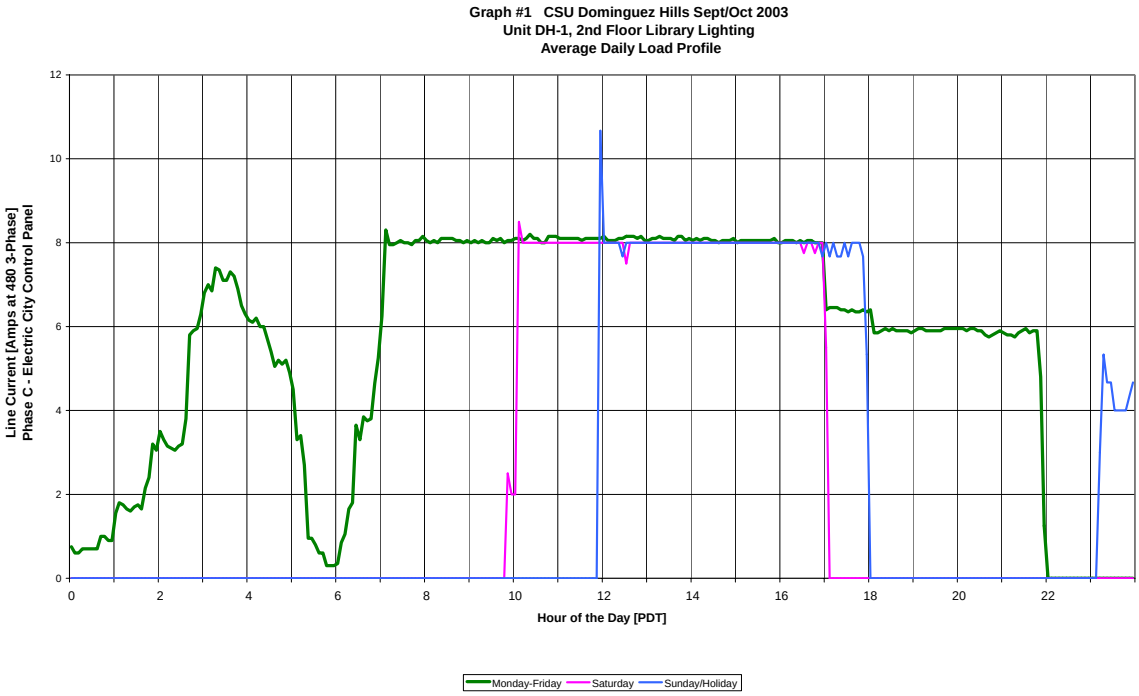
A datalogger was installed and recorded five-minute interval data from September 22 through October 20, 2003. The logger showed lighting use profiles that coordinated almost exactly with library operating hours – 7 am to 10 pm Monday through Thursday, 7 am to 5 pm Friday, 10 am to 5 pm Saturday, and noon to 6 pm Sunday. There was also some early morning usage on weekdays, perhaps for night cleaning or reshelving. The library sometimes keeps longer schedules (near finals) and shorter schedules (during break periods), but these are assumed to balance. Campus staff also indicate that they do not adjust the lighting during these times.

The load profile indicates an equivalent full-load operating time of 16.75 h/day on weekdays, 7.0 h/day on Saturdays, and 6.5 h/day on Sunday/holidays, resulting in an equivalent 4,972 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 9,944 kWh per year (2.00 kW * 4972 h/yr). The connected load reduction is 2.00 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is just over half of the 19,413 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours were slightly higher than those assumed on the spreadsheet, but the load reduction was only 2 kW rather than the assumed 5 kW.

The load profile of this Energy Saver is shown in the graph on the following page.




## DH-2. Library 3rd Floor

This 277/480-volt 60-amp unit is located in Room A231 of the library and controls lights on the third floor of the library in offices and common areas. It serves Panel LB. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral.

The input power was 19.74 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 24.07 kW, indicating that the power reduction was 4.33 kW, or 18.0% of the original load. The system operated at a 98% power factor in reduced- and full-voltage modes.

A datalogger was installed and recorded five-minute interval data from September 22 through October 20, 2003. The logger showed lighting use profiles that coordinated almost exactly with library operating hours – 7 am to 10 pm Monday through Thursday, 7 am to 5 pm Friday, 10 am to 5 pm Saturday, and noon to 6 pm Sunday. There was also some early morning usage on weekdays, perhaps for night cleaning or reshelving. The library sometimes keeps longer schedules (near finals) and shorter schedules (during break periods), but these are assumed to balance. Campus staff also indicate that they do not adjust the lighting during these times.

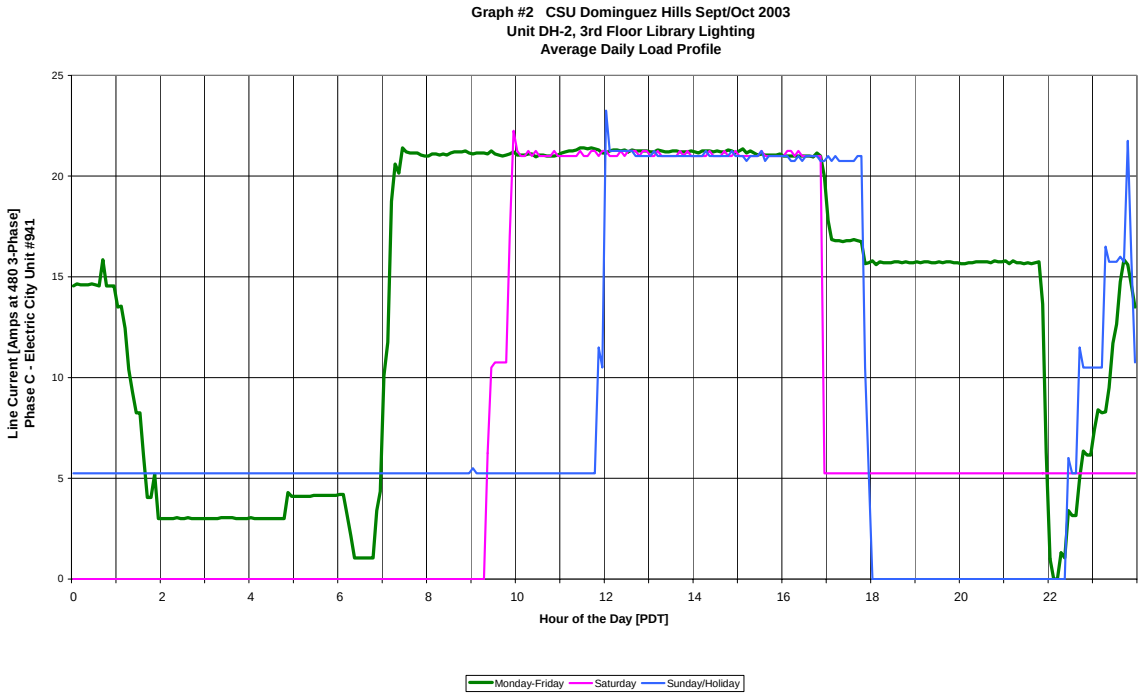
The load profile indicates an equivalent full-load operating time of 16.11 h/day on weekdays, 9.0 h/day on Saturdays, and 9.8 h/day on Sunday/holidays, resulting in an equivalent 5,119 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. This is very similar to the 4,972 h/yr observed for the second floor

lights, the difference being caused by different use during times when the library is closed.

The resultant energy savings achieved by this Energy Saver unit is 22,165 kWh per year (4.33 kW * 5119 h/yr). The connected load reduction is 4.33 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 76% of the 22,165 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours were slightly higher than those assumed on the spreadsheet, but the load reduction was only 4.3 kW rather than the assumed 7 kW.

The load profile of this Energy Saver is shown in the graph below.




## DH-3. Library 4th Floor

This 277/480-volt 40-amp unit is located in Room A417 of the library and controls lights on the fourth floor of the library in offices and common areas. It serves Panel LC. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral.

The input power was 16.88 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 20.77 kW, indicating that the power reduction was 3.89 kW, or 18.7% of the original load. The system operated at a 95% power factor in reduced-voltage mode and 92% power factor and full-voltage mode.

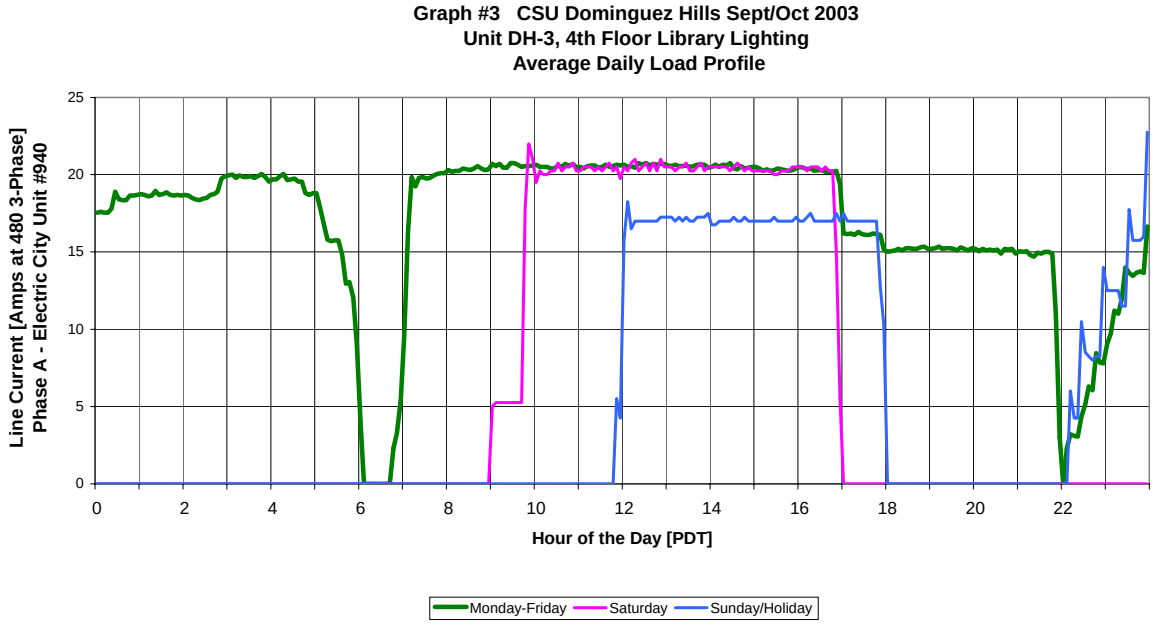
A datalogger was installed and recorded five-minute interval data from September 22 through October 20, 2003. The logger showed lighting use profiles that coordinated almost exactly with library operating hours – 7 am to 10 pm Monday through Thursday, 7 am to 5 pm Friday, 10 am to 5 pm Saturday, and noon to 6 pm Sunday. Sunday lighting loads were less than on other days. There was also some early morning usage on weekdays, perhaps for night cleaning or reshelving. The library sometimes keeps longer schedules (near finals) and shorter schedules (during break periods), but these are assumed to balance. Campus staff also indicate that they do not adjust the lighting during these times.

The load profile indicates an equivalent full-load operating time of 19.9 h/day on weekdays, 7.3 h/day on Saturdays, and 6.0 h/day on Sunday/holidays, resulting in an equivalent 5,742 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. This is higher than the 4,972 h/yr observed for the second floor lights, the difference being caused by much greater early morning use when the library is closed.

The resultant energy savings achieved by this Energy Saver unit is 22,336 kWh per year (3.89 kW * 5742 h/yr). The connected load reduction is 3.89 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 115% of the 19,413 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours were higher than those assumed on the spreadsheet and the load reduction was not as much less as in other library units.

The load profile of this Energy Saver is shown in the graph below.



## DH-4. Walkway and Roadway Lights

This 277/480-volt 60-amp unit is located in Electric Room ERC LCH in a separate building. It controls walkway and roadway lights. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We read the average output voltage as 232.1 volts.

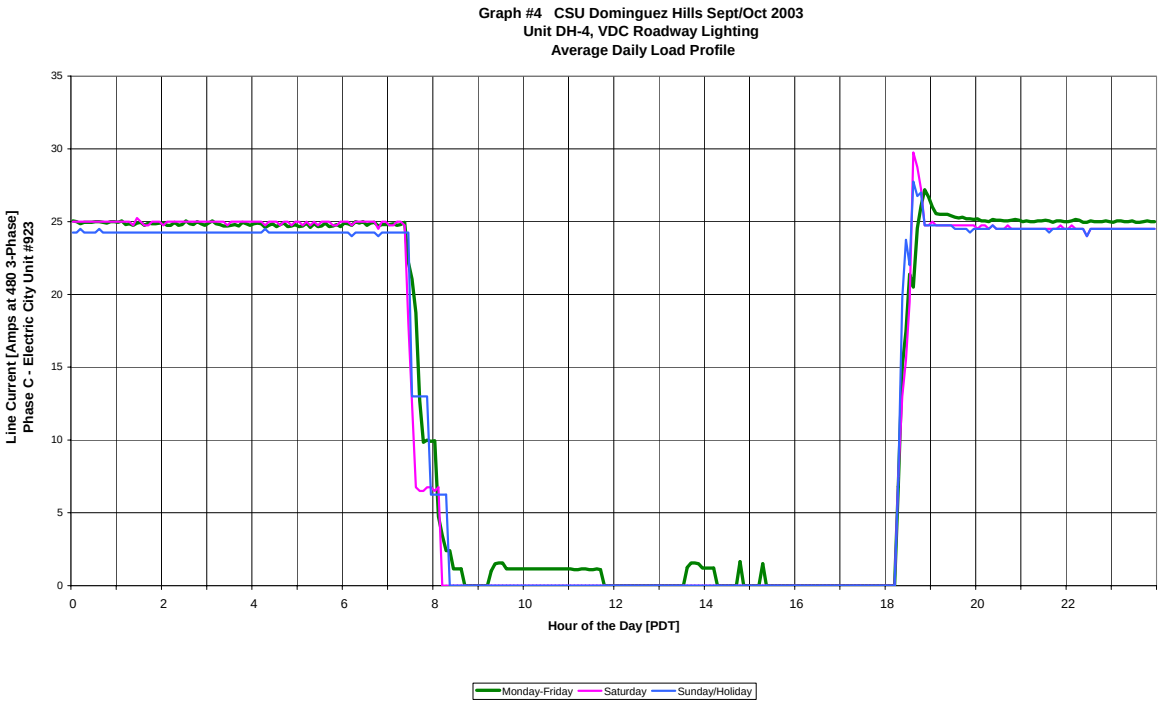
The input power was 23.83 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 30.38 kW, indicating that the power reduction was 6.55 kW, or 21.6% of the original load. The system operated at a 99% power factor in both reduced- and full-voltage modes.

A datalogger was installed and recorded five-minute interval data from September 22 through October 20, 2003. The logger showed lighting use profiles that corresponded with sunrise and sunset. The lights tended to stay on approximate one-half hour after sunrise and turn on at sunset. We add an extra 183 hours/year to accommodate this extra time, resulting in 4,563 hours per year of operation.

The resultant energy savings achieved by this Energy Saver unit is 29,888 kWh per year (6.55 kW * 4563 h/yr). The connected load reduction is 6.55 kW, and the summer on-peak demand reduction is zero because the lights do not operate during the summer on-peak period.

This value is 102% of the 29,120 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours were slightly higher than those assumed on the spreadsheet and the load reduction was just slightly less than originally assumed.

The load profile of this Energy Saver is shown in the graph below.



## DH-5. Parking Lot and Roadway Lights

This 277/480-volt 40-amp unit is located in the electric vault of Parking Lot #1. It controls parking lot and roadway lights. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. A power board problem was noted on the "C" phase of the Energy Saver. This problem was reported to the manufacturer and it was fixed before our second visit.

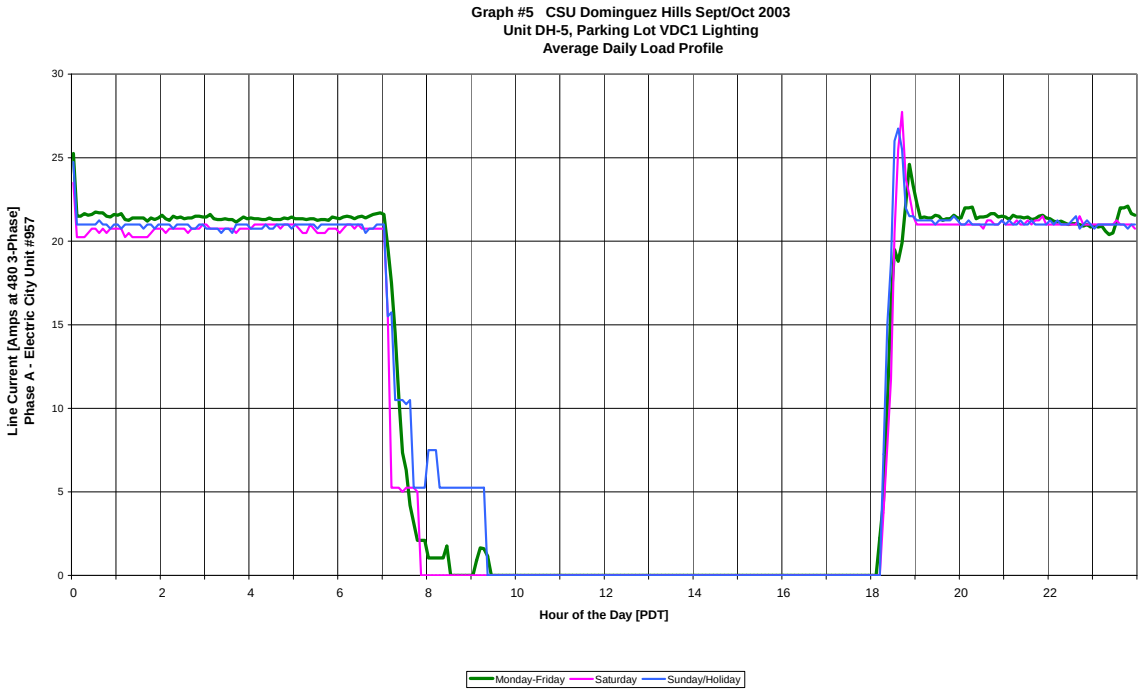
We read the average output voltage as 231.1 volts. The input power was 17.05 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 23.87 kW, indicating that the power reduction was 6.82 kW, or 28.6% of the original load. The system operated at a 96% power factor in reduced-voltage mode and 95% in full-voltage modes.

A datalogger was installed and recorded five-minute interval data from September 22 through October 20, 2003. The logger showed lighting use profiles that corresponded with sunrise and sunset. The lights tended to stay on approximate a short time after sunrise, but also and turn on a short time after sunset. This results in an annual average of 12 hours per day, or 4,380 hours per year.

The resultant energy savings achieved by this Energy Saver unit is 29,872 kWh per year (6.82 kW * 4380 h/yr). The connected load reduction is 6.82 kW, and the summer on-peak demand reduction is zero because the lights do not operate during the summer on-peak period.

This value is 154% of the 19,413 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours were slightly higher than those assumed on the spreadsheet and the load reduction was actually greater than the 5 kW originally assumed.

The load profile of this Energy Saver is shown in the graph on the following page.




## DH-6. Gymnasium Floor

This 277/480-volt 60-amp unit is located in the training room of the gym and controls the T5 lights on the gym floor. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. Power board problems were noted on the "B" and "C" phases of the Energy Saver. These problems were reported to the manufacturer, and they were fixed before our second visit.

We read the average output voltage as 230.1 volt. The input power was 27.65 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 32.60 kW, indicating that the power reduction was 4.95 kW, or 15.2% of the original load. The system operated at a 99% power factor in reduced-voltage mode and 98% in full-voltage mode.

A datalogger was installed and recorded five-minute interval data from September 22 through October 20, 2003. The logger showed use profiles consistent with campus operation, plus consistent full lighting during the early morning hours of weekdays.

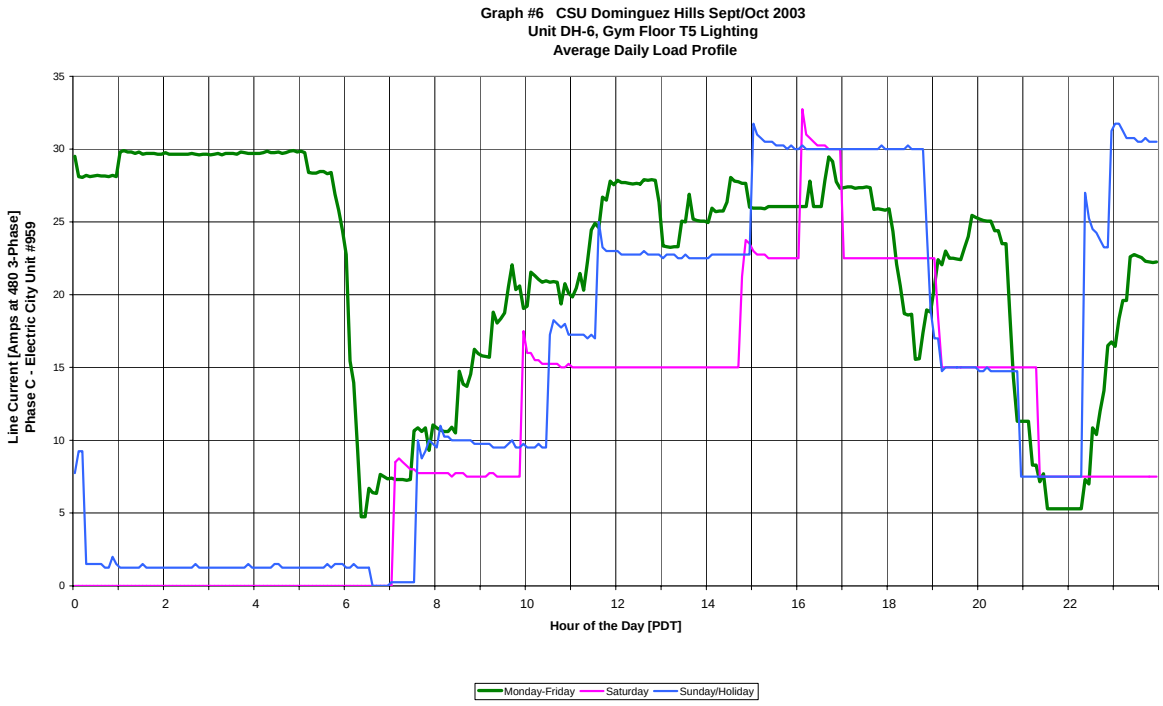
The load profile indicates an equivalent full-load operating time of 17.3 h/day on weekdays, 8.3 h/day on Saturdays, and 11.2 h/day on Sunday/holidays, resulting in an equivalent 5,468 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 27,067 kWh per year (4.95 kW * 5468 h/yr). The connected load reduction is 4.95 kW, and the

summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 93% of the 22,165 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours were higher than those assumed on the spreadsheet, but the load reduction was only 5 kW rather than the assumed 7 kW.

The load profile of this Energy Saver is shown in the graph below.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *DH-1 Dominguez Hills*

| | | | |
|---|---|---|---|
| Location: | Project #DH-1 - Library, 2nd Floor, Room A219A | Date Measured: | 9/22/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40amp/ # |
| Panel Fed By Energy Saver: | | Datalogger #: | M-31 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 277.8 | 10.44 | 2.83 | 2.90 | 0.61 | 0.98 |
| B | 279.6 | 10.16 | 2.78 | 2.84 | 0.56 | 0.98 |
| C | 278.2 | 10.71 | 2.92 | 2.99 | 0.63 | 0.98 |
| TOT/AVG | 278.53 | 10.44 | 8.53 | 8.73 | 1.80 | 0.98 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| TOT/AVG | | | | | | |

**Description of Lights Controlled:**

2nd floor lighting

## CSU Chancellor's Office

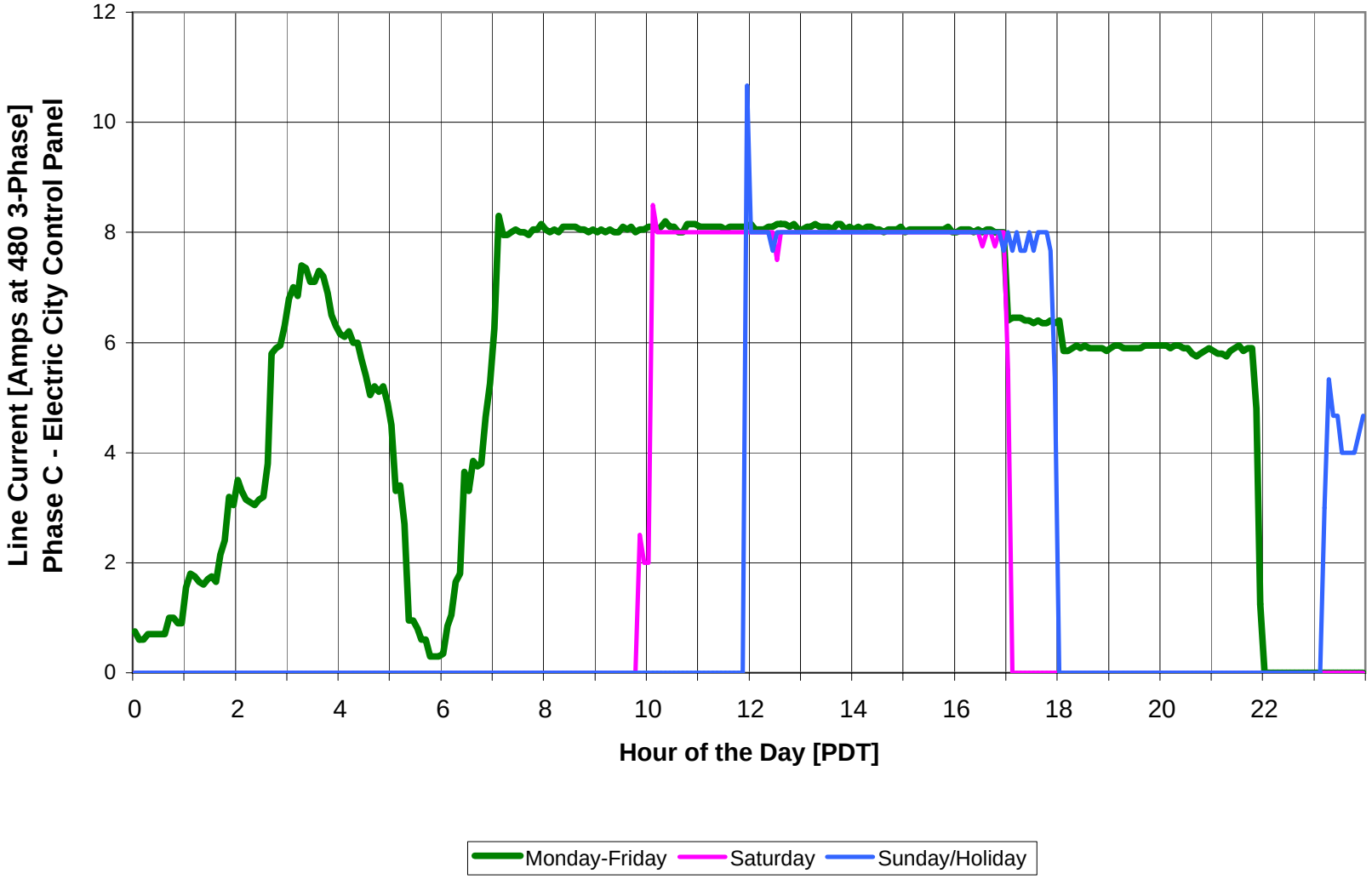
## *DH-1 Dominguez Hills*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 278.7 | 13.20 | 3.68 | 3.74 | 0.64 | 0.89 |
| B | 279.6 | 11.81 | 3.25 | 3.30 | 0.59 | 0.98 |
| C | 278.6 | 13.16 | 3.60 | 3.64 | 0.56 | 0.99 |
| TOT/AVG | 278.97 | 12.72 | 10.53 | 10.68 | 1.79 | 0.95 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| TOT/AVG | | | | | | |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 278.5 | 10.44 | 8.53 | 8.73 | 1.80 | 0.98 |
| **Reduce Output** | | | | | | |
| **Full Input** | 279.0 | 12.72 | 10.53 | 10.68 | 1.79 | 0.95 |
| **Full Output** | | | | | | |
| **Power Savings** | | | **2.00** | | | |
| **Power % Savings** | | | **18.99%** | | | |

**Graph #1 CSU Dominguez Hills Sept/Oct 2003**
**Unit DH-1, 2nd Floor Library Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *DH-2 Dominguez Hills*

| | | | |
|---|---|---|---|
| Location: | Project #DH-2 - Library, 3rd Floor Room A231A | Date Measured: | 9/22/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60amp / #941 |
| Panel Fed By Energy Saver: | Panel LB | Datalogger #: | M-22 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 277.9 | 24.19 | 6.61 | 6.71 | 1.19 | 0.98 |
| B | 278.2 | 24.31 | 6.62 | 6.76 | 1.36 | 0.98 |
| C | 276.9 | 23.91 | 6.51 | 6.61 | 1.14 | 0.99 |
| TOT/AVG | 277.67 | 24.14 | 19.74 | 20.08 | 3.69 | 0.98 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 233.1 | | | | | |
| B | 232.9 | | | | | |
| C | 233.5 | | | | | |
| TOT/AVG | 233.17 | | | | | |

**Description of Lights Controlled:**

3rd floor lighting

Offices, Common areas

## CSU Chancellor's Office

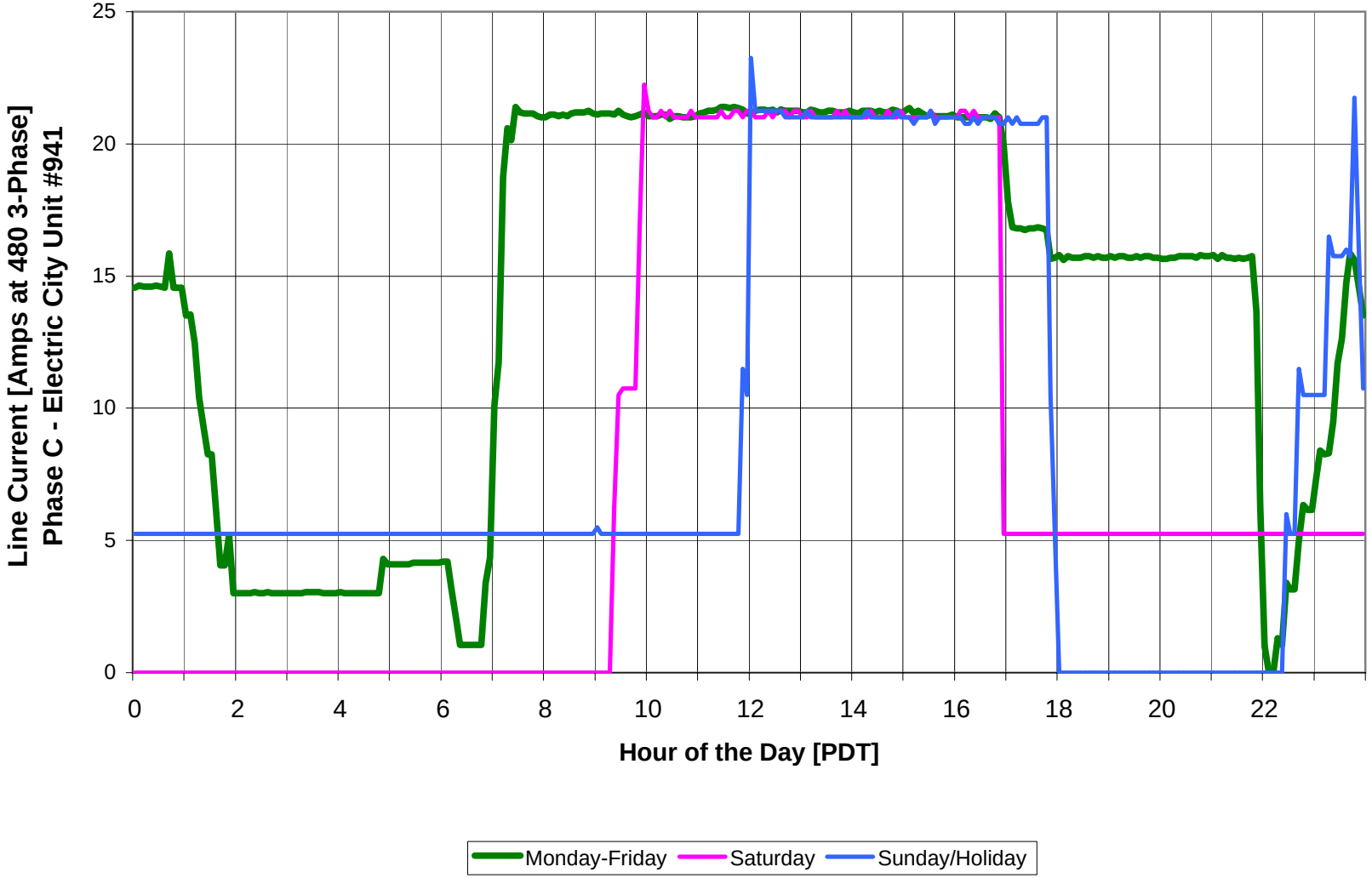
## *DH-2 Dominguez Hills*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.7 | 29.32 | 8.01 | 8.14 | 1.48 | 0.98 |
| B | 278.8 | 29.80 | 8.15 | 8.28 | 1.51 | 0.98 |
| C | 278.0 | 28.99 | 7.91 | 8.06 | 1.60 | 0.98 |
| TOT/AVG | 278.17 | 29.37 | 24.07 | 24.48 | 4.59 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.3 | | | | | |
| B | 275.1 | | | | | |
| C | 276.7 | | | | | |
| TOT/AVG | 276.03 | | | | | |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 277.7 | 24.14 | 19.74 | 20.08 | 3.69 | 0.98 |
| **Reduce Output** | 233.2 | | | | | |
| **Full Input** | 278.2 | 29.37 | 24.07 | 24.48 | 4.59 | 0.98 |
| **Full Output** | 276.0 | | | | | |
| **Power Savings** | | | **4.33** | | | |
| **Power % Savings** | | | **17.99%** | | | |

**Graph #2 CSU Dominguez Hills Sept/Oct 2003**
**Unit DH-2, 3rd Floor Library Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *DH-3 Dominguez Hills*

| | | | |
|---|---|---|---|
| Location: | Project #DH-3 - Library, 4th Floor, Room ERC A417A | Date Measured: | 9/22/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40amp / #940 |
| Panel Fed By Energy Saver: | Panel LC | Datalogger #: | M-32 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 277.6 | 18.90 | 4.86 | 5.24 | 1.94 | 0.93 |
| B | 278.2 | 20.43 | 5.43 | 5.67 | 1.63 | 0.96 |
| C | 276.7 | 24.34 | 6.59 | 6.76 | 1.54 | 0.97 |
| TOT/AVG | 277.50 | 21.22 | 16.88 | 17.67 | 5.11 | 0.95 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 233.7 | | | | | |
| B | 231.4 | | | | | |
| C | 232.6 | | | | | |
| TOT/AVG | 232.57 | | | | | |

| **Description of Lights Controlled:** |
|---|
| 4th floor lighting |
| Offices, Common areas |
| |

## CSU Chancellor's Office

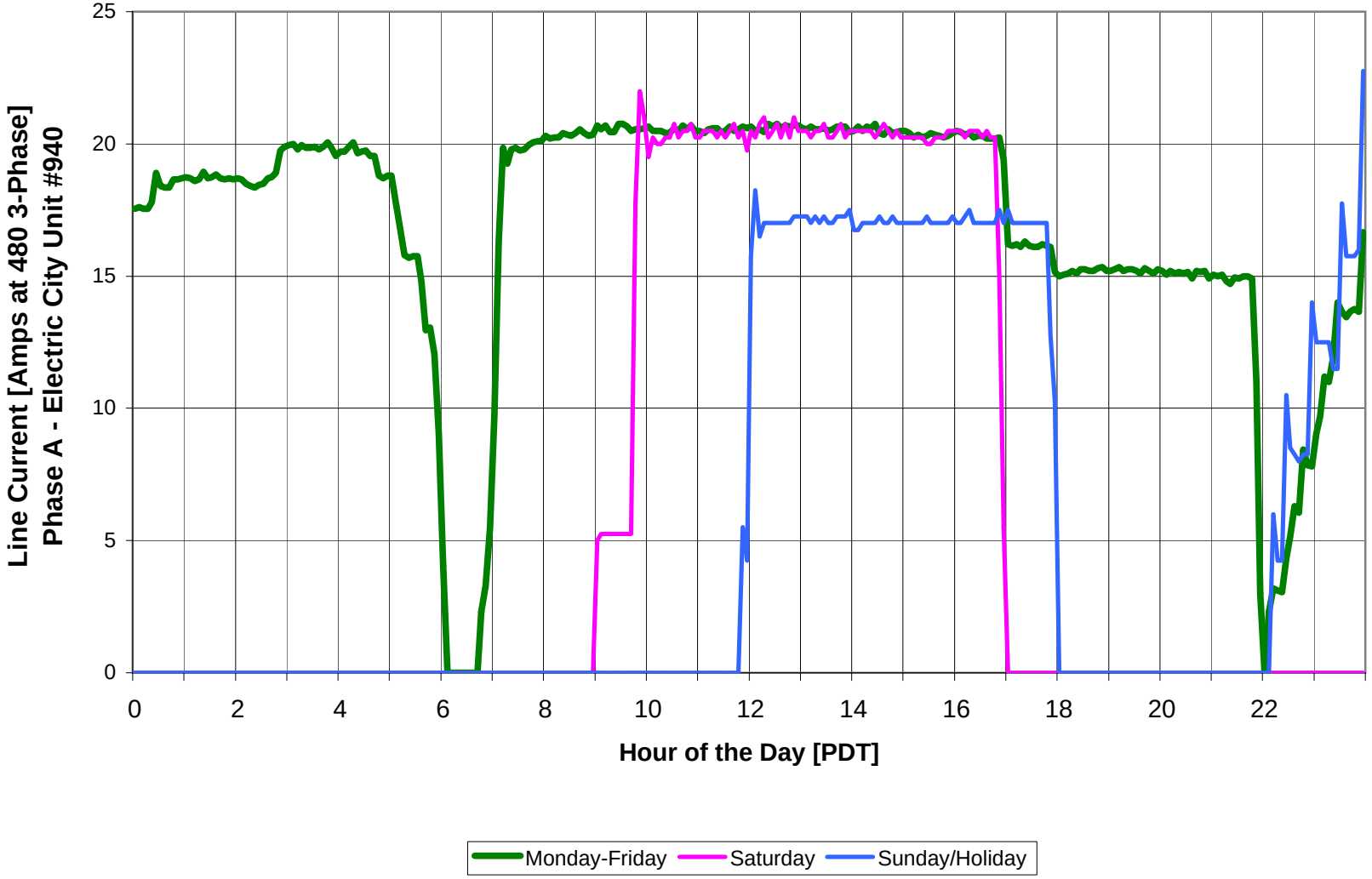
## *DH-3 Dominguez Hills*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.6 | 24.78 | 6.09 | 6.87 | 3.19 | 0.89 |
| B | 277.9 | 26.50 | 6.65 | 7.36 | 3.15 | 0.90 |
| C | 276.5 | 30.16 | 8.03 | 8.34 | 2.24 | 0.96 |
| TOT/AVG | 277.00 | 27.15 | 20.77 | 22.57 | 8.58 | 0.92 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 278.5 | | | | | |
| B | 276.5 | | | | | |
| C | 274.9 | | | | | |
| TOT/AVG | 276.63 | | | | | |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 277.5 | 21.22 | 16.88 | 17.67 | 5.11 | 0.95 |
| **Reduce Output** | 232.6 | | | | | |
| **Full Input** | 277.0 | 27.15 | 20.77 | 22.57 | 8.58 | 0.92 |
| **Full Output** | 276.6 | | | | | |
| **Power Savings** | | | **3.89** | | | |
| **Power % Savings** | | | **18.73%** | | | |

**Graph #3 CSU Dominguez Hills Sept/Oct 2003**
**Unit DH-3, 4th Floor Library Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *DH-4 Dominguez Hills*

| | | | |
|---|---|---|---|
| Location: | Project #DH-4 - Electric Bunker, Room ERC LCH, VDC3 | Date Measured: | 9/22/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60amp / #923 |
| Panel Fed By Energy Saver: | | Datalogger #: | V-3 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 277.4 | 25.70 | 7.17 | 7.25 | 1.08 | 0.99 |
| B | 275.5 | 32.93 | 8.97 | 9.06 | 1.23 | 0.99 |
| C | 276.4 | 28.30 | 7.69 | 7.80 | 1.35 | 0.99 |
| TOT/AVG | 276.43 | 28.98 | 23.83 | 24.11 | 3.66 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 233.0 | 30.18 | 3.94 | 7.03 | 1.11 | 0.99 |
| B | 230.9 | 39.70 | 8.96 | 9.04 | 1.25 | 0.99 |
| C | 232.5 | 32.01 | 7.30 | 7.42 | 1.31 | 0.98 |
| TOT/AVG | 232.13 | 33.96 | 20.20 | 23.49 | 3.67 | 0.99 |

**Description of Lights Controlled:**

Walkway and roadway lights

## CSU Chancellor's Office

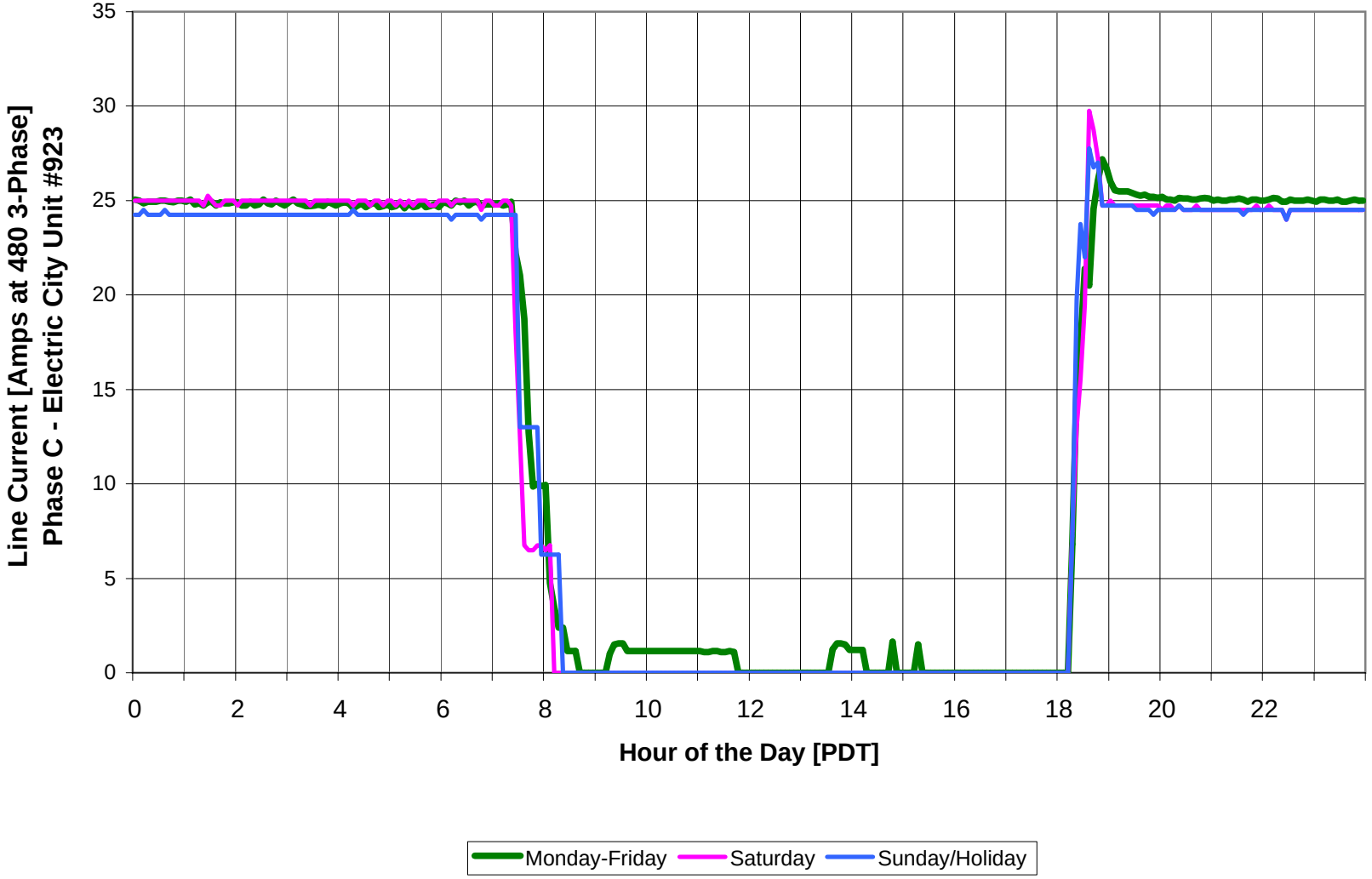
## *DH-4 Dominguez Hills*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.9 | 33.51 | 9.08 | 9.20 | 1.53 | 0.99 |
| B | 275.4 | 42.52 | 11.50 | 11.70 | 1.99 | 0.99 |
| C | 276.0 | 36.33 | 9.80 | 10.00 | 2.14 | 0.98 |
| TOT/AVG | 276.10 | 37.45 | 30.38 | 30.90 | 5.66 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 275.8 | 33.87 | 9.17 | 9.30 | 1.55 | 0.99 |
| B | 273.8 | 42.48 | 11.40 | 11.60 | 2.05 | 0.98 |
| C | 274.9 | 35.60 | 9.65 | 9.78 | 1.65 | 0.99 |
| TOT/AVG | 274.83 | 37.32 | 30.22 | 30.68 | 5.25 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 276.4 | 28.98 | 23.83 | 24.11 | 3.66 | 0.99 |
| **Reduce Output** | 232.1 | 33.96 | 20.20 | 23.49 | 3.67 | 0.99 |
| **Full Input** | 276.1 | 37.45 | 30.38 | 30.90 | 5.66 | 0.99 |
| **Full Output** | 274.8 | 37.32 | 30.22 | 30.68 | 5.25 | 0.99 |
| **Power Savings** | | | **6.55** | | | |
| **Power % Savings** | | | **21.56%** | | | |

**Graph #4 CSU Dominguez Hills Sept/Oct 2003**
**Unit DH-4, VDC Roadway Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *DH-5 Dominguez Hills*

**AFTER CORRECTIONS**

| | | | |
|---|---|---|---|
| Location: | Project #DH-5 - Parking Lot #1 Vault (VDC#1) | Date Measured: | 10/21/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40 amp / #957 |
| Panel Fed By Energy Saver: | | Datalogger #: | V-8 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 278.8 | 21.30 | 5.78 | 5.93 | 1.30 | 0.98 |
| B | 277.7 | 20.49 | 5.38 | 5.66 | 1.76 | 0.97 |
| C | 276.4 | 22.96 | 5.89 | 6.37 | 2.42 | 0.93 |
| TOT/AVG | 277.63 | 21.58 | 17.05 | 17.96 | 5.48 | 0.96 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.8 | 25.95 | 5.81 | 5.77 | 1.36 | 0.97 |
| B | 230.6 | 24.79 | 5.29 | 5.61 | 1.86 | 0.94 |
| C | 230.8 | 27.33 | 5.87 | 6.34 | 2.40 | 0.94 |
| TOT/AVG | 231.07 | 26.02 | 16.97 | 17.72 | 5.62 | 0.95 |

**Description of Lights Controlled:**

Parking lot and roadway lights (HID)

Electric City Unit Serial #957

## CSU Chancellor's Office

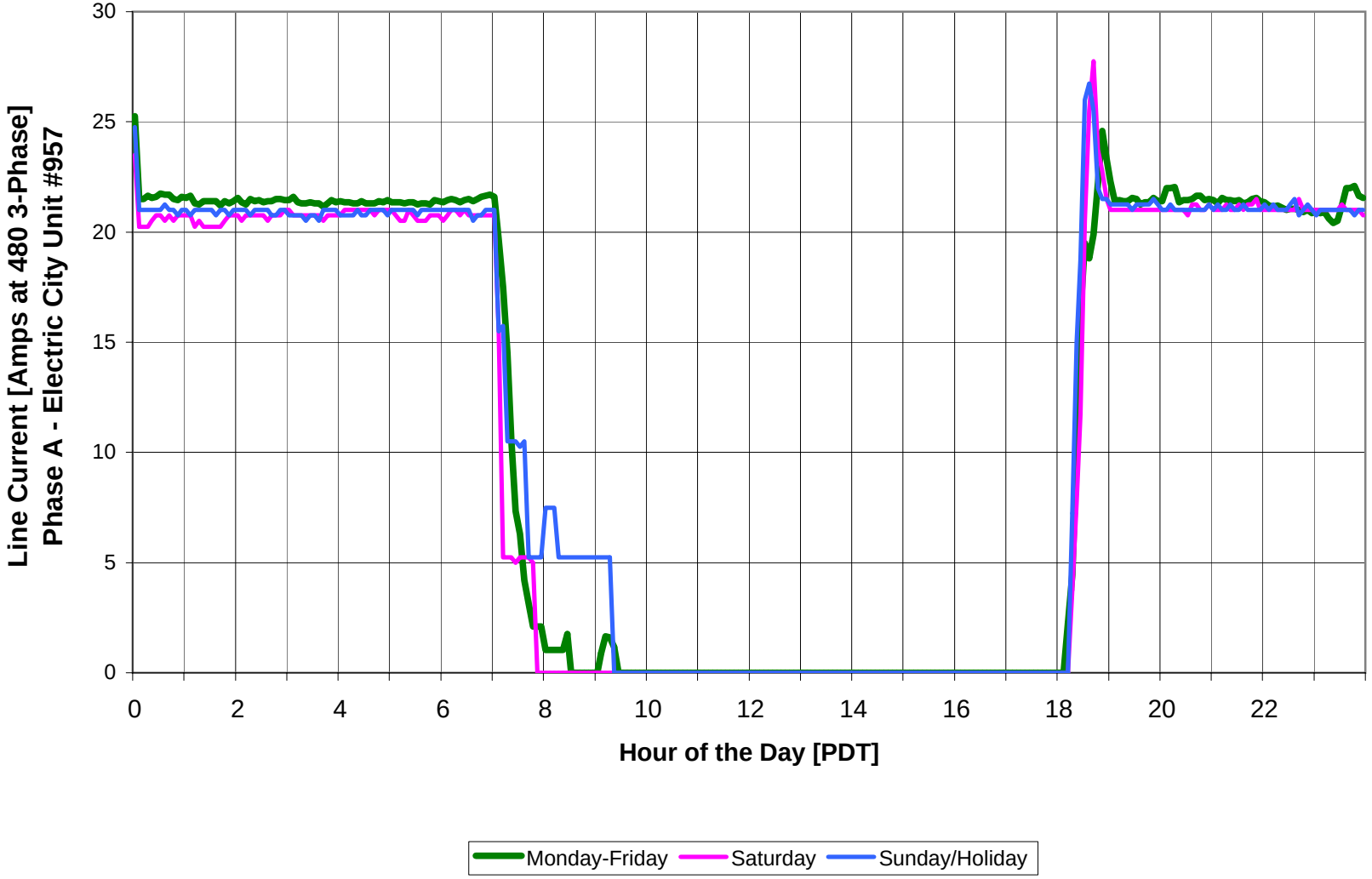
## *DH-5 Dominguez Hills*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 280.0 | 28.98 | 7.92 | 8.14 | 1.84 | 0.97 |
| B | 279.2 | 28.89 | 7.70 | 8.13 | 2.58 | 0.95 |
| C | 278.1 | 32.10 | 8.25 | 8.92 | 3.39 | 0.93 |
| TOT/AVG | 279.10 | 29.99 | 23.87 | 25.19 | 7.81 | 0.95 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.7 | 29.90 | 7.95 | 8.17 | 1.88 | 0.97 |
| B | 278.2 | 29.05 | 7.78 | 8.15 | 2.50 | 0.95 |
| C | 277.2 | 32.43 | 8.30 | 8.99 | 3.44 | 0.92 |
| TOT/AVG | 277.37 | 30.46 | 24.03 | 25.31 | 7.82 | 0.95 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 277.6 | 21.58 | 17.05 | 17.96 | 5.48 | 0.96 |
| **Reduce Output** | 231.1 | 26.02 | 16.97 | 17.72 | 5.62 | 0.95 |
| **Full Input** | 279.1 | 29.99 | 23.87 | 25.19 | 7.81 | 0.95 |
| **Full Output** | 277.4 | 30.46 | 24.03 | 25.31 | 7.82 | 0.95 |
| **Power Savings** | | | **6.82** | | | |
| **Power % Savings** | | | **28.57%** | | | |

**Graph #5 CSU Dominguez Hills Sept/Oct 2003**
**Unit DH-5, Parking Lot VDC1 Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *DH-6 Dominguez Hills*

**AFTER CORRECTIONS**

| | | | |
|---|---|---|---|
| Location: | Project #DH-6 - Training Room, Gym | Date Measured: | 10/21/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60amp / #959 |
| Panel Fed By Energy Saver: | | Datalogger #: | M-21 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 279.0 | 33.60 | 9.24 | 9.37 | 1.57 | 0.99 |
| B | 279.9 | 34.29 | 9.53 | 9.66 | 1.57 | 0.99 |
| C | 281.1 | 32.12 | 8.88 | 9.01 | 1.49 | 0.99 |
| TOT/AVG | 280.00 | 33.34 | 27.65 | 28.04 | 4.63 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.2 | 40.26 | 9.39 | 9.40 | 1.46 | 0.99 |
| B | 230.5 | 42.92 | 9.65 | 9.81 | 1.72 | 0.99 |
| C | 228.8 | 39.56 | 8.76 | 8.89 | 1.56 | 0.99 |
| TOT/AVG | 230.17 | 40.91 | 27.80 | 28.10 | 4.74 | 0.99 |

**Description of Lights Controlled:**

Gym floor lighting, T-5 lights

## CSU Chancellor's Office

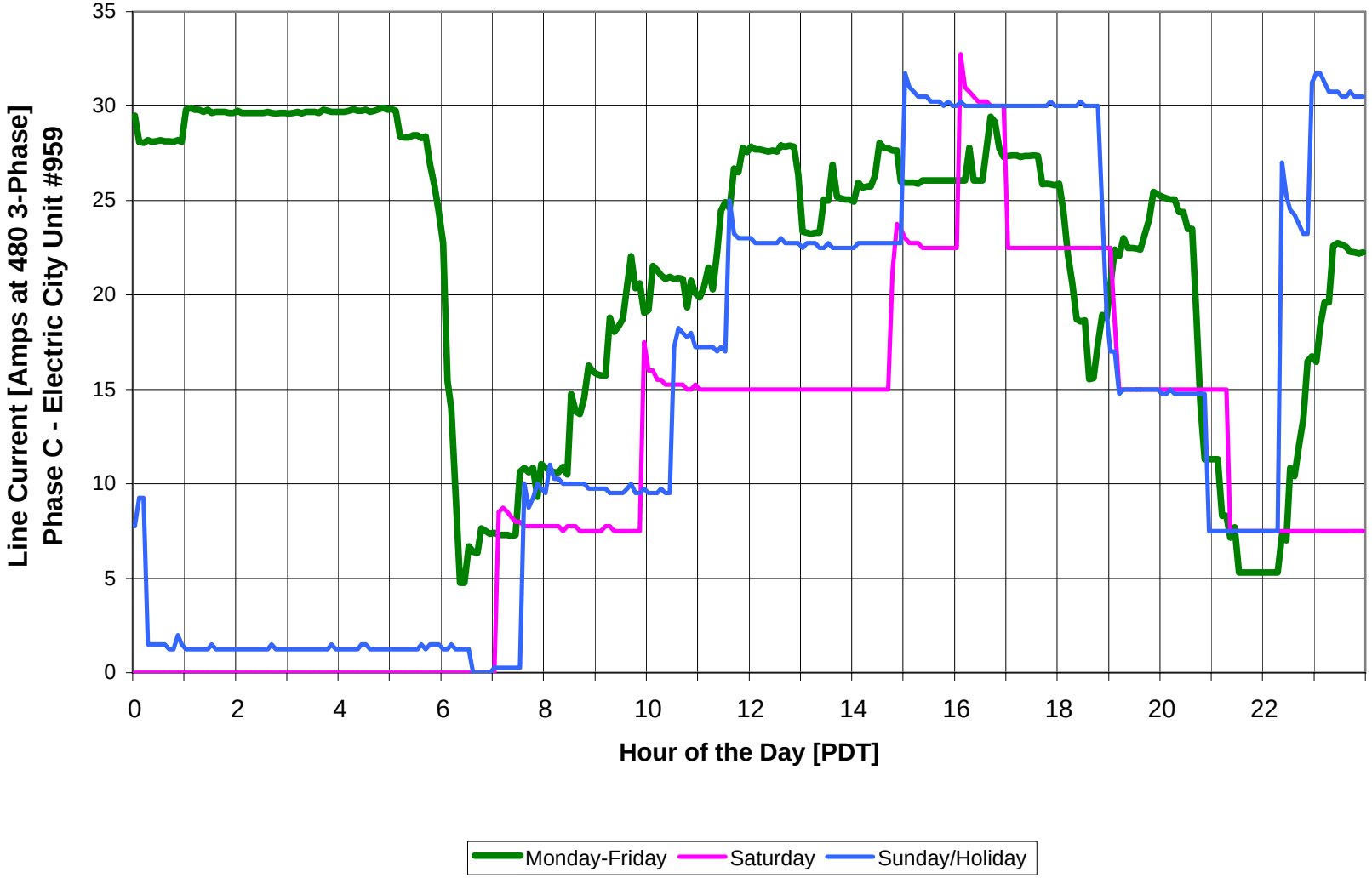
## *DH-6 Dominguez Hills*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 280.1 | 39.80 | 10.90 | 11.10 | 2.20 | 0.98 |
| B | 280.8 | 41.46 | 11.30 | 11.60 | 2.50 | 0.98 |
| C | 282.4 | 37.48 | 10.40 | 10.60 | 2.10 | 0.98 |
| TOT/AVG | 281.10 | 39.58 | 32.60 | 33.30 | 6.80 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.2 | 40.75 | 10.90 | 11.10 | 2.33 | 0.98 |
| B | 274.8 | 42.53 | 11.40 | 11.70 | 2.53 | 0.98 |
| C | 273.7 | 39.33 | 10.50 | 10.70 | 2.24 | 0.98 |
| TOT/AVG | 273.90 | 40.87 | 32.80 | 33.50 | 7.10 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 280.0 | 33.34 | 27.65 | 28.04 | 4.63 | 0.99 |
| **Reduce Output** | 230.2 | 40.91 | 27.80 | 28.10 | 4.74 | 0.99 |
| **Full Input** | 281.1 | 39.58 | 32.60 | 33.30 | 6.80 | 0.98 |
| **Full Output** | 273.9 | 40.87 | 32.80 | 33.50 | 7.10 | 0.98 |
| **Power Savings** | | | **4.95** | | | |
| **Power % Savings** | | | **15.18%** | | | |

**Graph #6 CSU Dominguez Hills Sept/Oct 2003**
**Unit DH-6, Gym Floor T5 Lighting**
**Average Daily Load Profile**



# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSU Fullerton

## Energy Savings Summary

Twelve EnergySaver units were installed on the campus of the California State University at Fullerton (CSUF). Four of the units were installed to control lights in the library. One controls lights in a parking structure. One controls lights in the gym. Six control lights on the baseball and football fields.

We discovered several installation and equipment problems at this campus, and these problems were reported to CSU staff and/or the equipment manufacturer. In the case of one potentially dangerous electrical connection problem, Aloha Systems engineers shut down the unit and repaired it at that time. These problems included units that did not set at their proper voltage, and one contactor relay whose coil was connected to the reduced-voltage side of the EnergySaver, preventing it from turning on the lights. Because of some of these problems, most of which were found on the sports field or gym installations, campus personnel had operated these units in bypass mode, thus eliminating their energy-saving capability.

There also remains an issue with the units on sports fields regarding whether the lighting levels achieved in energy-saving mode meet the requirements of the National Collegiate Athletic Association (NCAA). The university will be contracting with Aloha Systems to specifically assess this on the baseball field, and then determine what to do with the EnergySaver units. Electric City, the manufacturer, has agreed to relocate the units when campus and chancellor's office staff agrees upon suitable locations. *It is important to note that when this is accomplished, the energy savings at this campus will be significantly increased.* Through the EM&V process, CSU personnel have become very aware of good and mediocre locations for installing these units, and the new locations will be specifically chosen to optimize energy-saving capabilities. This relocation could increase annual energy savings by approximately 400,000 kWh.

The following table delineates the savings estimates for each EnergySaver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the EnergySaver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are in the table on the following page.

| CSUF Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Location | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| FU-1 | 60 | Library 6th Floor | 29,120 | 20,807 |
| FU-2 | 120 | Library | 58,240 | 63,068 |
| FU-3.1 | 200 | Football Field | 91,520 | 11,232 |
| FU-3.2 | 200 | Football Field | 91,520 | 13,900 |
| FU-3.3 | 200 | Football Field | 91,520 | 13,338 |
| FU-4a | 100 | Baseball Field | 49,920 | 6,768 |
| FU-4b | 100 | Baseball Field | 49,920 | 6,542 |
| FU-5 | 150 | Baseball Field | 74,880 | 11,618 |
| FU-6 | 150 | Gymnasium | 74,880 | 14,690 |
| FU-7 | 40 | Parking Structure West Side | 24,638 | 13.565 |
| FU-8 | 150 | Library | 74,880 | 73,089 |
| FU-9 | 100 | Library | 49,920 | 55,180 |
| **Total** | | **Fullerton Campus** | **760,958** | **303,797*** |

*The *ex-post* total will become 701,514 if the campus staff relocates the seven sports-related units to facilities similar to the campus library.

The library lights were reportedly operated in bypass mode because of concerns that the lowered voltages were causing compact fluorescent lamp ballasts to burn out prematurely. We anticipate resolution of this problem, perhaps by wiring the CLFs on to a circuit not fed through the EnergySaver. The CFLs contribute only a small portion of the energy savings, so this issue was not taken into account in calculating the savings.

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak (summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSUF Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| FU-1 | 60 | 7.000 | 3.49 | 3.49 |
| FU-2 | 120 | 14.000 | 7.82 | 7.82 |
| FU-3.1 | 200 | 22.000 | 16.00 | 0.00 |
| FU-3.2 | 200 | 22.000 | 19.80 | 0.00 |
| FU-3.3 | 200 | 22.000 | 19.00 | 0.00 |
| FU-4a | 100 | 12.000 | 12.00 | 0.00 |
| FU-4b | 100 | 12.000 | 11.60 | 0.00 |
| FU-5 | 150 | 18.000 | 20.60 | 0.00 |
| FU-6 | 150 | 18.000 | 2.60 | 2.60 |
| FU-7 | 40 | 5.625 | 2.21 | 0.66 |
| FU-8 | 150 | 18.000 | 10.3 | 10.3 |
| FU-9 | 100 | 12.000 | 9.55 | 9.55 |
| **Total** | | **182.625** | **134.97** | **34.42** |

The estimated annual energy savings, 303,797 kWh/yr, is only 40% of the 760,958 kWh/yr reported in the CPUC project spreadsheet. Nearly all of the more than 450,000 kWh/yr savings not found were lost in the sports fields and gymnasium. The football and baseball fields simply do not use their lights sufficiently enough to achieve the energy savings estimated. The gymnasium unit did not achieve much power reduction because of the T5 lighting. Although the individual library units diverged either up or down from the original estimate, together they saved just about the same amount of energy as indicated by the spreadsheet values.

The athletic field and gymnasium lights are also often bypassed because of concerns as to whether lighting levels meet various sports association requirements. This, of course, inhibits their ability to save energy.

We are encouraged by the university's plan to relocate these units to places where they will achieve greater energy savings. A total of seven units could be relocated to non-sports areas with longer operating hours. These are three 200-amp units, two 150-amp units, and two 100-amp units. In the library, the 100-amp unit saves 55,180 kWh/year and the 150-amp unit saves 73,089 kWh/year. No non-sports 200-amp units were installed and we suspect that other areas will not have sufficient load to necessitate

a 200-amp unit. However, there is no requirement that a unit serves its full rated load, and the 200-amp units could be installed on lighting systems that would otherwise require a 150-amp unit. We therefore believe that the 200-amp units are reasonably capable of saving the same 73,089 kWh/year that the 150-amp units save in the library. If these seven units are installed in the proper locations, the savings could be 475,805 kWh/year. The units presently save only 78,088 kWh/year, so this is an increase of 397,717 kWh per year.

If the units are properly relocated, as is being negotiated at the time of this report, the total campus savings could be 701,514 kWh per year, which is 92% of the predicted savings.

The demand reduction estimate is 74% of that assumed in the spreadsheet. However, a large portion of this, particularly on the sports fields, is off-peak demand.

Following are descriptions of each of the EnergySaver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## FU-1. Library 6th Floor

This 277/480-volt 60-amp unit controls the lights on the sixth floor of the library. The EnergySaver unit is located in the 7th floor penthouse. It is fed by distribution panel D and feeds panels 6HA and 6HB. The EnergySaver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. No installation or operational problems were noted.

We measured actual output voltages averaging 230.6 volts. The input power was 16.17 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 19.66 kW, indicating that the power reduction was 3.49 kW, or 17.8% of the original load. The system operated at a 98% power factor in reduced-load mode and 95% power factor in full-load mode.

A datalogger was installed and recorded five-minute interval data from October 23 through November 20, 2003. The logger showed consistent lighting use from 2:00 a.m. until 11:00 p.m. Monday through Thursday, from 2:00 a.m. until 7:00 p.m. Friday, from 8:00 a.m. until 6:00 p.m. Saturday, and 8:00 a.m. until 7:30 p.m. Sunday. This is roughly consistent with standard library operating hours, with the addition of the early morning hours before the library opens at 7:30 a.m. on weekdays.

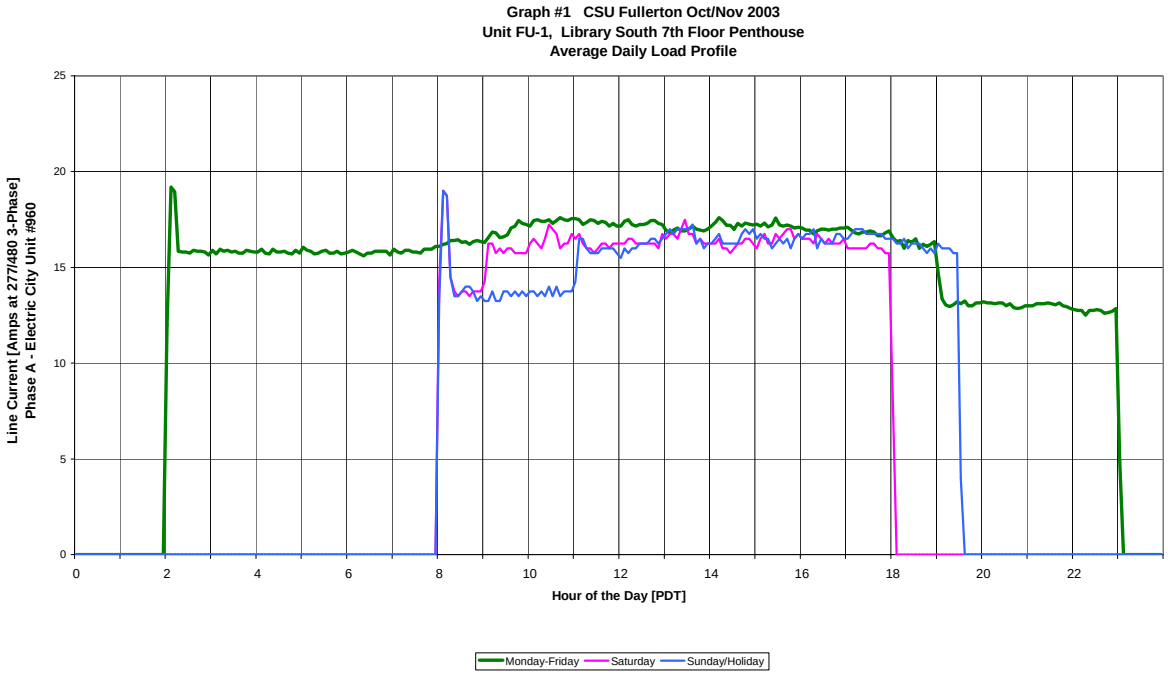
The load profile shows that the lighting loads were relatively constant, showing only minor fluctuations that could have been produced by the occupancy sensors. The lower value in the weekday load profile beginning at 7:00 p.m. is not an indication of partial lighting, but an averaging of the five weekdays, including Friday evenings when the library is closed and unlighted. The spikes at the beginning of the load profiles are caused by the EnergySaver starting the lights at full-voltage.

The load profile indicates a daily full-load operating time of 19.7 h/day on weekdays, 9.5 h/day on Saturdays, and 10.7 h/day on Sundays. There are ten days in the 2003-04 calendar when the campus is closed. Library use is assumed to be zero on those days. Based on 251 weekdays, 52 Saturdays, and 52 Sundays, the annual equivalent full-load operating time is 5,988 hours per year. From this value we subtract 26 hours to account for shortened library hours during break period, giving a total of 5,962 hours per year.

The resultant energy savings achieved by this EnergySaver unit is 20,807 kWh per year (3.49 kW * 5962 h/yr). The connected load reduction is 3.49 kW, and the summer on-peak demand reduction is also 3.49 kW because the lights are fully operating during the summer on-peak period.

This value is 71% of the 29,120 kWh/yr estimate on the CPUC spreadsheet. Even though the operating hours measured were greater than those assumed on the spreadsheet, the power load controlled was only 50% of the value assumed for this size unit.

The load profile of this EnergySaver is shown in the following graph.




## FU-2. Library 4th and 5th Floor

This 277/480-volt 120-amp unit controls the lights on the fourth and fifth floors of the library. The EnergySaver unit is located in the basement in room B9. It is fed by distribution panel A and feeds panels 4HA, 4HB, 5HA, and 5HB. The EnergySaver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. No installation or operational problems were noted.

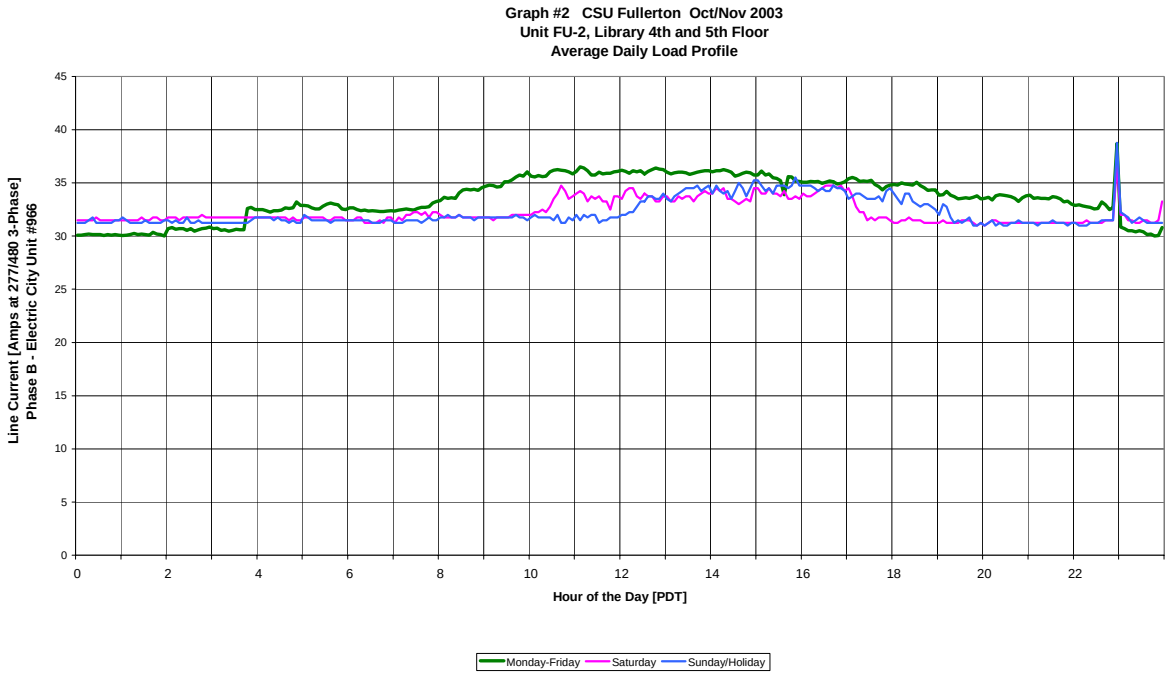
We measured actual output voltages averaging 230.2 volts. The input power was 32.78 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 40.60 kW, indicating that the power reduction was 7.82 kW, or 19.3% of the original load. The system operated at a 99% power factor in reduced-load mode and 96% power factor in full-load mode.

A datalogger was installed and recorded five-minute interval data from October 23 through November 20, 2003. The logger showed that the vast majority (over 80%) of the lights run continuously throughout the night and day every day. The equivalent full-load operation is 8,065 hours per year.

The resultant energy savings achieved by this EnergySaver unit is 63,068 kWh per year (7.82 kW * 8065 h/yr). The connected load reduction is 7.82 kW, and the summer on-peak demand reduction is also 7.82 kW because the lights are fully operating during the summer on-peak period.

This value is 108% of the 58,240 kWh/yr estimate on the CPUC spreadsheet. The operating hours measured were almost twice the 12 h/day assumed on the spreadsheet, but the power load controlled was only 56% of the value assumed for this size unit.

The load profile of this EnergySaver is shown in the following graph.




## FU-3.1, 3.2, and 3.3. Football Field

These three 277/480-volt 200-amp units control the lights on the football field. The EnergySaver units are located in the electrical room, 105. The lights are HID pole lights with 9 rows of lights per pole. Unit 3.1 feeds Panel LA, which controls the top

three rows of lights on each pole. Unit 3.2 feeds Panel LB, which controls the middle three rows of lights on each pole. Unit 3.3 feeds Panel LC, which controls the bottom three rows of lights on each pole.

On Unit 3.1 we discovered a malfunction in the equipment that caused two of the phase voltages to not set properly. We notified the manufacturer, and a repair crew was later sent out to fix it. On Unit 3.2 we found that the incoming "C" Phase wire to the EnergySaver unit was loose and began arcing when we measured the current. We shut down the power to the unit, removed the wire from its terminal and inspected it for any damage. We re-inserted it into its connection terminal block and tightened it properly. We thoroughly checked all other main power connections for both incoming and outgoing lines for problems and did not find any.

The EnergySaver units were set to reduce the voltage to the lights to 230 volts line-to-neutral. We measured actual output voltages averaging 232.8 V on Unit 3.1, 231.7 V on Unit 3.2, and 229.7 V on Unit 3.3. The following table shows the input power values for the three units under reduced-load and full-load modes. The system operated at a 99% power factor in both reduced-load and full-load modes. The units were found in bypass mode during our second visit, and this was reported to CSU staff.

| Unit | Reduced-Load Power | Full-Load Power | Power Reduction |
|---|---:|---:|---:|
| 3.1 | 87.60 | 103.60 | 16.00 |
| 3.2 | 86.20 | 106.00 | 19.80 |
| 3.3 | 90.60 | 109.60 | 19.00 |
| **Total** | **264.40** | **319.20** | **54.80** |

One datalogger was installed on Unit 3.2 to represent all three units since they are operated concurrently. The logger recorded five-minute interval data from October 23 through November 20, 2003. The logger showed sporadic usage, mostly on Friday and Saturday night, as would be expected from a college sports field.

The load profile indicates a daily full-load operating time of 1.3 h/day on weekdays, 4.4 h/day on Saturdays, and 2.3 h/day on Sundays. To the extent that this fall monitoring period represents the year, this amounts to 702 hours per year.

The graphic load profile does not give a clear visual depiction of how these lights operate because the weekdays are averaged together. The lights operate every Friday and Saturday. During the four-week monitoring period they were also on one Tuesday, one Thursday, and one Sunday. No other usage was indicated. We tried to get scheduling information from campus personnel, but this information was not readily meaningful. Although there are schedules for actual games, practice and other use schedules are not well documented. The 702 h/yr value is very low – much lower than that used in the original spreadsheet assumption. However, we believe at best it is a high figure. The monitoring period was during the fall, which is football season and has early sunsets.

Summer usage is quite possibly less. We used the 702 h/yr figure for the energy savings calculations.

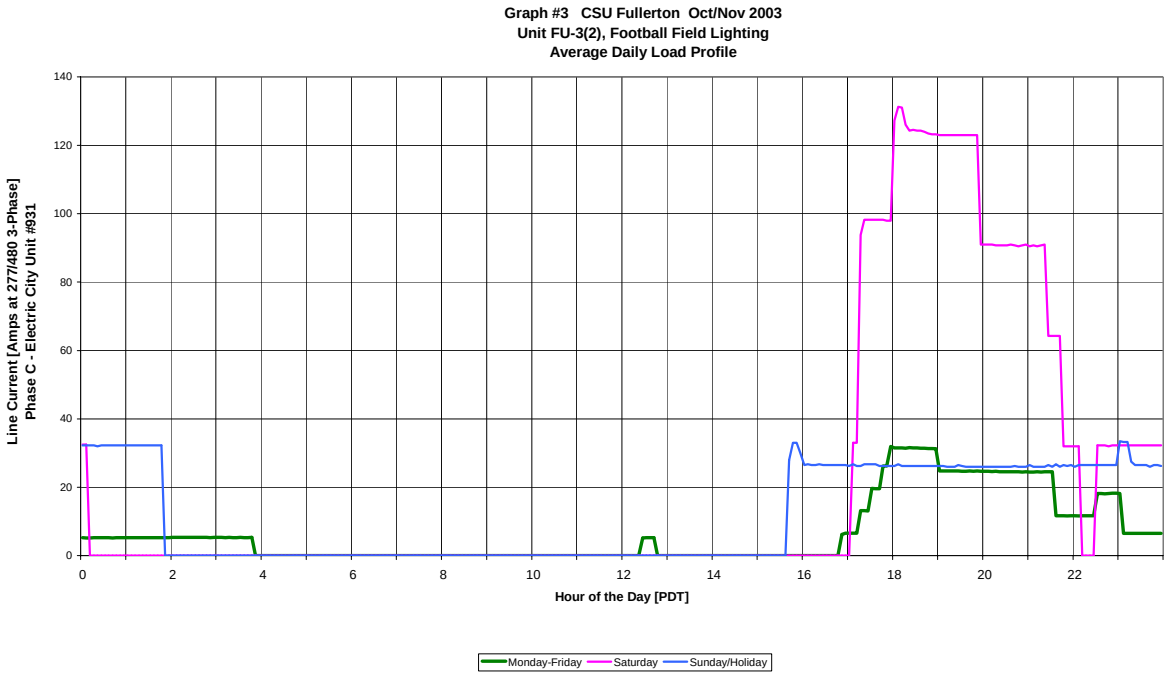
The resultant energy savings achieved by these EnergySaver units are shown in the table below.

| Unit | Power Reduction | Annual Hours | Annual kWh Savings |
|---|---|---|---|
| 3.1 | 16.00 | 702 | 11,232 |
| 3.2 | 19.80 | 702 | 13,900 |
| 3.3 | 19.00 | 702 | 13,338 |
| **Total** | **54.80** | | **38,470** |

The total connected load reduction is 54.8 kW as detailed in the power table above. The summer on-peak demand reduction is zero because the lights do not operate during the summer on-peak period.

Each of the 200-amp units were estimated to save 91,520 kWh/year in the CPUC spreadsheet, for a total of 274,560 kWh/yr. The 38,740 estimate above is only 14% of that value. This is primarily due to the operating hours being about 1/6 of the spreadsheet assumption. Additionally, the connected load is only 83% of the spreadsheet assumption.

The load profile of these EnergySavers is shown in the following graph.



## FU-4a, 4b, and 5. Baseball Field

These three 277/480-volt units control the HID pole lights on the baseball field. Campus staff told us that none of the three EnergySaver units for the baseball field would start the night before we visited. All three units had the main breaker switch set to the bypass mode. We attempted to start the unit ourselves but it would not start until we pushed the red "reset" button on the unit. We discovered that the control system power is also tapped wrong for the main contactor. It is taken from the output side of the EnergySaver unit. The control transformer output read 60 volts, which was barely enough to pull in the main lighting contactor on startup. Manufacturer (Electric City) personnel were informed of the problem.

Unit FU-4a is a 100-amp unit located in the west baseball field electric room that feeds Panel LG, which controls the pole lights on the third base side of the field. Unit FU-4b is a 100-amp unit that feeds Panel LH, which controls the pole lights on the first base side of the field. Unit FU-5 is a 150-amp unit that feeds Panel LC-J, which controls the pole lights in center field. Units FU-4b and FU-5 are located in the east baseball field electric room.

The EnergySaver units were set to reduce the voltage to the lights to 230 volts line-to-neutral. We measured actual output voltages averaging 232.4 V on Unit 4a, 231.2 V on Unit 4b, and 229.7 V on Unit 5. The following table shows the input power values for the three units under reduced-load and full-load modes. The system operated near unity power factor in both reduced-load and full-load modes.

| Unit | Reduced-Load Power | Full-Load Power | Power Reduction |
|---|---:|---:|---:|
| 4a | 41.90 | 53.90 | 12.00 |
| 4b | 40.50 | 52.10 | 11.60 |
| 5 | 68.10 | 88.70 | 20.60 |
| **Total** | **150.50** | **194.70** | **44.20** |

Dataloggers were installed on each of the units because the various sections of the lights are not always used concurrently. The loggers recorded five-minute interval data from October 23 through November 20, 2003. The loggers showed sporadic usage, mostly during weekday late afternoon and early evening. The narrow rectangles on the load profiles represent the equivalent full-load operating times. The light green rectangles, for example, represent the amount of time that the lights would run consistently each weekday to achieve the same amount of energy consumption. These rectangles, which demonstrate the actual lights-on demand, are much higher than the averaged load profile because the lights do not actually run at a consistent time each day.

The three load profiles estimate annual operating times of 273 h/yr for FU-4a, 310 h/yr for FU-4b, and 262 h/yr for FU-5. This results in an average of 282 hours per year.

We note that the football field operating hours were 702 hours per year if its monitoring period represented the full year, and that we believe this value may be high since the monitoring period was during football season. Likewise we believe the baseball field estimate may be low because the monitoring period was *not* during baseball season. However, we also note that baseball season is during the spring and summer when daylight is extended, making afternoon use of field lighting unnecessary. We chose to use 564 hours per year – double the estimate from the monitoring period – to represent the baseball field. No matter what realistic factor that could have been chosen, the actual operation of these lights is far less than the 12 hours per day underlying the savings estimates in the original spreadsheet calculation.

The resultant energy savings achieved by these EnergySaver units are shown in the table below.

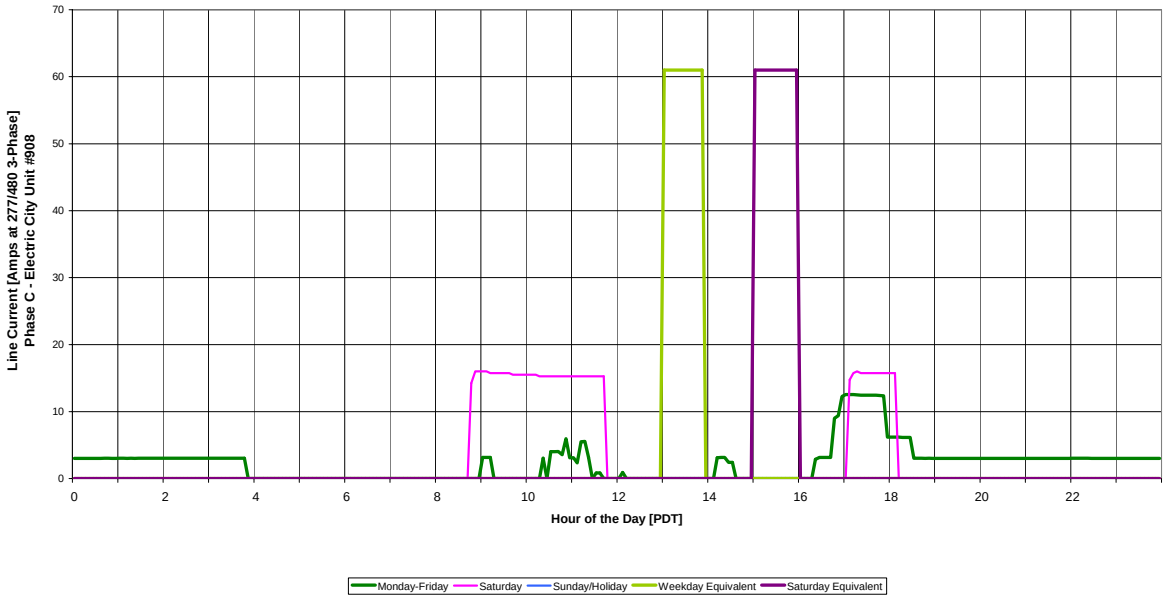
| Unit | Power Reduction | Annual Hours | Annual kWh Savings |
|---|---|---|---|
| 4a | 12.00 | 564 | 6,768 |
| 4b | 11.60 | 564 | 6,542 |
| 5 | 20.60 | 564 | 11,618 |
| **Total** | **44.20** | | **24,928** |

The total connected load reduction is 44.2 kW as detailed in the power table above. This is actually slightly higher than the 42 kW reduction assumed in the spreadsheet. The summer on-peak demand reduction is zero because the lights do not operate during the summer on-peak period.

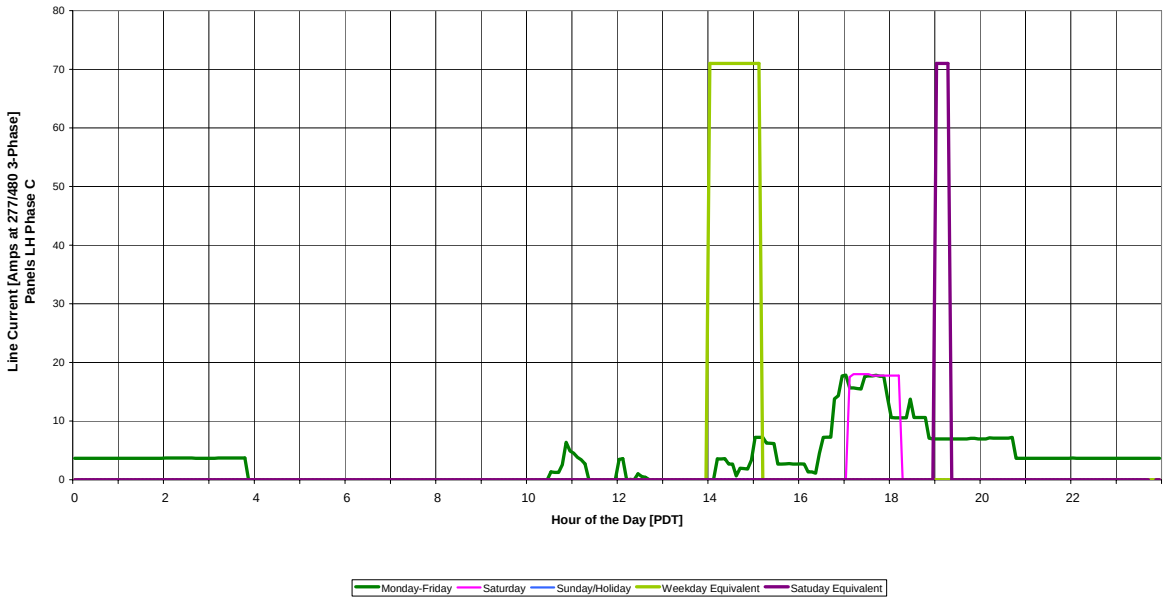
The two 100-amp units were estimated to save 49,920 kWh/year in the CPUC spreadsheet, and the 150-amp unit was estimated to save 74,880 kWh/year, for a total of 174,720 kWh/yr. The 24,298 estimate above is only 14% of that value. This is due to the operating hours being about 1/8 of the spreadsheet assumption.

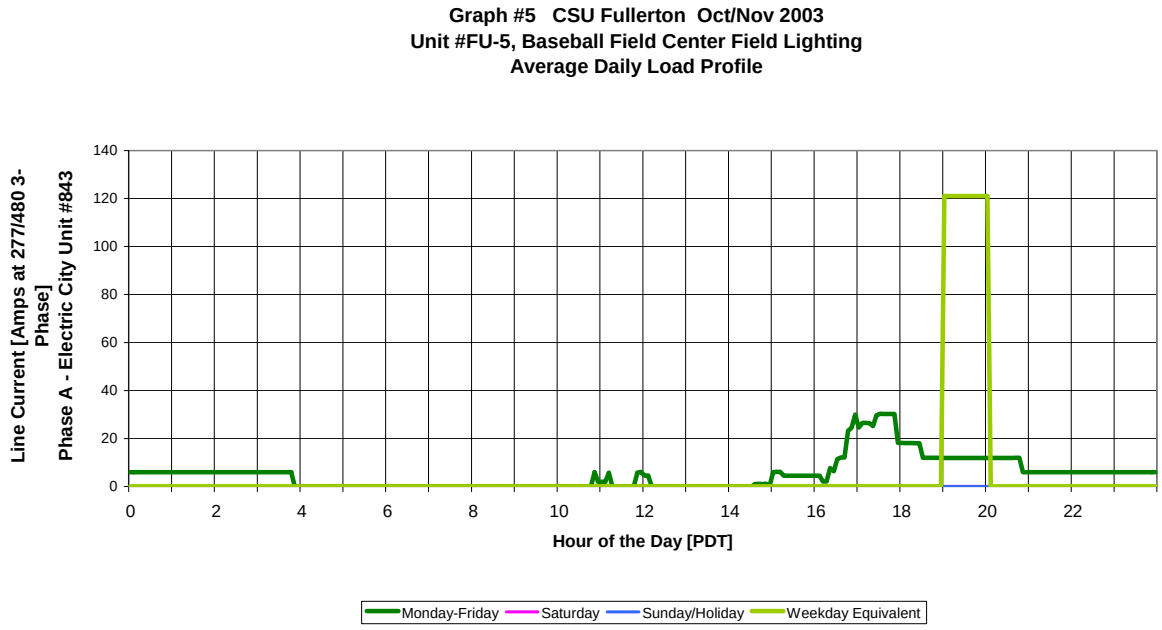
The load profiles of these EnergySavers are shown in the following three graphs.

**Graph #4a CSU Fullerton Oct/Nov 2003**
**Unit FU-4a, Baseball Field 3rd Base Line Lighting**
**Average Daily Load Profile**




**Graph #4b CSU Fullerton Oct/Nov 2003**
**Energy Saver FU-4b Baseball Field 1st Base Line Lighting**
**Average Daily Load Profile**






## FU-6. Gymnasium

This 120/208-volt 150-amp unit controls the lights on the gym floor. The EnergySaver unit is located in the upstairs fan room of the gymnasium. It is fed by distribution panel P6 and feeds panel R-2. The EnergySaver unit was set to reduce the voltage to the lights to 105 volts line-to-neutral. During our first visit the unit was operating normally, but on the second visit it was in bypass mode. This problem was reported to CSU staff. No installation or equipment problems were noted.

We measured actual output voltages averaging 106.7 volts. The input power was 26.00 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 28.60 kW, indicating that the power reduction was 2.60 kW, or 9.1% of the original load. The system operated at a 98% power factor in reduced-load mode and 97% power factor in full-load mode.

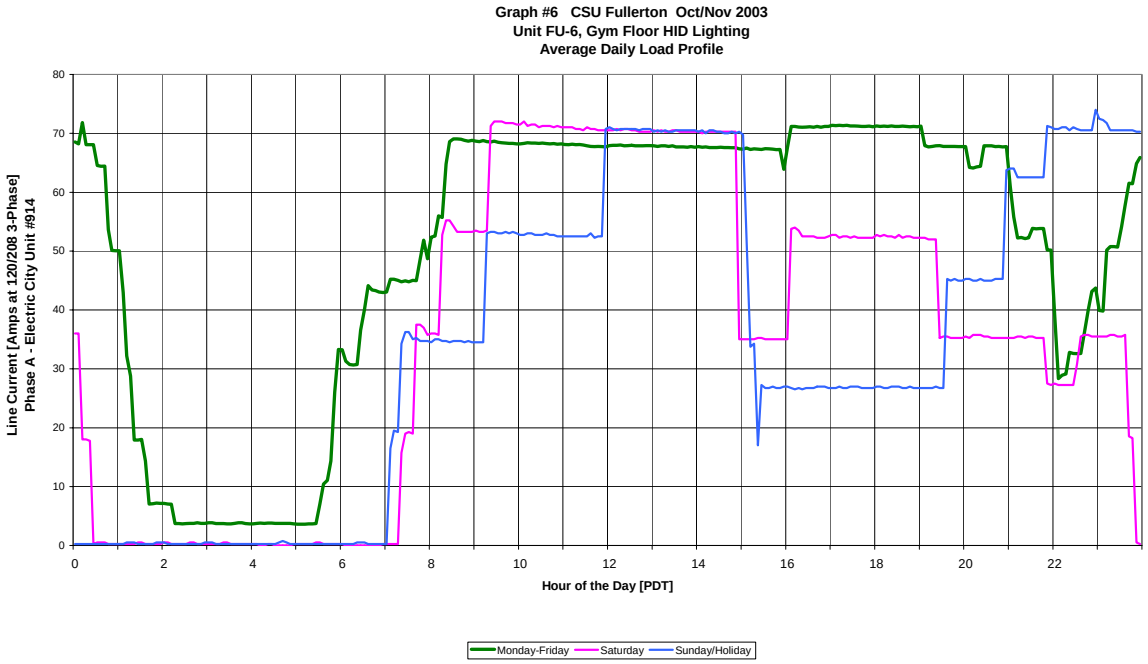
A datalogger was installed and recorded five-minute interval data from October 23 through November 20, 2003. The logger showed rather consistent lighting use during the day and evening, seven days per week. The non-zero early morning (2:00-5:00 a.m.) value of the weekday profile results from the lights being left on all night one day of the monitoring period.

The load profile indicates a daily full-load operating time of 17.1 h/day on weekdays, 12.0 h/day on Saturdays, and 11.7 h/day on Sundays. There are ten days in the 2003-04 calendar when the campus is closed. Usage these days were assumed to be similar to that on Sunday. Based on 251 weekdays, 52 Saturdays, and 62 Sunday/holidays, the annual equivalent full-load operating time is 5,650 hours per year.

The resultant energy savings achieved by this EnergySaver unit is 14,690 kWh per year (2.60 kW * 5650 h/yr). The connected load reduction is 2.60 kW, and the summer on-peak demand reduction is also 2.60 kW because the lights are fully operating during the summer on-peak period.

This value is 20% of the 74,880 kWh/yr estimate on the CPUC spreadsheet. Even though the operating hours measured were greater than those assumed on the spreadsheet, the power load controlled was only 14% of the value assumed for this size unit. This is because it is a 120/208-volt system and because it was not loaded to rated capacity.

The load profile of this EnergySaver is shown in the following graph.




## FU-7. Parking Structure

This 277/480-volt 40-amp unit controls the high-pressure sodium lights in a four-story parking structure #4. The EnergySaver unit output feeds panel H1. The EnergySaver unit was set to reduce the voltage to the lights to 245 volts line-to-neutral.

We measured actual output voltages averaging 246.8 volts. The input power was 9.35 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 11.56 kW, indicating that the power reduction was 2.21 kW, or 19.1% of the original load. The system operated at an 83% power factor in both full- and reduced-load modes.

The lights are controlled by a time clock that enables the lights to turn on in the evening and off in the morning. A portion of the lights remain on continuously.

Although we worked on the system during the time when most of the lights are normally off, we turned all of the lights on to take the power readings.

A datalogger was installed and recorded five-minute interval data from October 23 through November 20, 2003. The logger showed consistent operation of the lights, with a portion of them being on continuously and a portion of them being shut off from 6:30 a.m. until 4:30 p.m. Weekday evening use is slightly higher for an unknown reason.

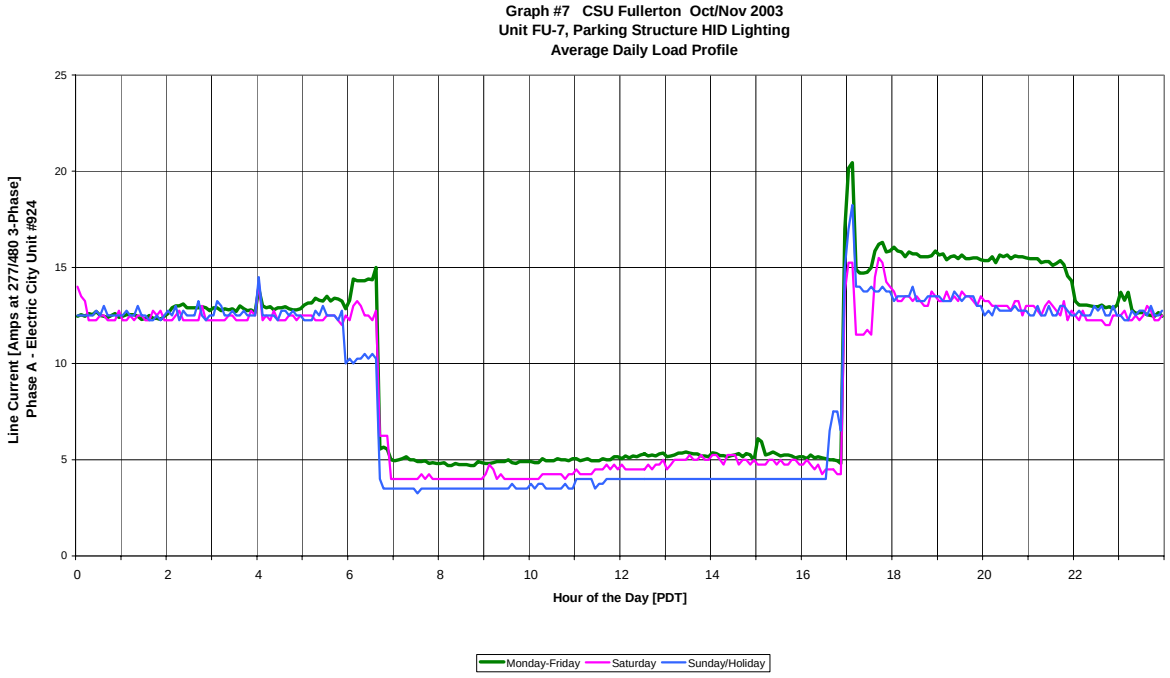
The load profile also shows a consistent power spike in the afternoon when the majority of the lights turn on. This spike is caused by the EnergySaver shifting to full-voltage in order to properly start the HID lights.

The load profile indicates an equivalent full-load operating time of 6,138 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this EnergySaver unit is 13,565 kWh per year (2.21 kW * 6138 h/yr). The connected load reduction is 2.21 kW, and the summer on-peak demand reduction is 0.66 kW because only 30% of the lights will be operating during the summer on-peak period.

This value is 70% of the 19,412 kWh/yr estimate on the CPUC spreadsheet. Although the operation hours measured was significantly greater than those assumed on the spreadsheet, the measured demand reduction is only 44% of that assumed in the spreadsheet because the unit is not operating at rated capacity.

The load profile of this EnergySaver is shown in the following graph.



## FU-8. Library 1st and 2nd Floors

This 277/480-volt 150-amp unit controls the lights on the first and second floors of the library. The EnergySaver unit is located in Room 206 of the library. It feeds panels 1HA and 2HA. The EnergySaver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. No installation or operational problems were noted.

We measured actual output voltages averaging 232.1 volts. The input power was 55.1 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 65.4 kW, indicating that the power reduction was 10.3 kW, or 15.8% of the original load. The system operated at a 99% power factor in reduced-load mode and 98% power factor in full-load mode.

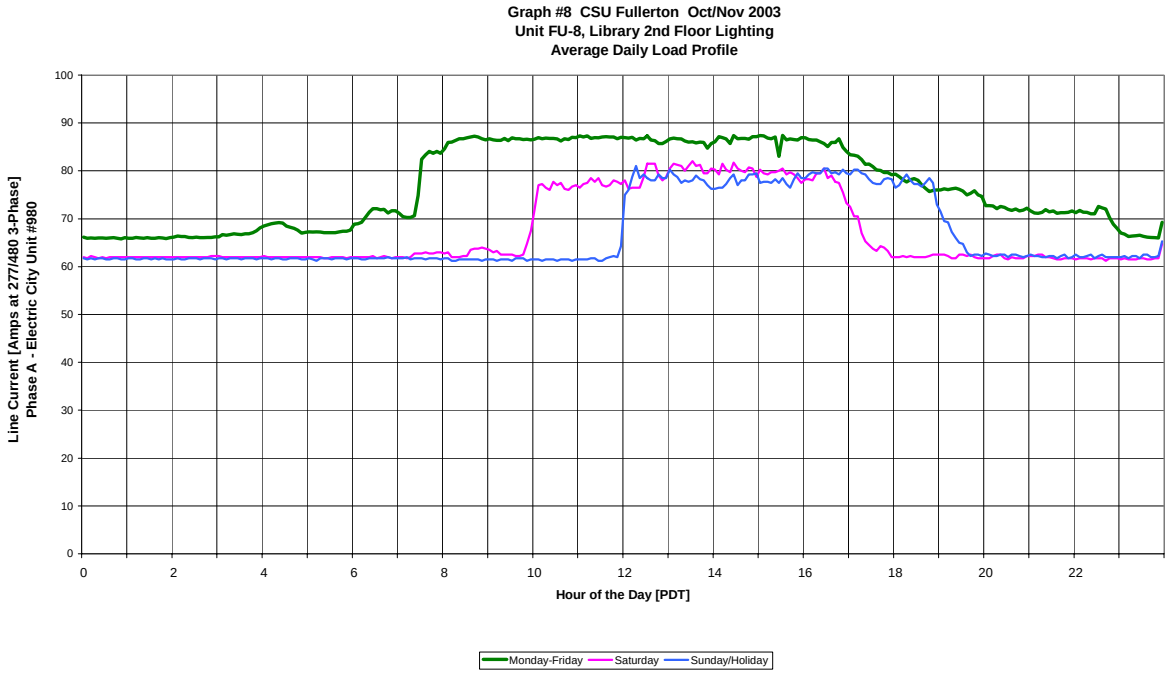
A datalogger was installed and recorded five-minute interval data from October 23 through November 20, 2003. The logger showed most of the lights operating 24 hours per day, seven days per week. There is slightly higher demand during the day, primarily because some of the lights are controlled by occupancy sensors. We made sure as many lights as possible were on when we took the power readings.

The load profile indicates an annual equivalent full-load operating time is 7,096 hours per year. Because most of the lights operate continuously, library schedules and campus holidays will have little effect on this value.

The resultant energy savings achieved by this EnergySaver unit is 73,089 kWh per year (10.3 kW * 7096 h/yr). The connected load reduction is 10.3 kW, and the summer on-peak demand reduction is also 10.3 kW because the lights are fully operating during the summer on-peak period.

This value is 98% of the 74,880 kWh/yr estimate on the CPUC spreadsheet. Even though the operating hours measured were greater than those assumed on the spreadsheet, the power load controlled was only 58% of the value assumed for this size unit. These variations cancelled each other's effects.

The load profile of this EnergySaver is shown in the following graph.




## FU-9. Library 3rd and 4th Floors

This 277/480-volt 100-amp unit controls the lights on the third and fourth floors of the library. The EnergySaver unit is located in Room 406 of the library. It feeds panels 3HA and 4HA. The EnergySaver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral.

We measured actual output voltages averaging 233.5 volts because Phase B was stuck at 240V in both reduced-voltage and full-voltage mode. The input power was 40.15 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 45.10 kW, indicating that the power reduction was 4.95 kW. The "full-load" value recorded, however, did not include the full load of Phase B, which was also the most heavily loaded phase. Extrapolating values indicate that the full-load power would have risen to 49.60 kW had this phase raised its voltage to 277. This makes the power reduction of the unit 9.55 kW. The system operated at a 99% power factor in reduced-load mode and 98% power factor in full-load mode.

A datalogger was installed and recorded five-minute interval data from October 23 through November 20, 2003. The logger showed most of the lights operating 24 hours per day, seven days per week. An energy management system disables some lights between 11:00 p.m. and 4:00 a.m. and occupancy sensors also reduce portions of the lighting load. We made sure as many lights as possible were on when we took the power readings.

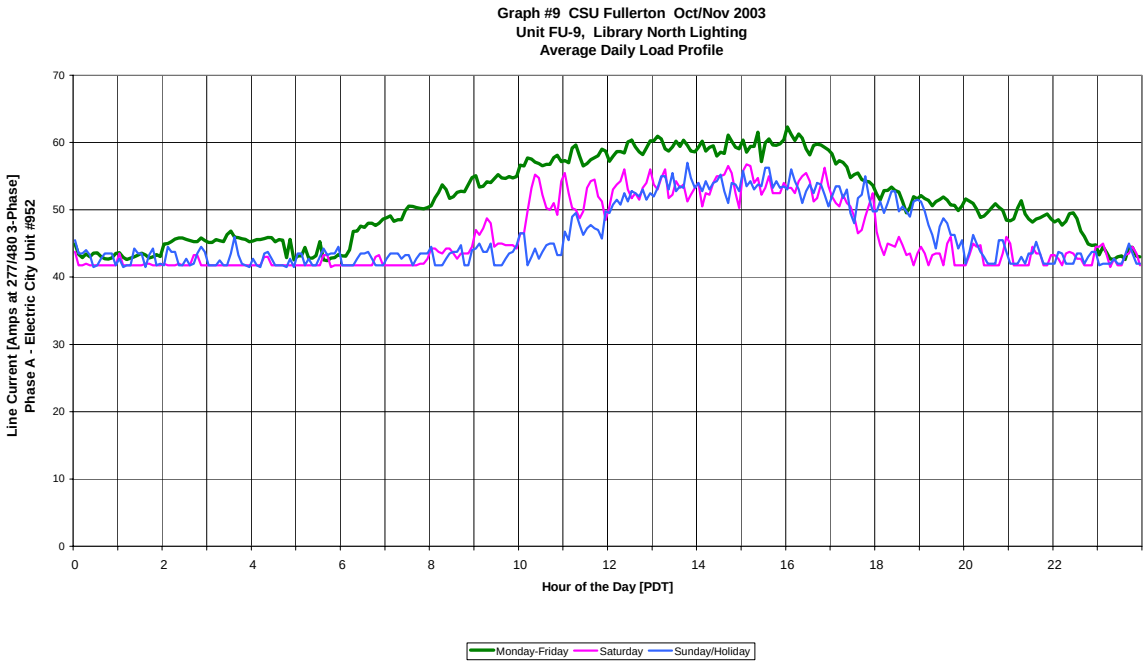
The load profile indicates an annual equivalent operating time for a lighting load equivalent to when our power readings were taken is 5,778 hours per year. Because most

of the lights operate continuously, library schedules and campus holidays will have little effect on this value.

The resultant energy savings achieved by this EnergySaver unit is 55,180 kWh per year (10.3 kW * 5778 h/yr). The connected load reduction is 9.55 kW, and the summer on-peak demand reduction is also 9.55 kW because the lights are fully operating during the summer on-peak period.

This value is 110% of the 49.920 kWh/yr estimate on the CPUC spreadsheet. The operating hours measured was significantly greater than those assumed on the spreadsheet, and the power load controlled was 80% of the value assumed for this size unit.

The load profile of this EnergySaver is shown in the following graph.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *FU-1 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Library South 7th Floor Penthouse | Date Measured: | 11/25/2003 |
| Panel Serving Energy Saver: | DIST Panel D | Energy Saver Size/Serial #: | 60 amp / #960 |
| Panel Fed By Energy Saver: | Panels 6HA, 6HB | Datalogger #: | **M-22** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 274.3 | 21.80 | 5.86 | 5.97 | 1.13 | 0.98 |
| B | 273.5 | 19.99 | 5.38 | 5.48 | 1.02 | 0.98 |
| C | 274.1 | 18.32 | 4.93 | 5.02 | 0.93 | 0.98 |
| TOT/AVG | 273.97 | 20.04 | 16.17 | 16.47 | 3.08 | 0.98 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.0 | 25.40 | 5.74 | 5.86 | 1.13 | 0.98 |
| B | 230.2 | 23.54 | 5.31 | 5.42 | 1.08 | 0.98 |
| C | 230.7 | 22.01 | 4.97 | 5.06 | 0.94 | 0.98 |
| TOT/AVG | 230.63 | 23.65 | 16.02 | 16.34 | 3.15 | 0.98 |

**Description of Lights Controlled:**

Controls the 6th floor library lights.

Energy Saver set for 230 volts

**UNIT WAS NOT IN BYPASS DURING THE SITE VISIT**

## CSU Chancellor's Office

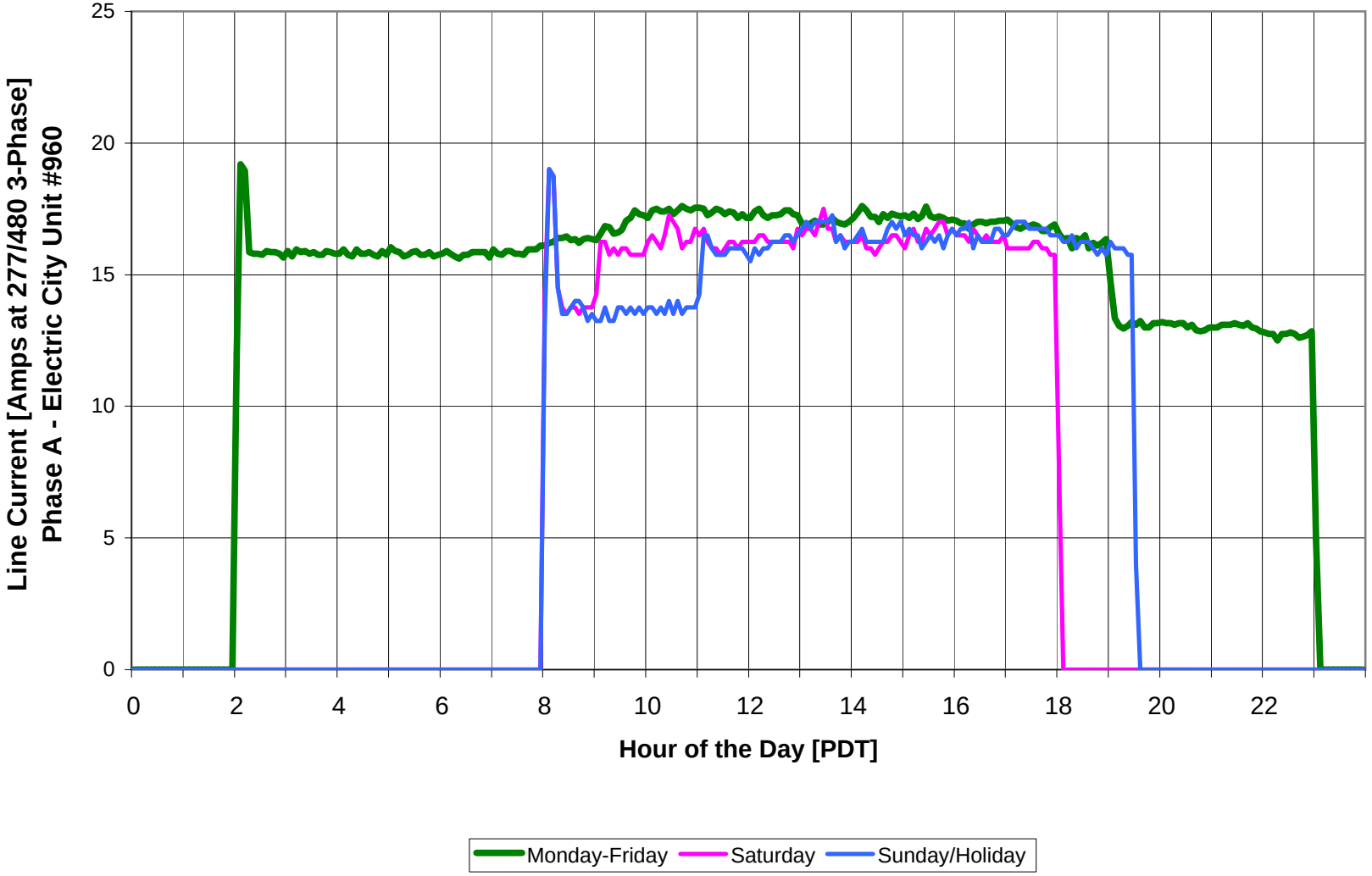
## *FU-1 Cal State Fullerton*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.6 | 26.89 | 7.01 | 7.38 | 2.30 | 0.95 |
| B | 273.4 | 25.38 | 6.60 | 6.94 | 2.12 | 0.95 |
| C | 273.8 | 23.23 | 6.05 | 6.35 | 1.92 | 0.95 |
| TOT/AVG | 273.93 | 25.17 | 19.66 | 20.67 | 6.34 | 0.95 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 275.8 | 26.78 | 6.87 | 7.76 | 2.36 | 0.95 |
| B | 273.3 | 24.12 | 6.24 | 6.60 | 2.14 | 0.95 |
| C | 275.3 | 22.41 | 5.80 | 6.19 | 1.93 | 0.95 |
| TOT/AVG | 274.80 | 24.44 | 18.91 | 20.55 | 6.43 | 0.95 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 274.0 | 20.04 | 16.17 | 16.47 | 3.08 | 0.98 |
| **Reduce Output** | 230.6 | 23.65 | 16.02 | 16.34 | 3.15 | 0.98 |
| **Full Input** | 273.9 | 25.17 | 19.66 | 20.67 | 6.34 | 0.95 |
| **Full Output** | 274.8 | 24.44 | 18.91 | 20.55 | 6.43 | 0.95 |
| **Power Savings** | | | **3.49** | | | |
| **Power % Savings** | | | **17.75%** | | | |

**Graph #1 CSU Fullerton Oct/Nov 2003**
**Unit FU-1, Library South 7th Floor Penthouse**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-2 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Basement Feeding: Library 4th Floor, etc. | Date Measured: | 11/25/2003 |
| Panel Serving Energy Saver: | DIST. A | Energy Saver Size/Serial #: | 120 amp / #966 |
| Panel Fed By Energy Saver: | 4HA, 4HB, 5HA, 5HB | Datalogger #: | **V-3** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 274.4 | 44.75 | 12.10 | 12.30 | 1.98 | 0.99 |
| B | 274.8 | 40.19 | 10.90 | 11.00 | 1.87 | 0.99 |
| C | 276.4 | 36.00 | 9.78 | 9.93 | 1.70 | 0.99 |
| TOT/AVG | 275.20 | 40.31 | 32.78 | 33.23 | 5.55 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 232.4 | 52.70 | 11.80 | 11.90 | 1.91 | 0.99 |
| B | 229.6 | 48.59 | 11.00 | 11.20 | 1.87 | 0.99 |
| C | 228.5 | 43.78 | 9.84 | 10.00 | 1.75 | 0.99 |
| TOT/AVG | 230.17 | 48.36 | 32.64 | 33.10 | 5.53 | 0.99 |

**Description of Lights Controlled:**

4th and 5th floor lights. Set Point of the Energy Saver Unit was 230-Volts

Located in room #89 (or B9?)

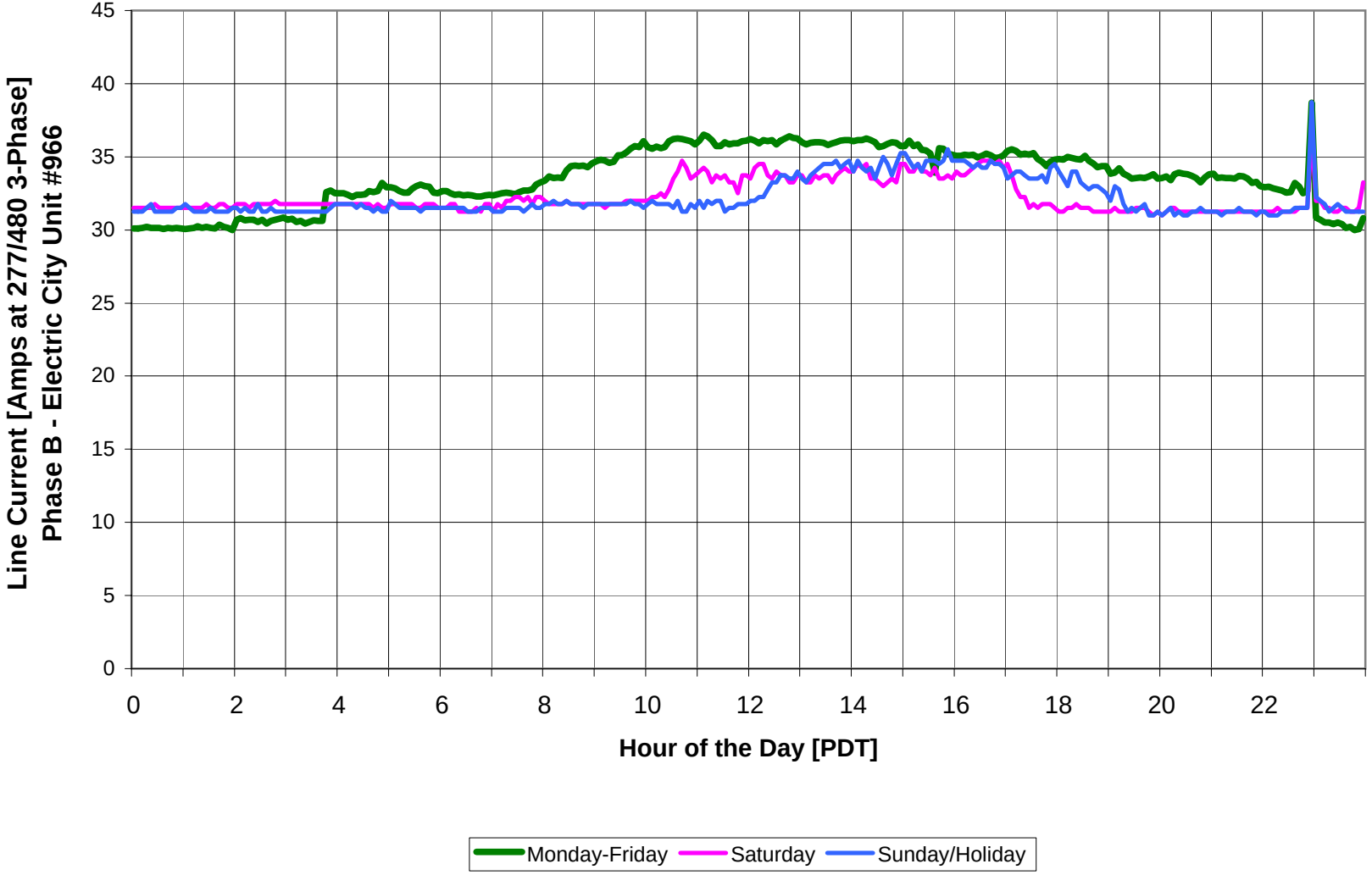
**UNIT WAS NOT IN BYPASS DURING THE SITE VISIT**

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.9 | 56.60 | 14.90 | 15.50 | 4.20 | 0.96 |
| B | 274.9 | 51.46 | 13.60 | 14.20 | 3.89 | 0.96 |
| C | 276.3 | 46.64 | 12.10 | 12.70 | 3.62 | 0.96 |
| TOT/AVG | 275.37 | 51.57 | 40.60 | 42.40 | 11.71 | 0.96 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.3 | 54.96 | 14.40 | 15.00 | 4.08 | 0.96 |
| B | 272.4 | 50.21 | 13.20 | 13.70 | 3.79 | 0.96 |
| C | 271.7 | 47.17 | 12.30 | 12.80 | 3.70 | 0.96 |
| TOT/AVG | 272.47 | 50.78 | 39.90 | 41.50 | 11.57 | 0.96 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 275.2 | 40.31 | 32.78 | 33.23 | 5.55 | 0.99 |
| **Reduce Output** | 230.2 | 48.36 | 32.64 | 33.10 | 5.53 | 0.99 |
| **Full Input** | 275.4 | 51.57 | 40.60 | 42.40 | 11.71 | 0.96 |
| **Full Output** | 272.5 | 50.78 | 39.90 | 41.50 | 11.57 | 0.96 |
| **Power Savings** | | | **7.82** | | | |
| **Power % Savings** | | | **19.26%** | | | |

**Graph #2 CSU Fullerton Oct/Nov 2003**
**Unit FU-2, Library 4th and 5th Floor**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-3 (LA) Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Football Field, Electric Room 105 | Date Measured: | 11/25/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 200 amp / #986 |
| Panel Fed By Energy Saver: | Panel LA | Datalogger #: | See FU-3 (2) |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 273.0 | 110.10 | 29.90 | 30.20 | 3.30 | 0.99 |
| B | 274.7 | 108.10 | 29.50 | 29.70 | 3.50 | 0.99 |
| C | 273.7 | 108.60 | 28.20 | 28.40 | 3.10 | 0.99 |
| TOT/AVG | 273.80 | 108.93 | 87.60 | 88.30 | 9.90 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 233.0 | 125.00 | 28.90 | 29.10 | 3.40 | 0.99 |
| B | 233.5 | 126.50 | 29.20 | 29.40 | 3.50 | 0.99 |
| C | 231.8 | 120.40 | 27.70 | 27.70 | 3.20 | 0.99 |
| TOT/AVG | 232.77 | 123.97 | 85.80 | 86.20 | 10.10 | 0.99 |

**Description of Lights Controlled:**

Top rows of all of the football field light poles, (top 3 rows)

ALL HID Lights

**UNIT WAS IN BYPASS DURING THE SITE VISIT**

## CSU Chancellor's Office

## *FU-3 (LA) Cal State Fullerton*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.3 | 135.70 | 36.50 | 37.20 | 7.20 | 0.98 |
| B | 274.8 | 116.70 | 31.60 | 32.10 | 5.60 | 0.99 |
| C | 273.5 | 132.10 | 35.50 | 36.10 | 6.30 | 0.99 |
| TOT/AVG | 273.87 | 128.17 | 103.60 | 105.40 | 19.10 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.0 | 132.40 | 36.50 | 36.30 | 7.30 | 0.98 |
| B | 263.1 | 134.20 | 34.60 | 35.30 | 7.30 | 0.98 |
| C | 273.9 | 127.00 | 34.00 | 34.80 | 7.00 | 0.98 |
| TOT/AVG | 270.33 | 131.20 | 105.10 | 106.40 | 21.60 | 0.98 |

This is the 2nd Measurement after Electric City made corrections.

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 273.8 | 108.93 | 87.60 | 88.30 | 9.90 | 0.99 |
| **Reduce Output** | 232.8 | 123.97 | 85.80 | 86.20 | 10.10 | 0.99 |
| **Full Input** | 273.9 | 128.17 | 103.60 | 105.40 | 19.10 | 0.99 |
| **Full Output** | 270.3 | 131.20 | 105.10 | 106.40 | 21.60 | 0.98 |
| **Power Savings** | | | **16.00** | | | |
| **Power % Savings** | | | **15.44%** | | | |

## CSU Chancellor's Office

## *FU-3 (LB) Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Football Field, Electric Room 105 | Date Measured: | 10/23/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 200 amp / #931 |
| Panel Fed By Energy Saver: | LB | Datalogger #: | **M-11** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 273.6 | 104.50 | 28.90 | 29.00 | 2.80 | 1.00 |
| B | 275.6 | 106.20 | 28.60 | 28.70 | 2.70 | 0.99 |
| C | 274.7 | 105.80 | 28.70 | 27.00 | 3.10 | 0.99 |
| TOT/AVG | 274.63 | 105.50 | 86.20 | 84.70 | 8.60 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.3 | 120.30 | 28.00 | 28.20 | 2.80 | 1.00 |
| B | 232.5 | 126.50 | 29.20 | 29.40 | 3.40 | 0.99 |
| C | 231.4 | 126.60 | 29.00 | 29.30 | 3.50 | 0.99 |
| TOT/AVG | 231.73 | 124.47 | 86.20 | 86.90 | 9.70 | 0.99 |

**Description of Lights Controlled:**

Middle rows of all of the football field light poles, (middle 3 rows) **ON 11-25-03 the unit was in BYPASS.**

ALL HID Lights. Repaired "C" phase incoming wire. It was loose

in its connection and was arcing. Removed wire, checked and tightened set screw connection.

## CSU Chancellor's Office

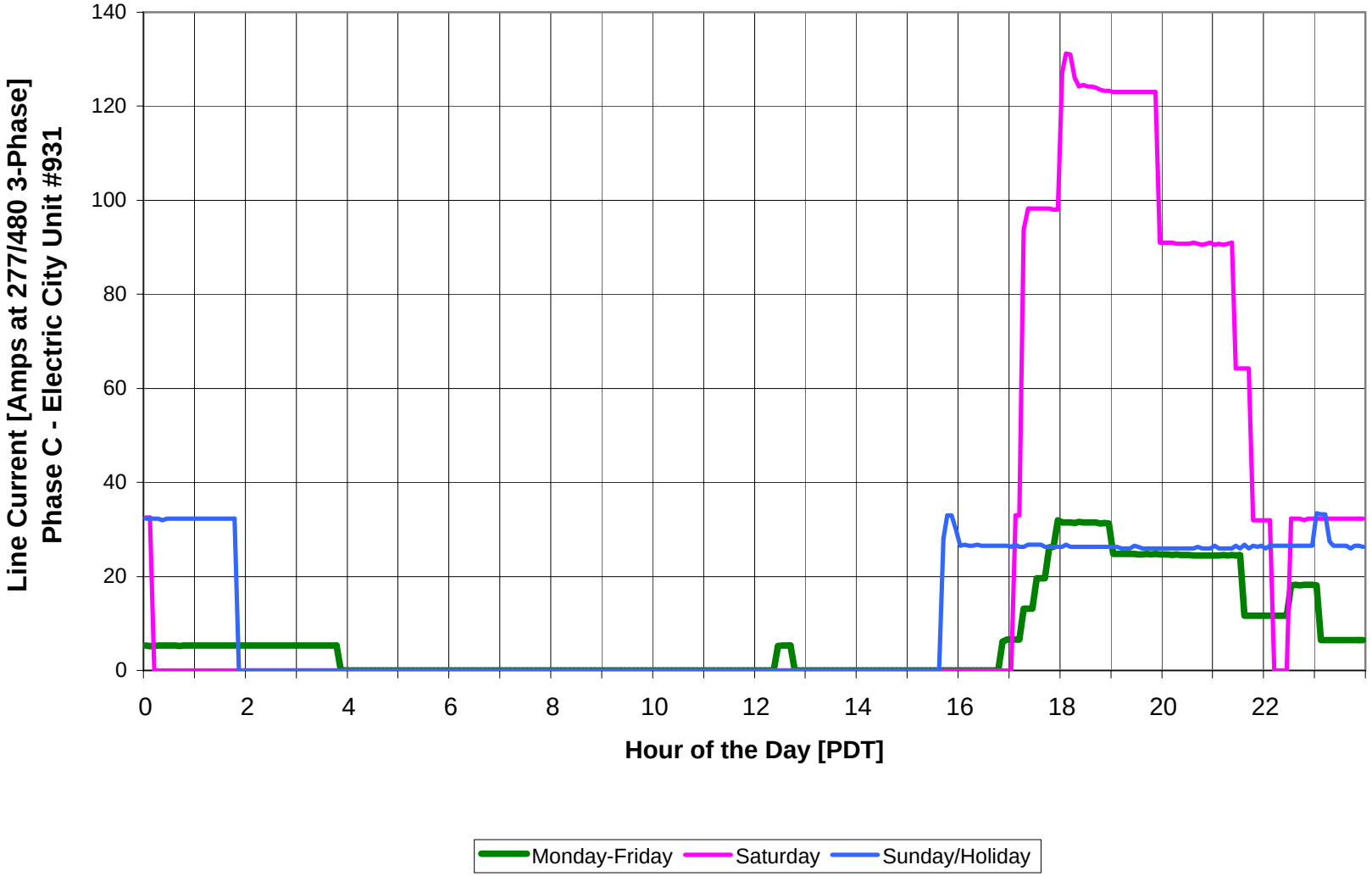
## *FU-3 (LB) Cal State Fullerton*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 271.9 | 129.10 | 34.70 | 35.10 | 5.30 | 0.99 |
| B | 274.1 | 134.10 | 36.30 | 36.70 | 5.80 | 0.99 |
| C | 272.5 | 130.60 | 35.00 | 35.60 | 6.50 | 0.98 |
| TOT/AVG | 272.83 | 131.27 | 106.00 | 107.40 | 17.60 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 272.9 | 125.00 | 33.70 | 34.10 | 5.50 | 0.99 |
| B | 274.4 | 131.30 | 35.40 | 36.00 | 6.50 | 0.98 |
| C | 273.6 | 130.00 | 34.90 | 35.50 | 6.50 | 0.98 |
| TOT/AVG | 273.63 | 128.77 | 104.00 | 105.60 | 18.50 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 274.6 | 105.50 | 86.20 | 84.70 | 8.60 | 0.99 |
| **Reduce Output** | 231.7 | 124.47 | 86.20 | 86.90 | 9.70 | 0.99 |
| **Full Input** | 272.8 | 131.27 | 106.00 | 107.40 | 17.60 | 0.99 |
| **Full Output** | 273.6 | 128.77 | 104.00 | 105.60 | 18.50 | 0.98 |
| **Power Savings** | | | **19.80** | | | |
| **Power % Savings** | | | **18.68%** | | | |

**Graph #3 CSU Fullerton Oct/Nov 2003**
**Unit FU-3(2), Football Field Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-3 (LC) Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Football Field, Electric Room 105 | Date Measured: | 10/23/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 200 amp / #983 |
| Panel Fed By Energy Saver: | LC | Datalogger #: | See FU-3 (2) |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 268.9 | 114.50 | 30.60 | 30.80 | 3.40 | 0.99 |
| B | 270.5 | 109.50 | 29.40 | 29.60 | 2.90 | 1.00 |
| C | 269.4 | 112.40 | 30.60 | 30.70 | 3.50 | 0.99 |
| TOT/AVG | 269.60 | 112.13 | 90.60 | 91.10 | 9.80 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 230.1 | 128.20 | 29.30 | 29.50 | 3.30 | 0.99 |
| B | 229.0 | 125.30 | 28.60 | 29.10 | 3.10 | 0.99 |
| C | 230.1 | 128.20 | 29.40 | 29.60 | 3.00 | 1.00 |
| TOT/AVG | 229.73 | 127.23 | 87.30 | 88.20 | 9.40 | 0.99 |

**Description of Lights Controlled:**

Bottom rows of all of the football field light poles, (bottom 3 rows)

ALL HID Lights.

**UNIT WAS IN BYPASS DURING THE SITE VISIT on 11/25/03**

## CSU Chancellor's Office

## *FU-3 (LC) Cal State Fullerton*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 269.5 | 137.10 | 36.30 | 37.00 | 7.00 | 0.98 |
| B | 271.4 | 135.70 | 36.20 | 36.80 | 6.60 | 0.98 |
| C | 270.1 | 139.90 | 37.10 | 37.70 | 7.20 | 0.98 |
| TOT/AVG | 270.33 | 137.57 | 109.60 | 111.50 | 20.80 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 272.9 | 134.30 | 36.00 | 36.70 | 7.50 | 0.98 |
| B | 274.4 | 132.40 | 35.60 | 36.30 | 6.90 | 0.98 |
| C | 273.5 | 135.60 | 36.50 | 37.10 | 6.80 | 0.98 |
| TOT/AVG | 273.60 | 134.10 | 108.10 | 110.10 | 21.20 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 269.6 | 112.13 | 90.60 | 91.10 | 9.80 | 0.99 |
| **Reduce Output** | 229.7 | 127.23 | 87.30 | 88.20 | 9.40 | 0.99 |
| **Full Input** | 270.3 | 137.57 | 109.60 | 111.50 | 20.80 | 0.98 |
| **Full Output** | 273.6 | 134.10 | 108.10 | 110.10 | 21.20 | 0.98 |
| **Power Savings** | | | **19.00** | | | |
| **Power % Savings** | | | **17.34%** | | | |

## CSU Chancellor's Office

## *FU-4a Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Baseball West Electric Room | Date Measured: | 10/23/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 100 amp / #908 |
| Panel Fed By Energy Saver: | Panel LG (3rd Base Side) | Datalogger #: | **G-6** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 271.2 | 52.64 | 14.20 | 14.30 | 1.05 | 1.00 |
| B | 272.9 | 54.50 | 14.90 | 14.90 | 1.00 | 1.00 |
| C | 272.4 | 43.36 | 12.80 | 12.90 | 0.94 | 1.00 |
| TOT/AVG | 272.17 | 50.17 | 41.90 | 42.10 | 2.99 | 1.00 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 229.3 | 60.50 | 13.80 | 13.90 | 1.00 | 1.00 |
| B | 230.5 | 64.60 | 15.00 | 15.00 | 1.00 | 1.00 |
| C | 237.3 | 54.70 | 12.70 | 12.70 | 0.90 | 1.00 |
| TOT/AVG | 232.37 | 59.93 | 41.50 | 41.60 | 2.90 | 1.00 |

**Description of Lights Controlled:**

Baseball field pole lights for panel LG on the 3rd base side of the field

ALL HID Pole lights. The lights would not turn on initially. We had to reset the reset button numerous times to get it to turn on.

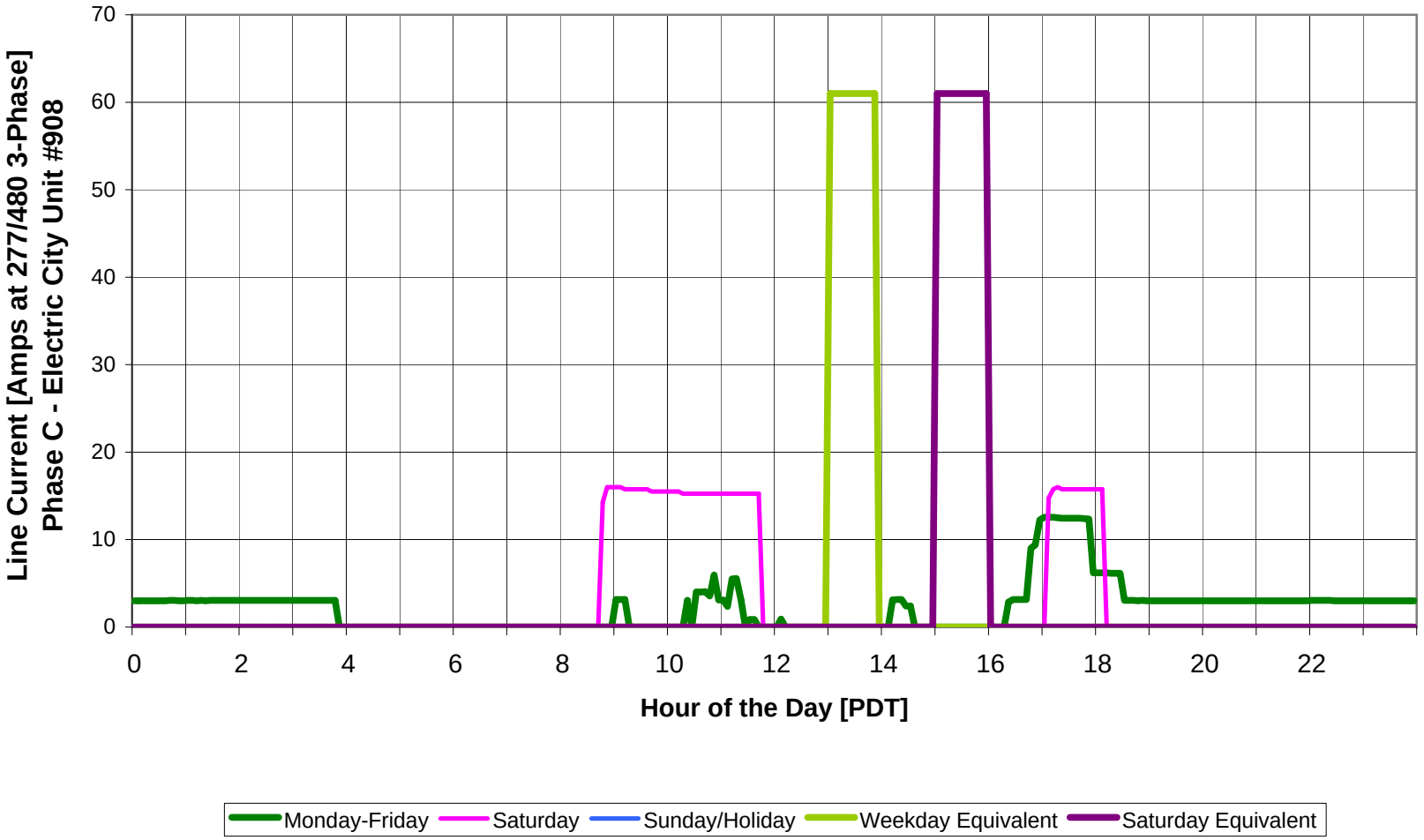
**UNIT WAS IN BYPASS DURING THE SITE VISIT on 11/25/03**

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 271.2 | 69.20 | 18.60 | 18.80 | 2.10 | 0.99 |
| B | 273.4 | 70.80 | 18.80 | 19.30 | 4.30 | 0.98 |
| C | 272.6 | 62.00 | 16.50 | 16.90 | 3.70 | 0.98 |
| TOT/AVG | 272.40 | 67.33 | 53.90 | 55.00 | 10.10 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 271.0 | 68.00 | 18.30 | 18.40 | 2.20 | 0.99 |
| B | 273.6 | 72.00 | 19.20 | 19.70 | 4.40 | 0.98 |
| C | 272.2 | 62.00 | 16.50 | 16.90 | 3.70 | 0.98 |
| TOT/AVG | 272.27 | 67.33 | 54.00 | 55.00 | 10.30 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 272.2 | 50.17 | 41.90 | 42.10 | 2.99 | 1.00 |
| **Reduce Output** | 232.4 | 59.93 | 41.50 | 41.60 | 2.90 | 1.00 |
| **Full Input** | 272.4 | 67.33 | 53.90 | 55.00 | 10.10 | 0.98 |
| **Full Output** | 272.3 | 67.33 | 54.00 | 55.00 | 10.30 | 0.98 |
| **Power Savings** | | | **12.00** | | | |
| **Power % Savings** | | | **22.26%** | | | |

**Graph #4a CSU Fullerton Oct/Nov 2003**
**Unit FU-4a, Baseball Field 3rd Base Line Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-4b Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Baseball East Electric Room Contactor and Panel | Date Measured: | 10/23/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 100 amp #1017 |
| Panel Fed By Energy Saver: | Panel LH (1st Base Side) | Datalogger #: | **V-9** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 270.9 | 51.96 | 14.00 | 14.10 | 1.74 | 0.99 |
| B | 272.8 | 43.21 | 11.80 | 11.80 | 0.50 | 1.00 |
| C | 271.7 | 54.40 | 14.70 | 11.80 | 1.10 | 1.00 |
| TOT/AVG | 271.80 | 49.86 | 40.50 | 37.70 | 3.34 | 1.00 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.5 | 60.00 | 13.70 | 13.90 | 1.90 | 0.99 |
| B | 230.2 | 51.40 | 11.80 | 11.90 | 0.69 | 1.00 |
| C | 231.9 | 63.10 | 14.60 | 14.60 | 1.10 | 1.00 |
| TOT/AVG | 231.20 | 58.17 | 40.10 | 40.40 | 3.69 | 1.00 |

**Description of Lights Controlled:**

Baseball field pole lights on the 1st base side of the field

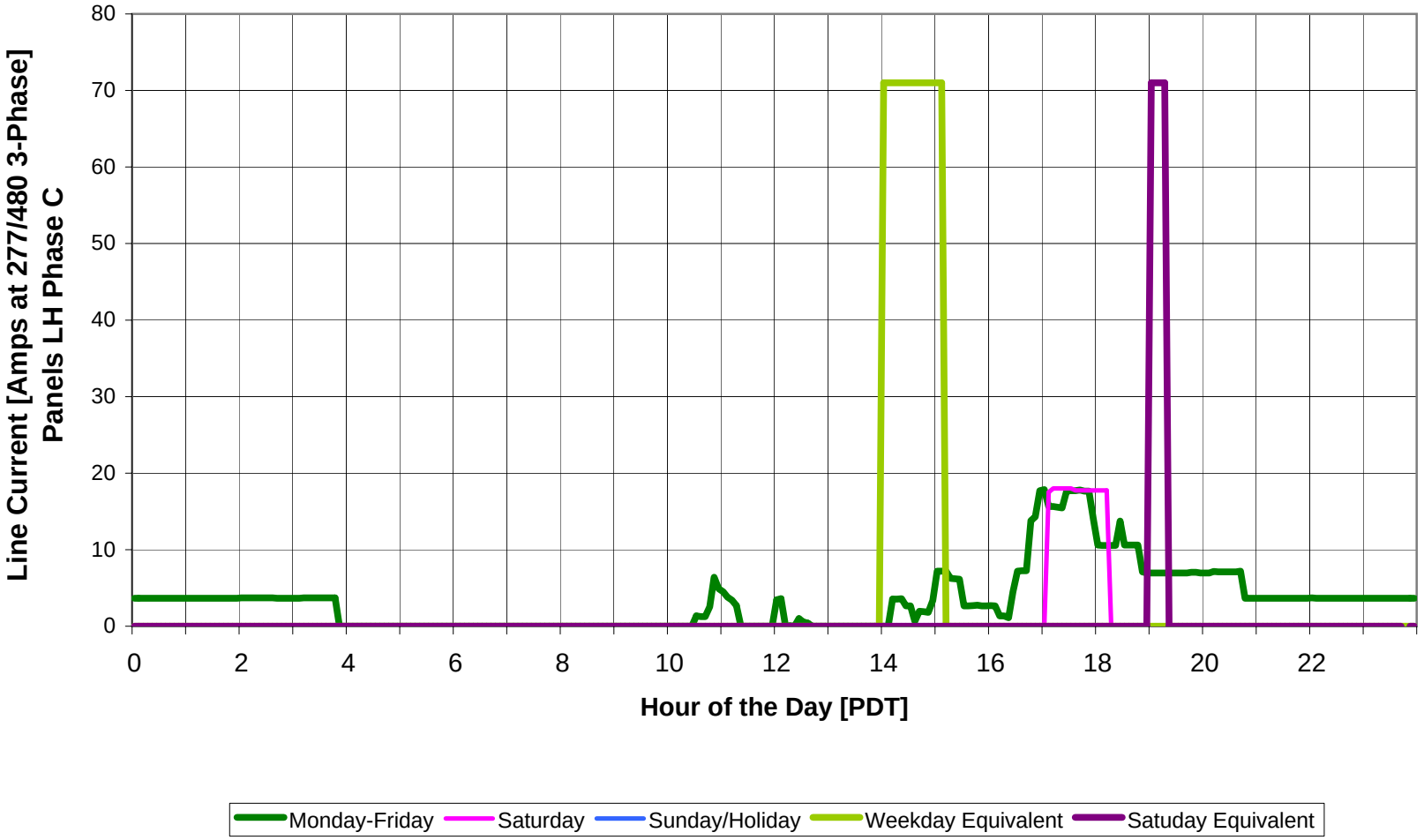
ALL HID Pole lights. The lights would not turn on initially. We had to reset the reset button numerous times to get it to turn on. **UNIT WAS IN BYPASS DURING THE SITE VISIT on 11/25/03**

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 271.1 | 68.00 | 17.70 | 18.40 | 5.00 | 0.96 |
| B | 273.5 | 56.20 | 15.20 | 15.40 | 2.00 | 0.99 |
| C | 272.0 | 70.90 | 19.20 | 19.30 | 1.50 | 1.00 |
| TOT/AVG | 272.20 | 65.03 | 52.10 | 53.10 | 8.50 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 272.0 | 67.10 | 17.50 | 18.30 | 5.30 | 0.98 |
| B | 273.3 | 56.10 | 15.20 | 15.30 | 1.90 | 0.99 |
| C | 272.7 | 70.80 | 19.30 | 19.40 | 1.60 | 1.00 |
| TOT/AVG | 272.67 | 64.67 | 52.00 | 53.00 | 8.80 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 271.8 | 49.86 | 40.50 | 37.70 | 3.34 | 1.00 |
| **Reduce Output** | 231.2 | 58.17 | 40.10 | 40.40 | 3.69 | 1.00 |
| **Full Input** | 272.2 | 65.03 | 52.10 | 53.10 | 8.50 | 0.98 |
| **Full Output** | 272.7 | 64.67 | 52.00 | 53.00 | 8.80 | 0.99 |
| **Power Savings** | | | **11.60** | | | |
| **Power % Savings** | | | **22.26%** | | | |

**Graph #4b CSU Fullerton Oct/Nov 2003**
**Energy Saver FU-4b Baseball Field 1st Base Line Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-5 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Baseball East Electric Room Contactor and Panel | Date Measured: | 10/23/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 150 amp / #843 |
| Panel Fed By Energy Saver: | LC-J (Center Field Lights) | Datalogger #: | **M-31** |

| Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.6 | 86.00 | 23.50 | 23.60 | 2.30 | 1.00 |
| B | 276.9 | 87.20 | 24.10 | 24.10 | 1.80 | 1.00 |
| C | 275.8 | 74.40 | 20.50 | 20.50 | 0.80 | 1.00 |
| TOT/AVG | 275.77 | 82.53 | 68.10 | 68.20 | 4.90 | 1.00 |

| Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 230.5 | 101.30 | 23.30 | 23.40 | 2.20 | 1.00 |
| B | 229.6 | 106.10 | 24.20 | 24.30 | 2.00 | 1.00 |
| C | 228.9 | 88.50 | 20.20 | 20.20 | 0.70 | 1.00 |
| TOT/AVG | 229.67 | 98.63 | 67.70 | 67.90 | 4.90 | 1.00 |

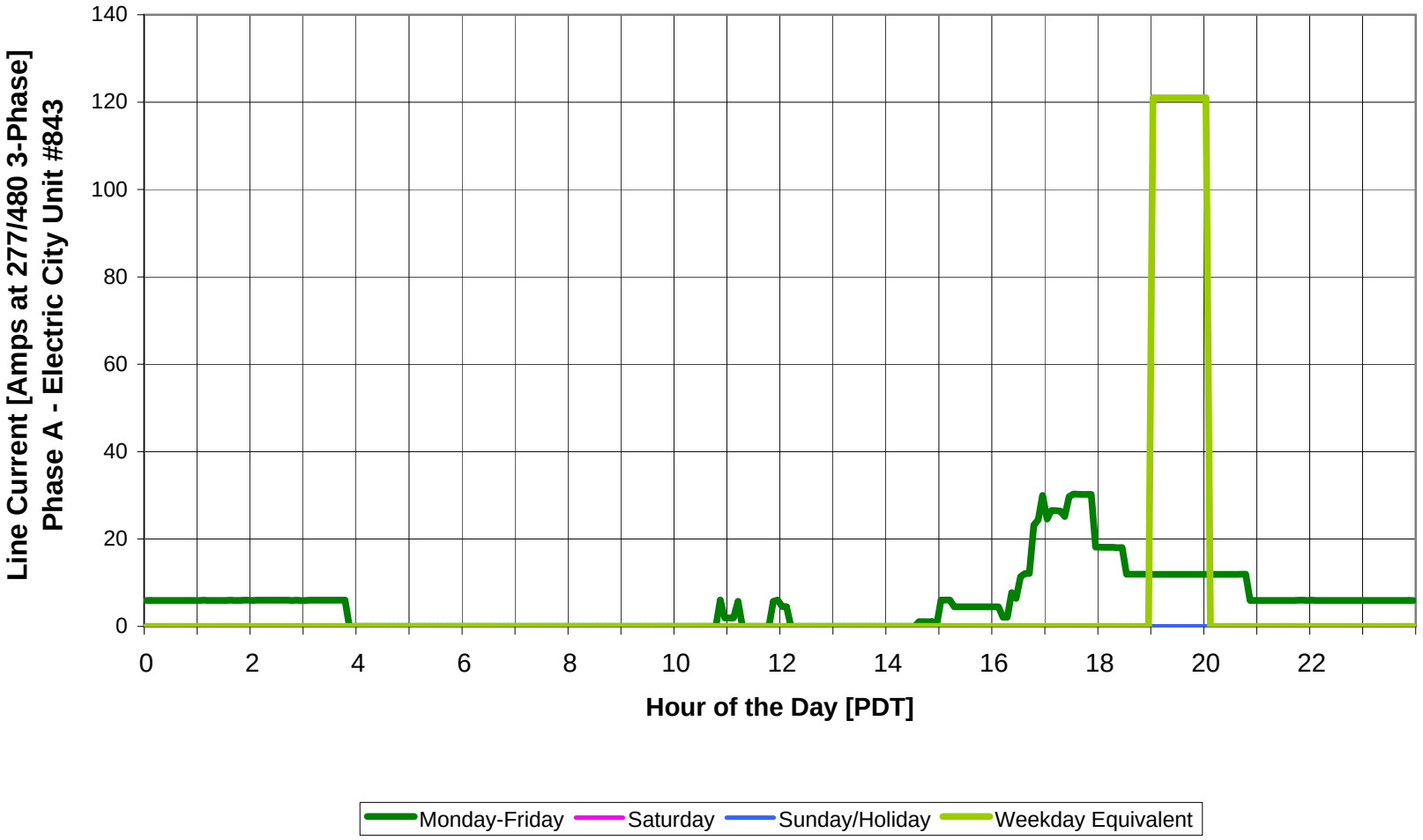
| **Description of Lights Controlled:** | |
|---|---|
| Baseball field pole lights for center field | |
| ALL HID Pole lights. The lights would not turn on initially. We had to reset the reset button numerous | |
| times to get it to turn on. | **UNIT WAS IN BYPASS DURING THE SITE VISIT on 11/25/03** |

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 272.1 | 114.50 | 30.80 | 31.00 | 2.90 | 1.00 |
| B | 274.4 | 118.00 | 31.40 | 32.50 | 3.20 | 0.97 |
| C | 273.5 | 99.30 | 26.50 | 27.00 | 5.40 | 0.98 |
| TOT/AVG | 273.33 | 110.60 | 88.70 | 90.50 | 11.50 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 271.5 | 114.30 | 31.00 | 31.10 | 3.20 | 1.00 |
| B | 273.9 | 117.10 | 31.00 | 32.10 | 3.10 | 0.97 |
| C | 272.7 | 98.30 | 26.30 | 26.30 | 5.20 | 0.98 |
| TOT/AVG | 272.70 | 109.90 | 88.30 | 89.50 | 11.50 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 275.8 | 82.53 | 68.10 | 68.20 | 4.90 | 1.00 |
| **Reduce Output** | 229.7 | 98.63 | 67.70 | 67.90 | 4.90 | 1.00 |
| **Full Input** | 273.3 | 110.60 | 88.70 | 90.50 | 11.50 | 0.98 |
| **Full Output** | 272.7 | 109.90 | 88.30 | 89.50 | 11.50 | 0.98 |
| **Power Savings** | | | **20.60** | | | |
| **Power % Savings** | | | **23.22%** | | | |

**Graph #5 CSU Fullerton Oct/Nov 2003**
**Unit #FU-5, Baseball Field Center Field Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-6 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Gym northwest Corner Fan Room, 3rd Floor (208) | Date Measured: | 11/25/2003 |
| Panel Serving Energy Saver: | Distribution Panel P6 | Energy Saver Size/Serial #: | 150 amp / #914 |
| Panel Fed By Energy Saver: | R-2 (208-volt) | Datalogger #: | **V-8** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 118.4 | 77.10 | 8.90 | 9.10 | 1.90 | 0.98 |
| B | 118.6 | 78.80 | 9.10 | 9.30 | 2.00 | 0.98 |
| C | 118.6 | 68.70 | 8.00 | 8.10 | 1.60 | 0.98 |
| TOT/AVG | 118.53 | 74.87 | 26.00 | 26.50 | 5.50 | 0.98 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 106.4 | 84.00 | 8.70 | 8.90 | 2.00 | 0.98 |
| B | 107.3 | 86.20 | 9.10 | 9.30 | 1.90 | 0.98 |
| C | 106.5 | 75.10 | 7.90 | 8.00 | 1.50 | 0.98 |
| TOT/AVG | 106.73 | 81.77 | 25.70 | 26.20 | 5.40 | 0.98 |

**Description of Lights Controlled:**

Gym floor lighting. All HID fixtures.This is a 208/120 volt unit and its set point is 105 volts.

Located in the upstairs fan room.

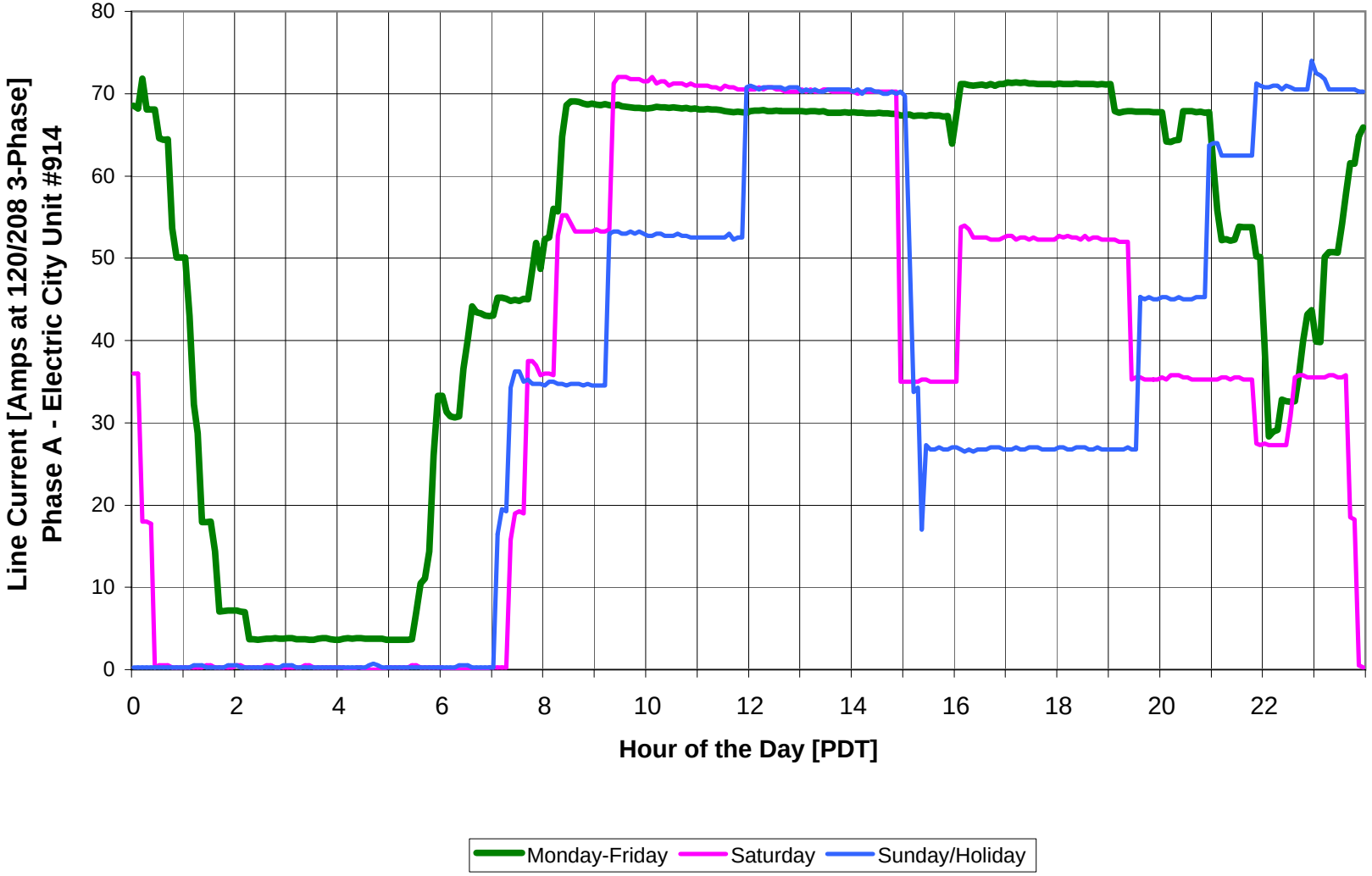
**UNIT WAS IN BYPASS DURING THE SITE VISIT on 11/25/03**

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 118.4 | 84.20 | 9.80 | 10.00 | 2.30 | 0.97 |
| B | 118.6 | 85.80 | 9.90 | 10.20 | 2.40 | 0.97 |
| C | 118.6 | 76.70 | 8.90 | 9.10 | 1.90 | 0.98 |
| TOT/AVG | 118.53 | 82.23 | 28.60 | 29.30 | 6.60 | 0.97 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 118.1 | 83.30 | 9.60 | 9.90 | 2.40 | 0.97 |
| B | 118.1 | 86.60 | 9.90 | 10.20 | 2.40 | 0.97 |
| C | 118.6 | 75.90 | 8.80 | 9.00 | 2.00 | 0.98 |
| TOT/AVG | 118.27 | 81.93 | 28.30 | 29.10 | 6.80 | 0.97 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 118.5 | 74.87 | 26.00 | 26.50 | 5.50 | 0.98 |
| **Reduce Output** | 106.7 | 81.77 | 25.70 | 26.20 | 5.40 | 0.98 |
| **Full Input** | 118.5 | 82.23 | 28.60 | 29.30 | 6.60 | 0.97 |
| **Full Output** | 118.3 | 81.93 | 28.30 | 29.10 | 6.80 | 0.97 |
| **Power Savings** | | | **2.60** | | | |
| **Power % Savings** | | | **9.09%** | | | |

**Graph #6 CSU Fullerton Oct/Nov 2003**
**Unit FU-6, Gym Floor HID Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-7 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | West Side Parking Structure, Panel H1 | Date Measured: | 10/23/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40 amp / #924 |
| Panel Fed By Energy Saver: | Panel H1 | Datalogger #: | **M-21** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 274.4 | 17.36 | 4.16 | 4.79 | 2.36 | 0.87 |
| B | 276.8 | 12.20 | 2.73 | 3.40 | 2.05 | 0.80 |
| C | 276.1 | 10.95 | 2.46 | 3.05 | 1.80 | 0.81 |
| TOT/AVG | 275.77 | 13.50 | 9.35 | 11.24 | 6.21 | 0.83 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 247.4 | 19.91 | 4.26 | 4.95 | 2.53 | 0.96 |
| B | 247.3 | 13.12 | 2.61 | 3.20 | 1.87 | 0.81 |
| C | 245.8 | 12.16 | 2.41 | 2.99 | 1.96 | 0.81 |
| TOT/AVG | 246.83 | 15.06 | 9.28 | 11.14 | 6.36 | 0.86 |

**Description of Lights Controlled:**

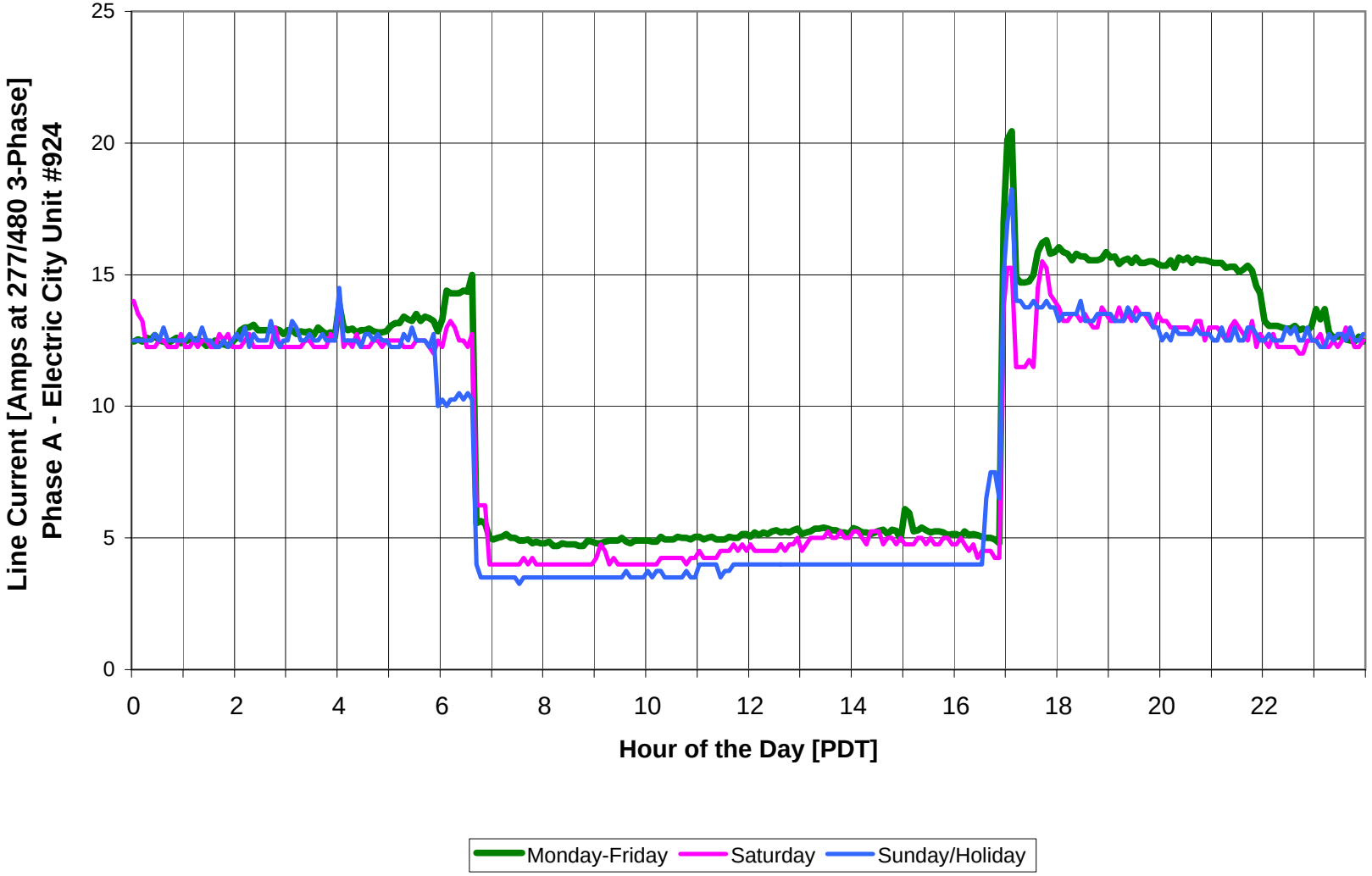
| | |
|---|---|
| 4-level parking structure with HPS lighting | **UNIT WAS NOT IN BYPASS DURING THE SITE VISIT** |
| Generally 6 fixtures are on 24-7 for security purposes. The rest are controlled by a timeclock which | |
| is set to turn the lights on at 6:30 pm and off at 6:00 am. The Energy Saver setpoint is 245 volts. | |

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.1 | 21.40 | 5.28 | 5.84 | 2.52 | 0.90 |
| B | 276.6 | 14.52 | 3.18 | 4.02 | 2.49 | 0.79 |
| C | 275.3 | 14.14 | 3.10 | 3.91 | 2.37 | 0.80 |
| TOT/AVG | 275.33 | 16.69 | 11.56 | 13.77 | 7.38 | 0.83 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.2 | 22.18 | 5.24 | 5.97 | 2.84 | 0.88 |
| B | 273.6 | 14.62 | 3.38 | 4.19 | 2.47 | 0.80 |
| C | 274.1 | 13.82 | 3.01 | 3.78 | 2.30 | 0.80 |
| TOT/AVG | 273.63 | 16.87 | 11.63 | 13.94 | 7.61 | 0.83 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 275.8 | 13.50 | 9.35 | 11.24 | 6.21 | 0.83 |
| **Reduce Output** | 246.8 | 15.06 | 9.28 | 11.14 | 6.36 | 0.86 |
| **Full Input** | 275.3 | 16.69 | 11.56 | 13.77 | 7.38 | 0.83 |
| **Full Output** | 273.6 | 16.87 | 11.63 | 13.94 | 7.61 | 0.83 |
| **Power Savings** | | | **2.21** | | | |
| **Power % Savings** | | | **19.12%** | | | |

**Graph #7 CSU Fullerton Oct/Nov 2003**
**Unit FU-7, Parking Structure HID Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-8 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | 2nd Floor Library South, Room 206 (Shared Feed) | Date Measured: | 11/25/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 150 amp / #980 |
| Panel Fed By Energy Saver: | 1HA, 2HA | Datalogger #: | G-14 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 273.8 | 79.80 | 21.70 | 21.90 | 2.60 | 0.99 |
| B | 272.2 | 69.70 | 18.90 | 19.00 | 2.20 | 0.99 |
| C | 273.1 | 53.30 | 14.50 | 14.60 | 1.50 | 1.00 |
| TOT/AVG | 273.03 | 67.60 | 55.10 | 55.50 | 6.30 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 233.0 | 94.60 | 21.80 | 22.00 | 2.70 | 0.99 |
| B | 231.8 | 81.50 | 18.80 | 18.90 | 2.20 | 0.99 |
| C | 231.5 | 61.90 | 14.30 | 14.30 | 1.50 | 1.00 |
| TOT/AVG | 232.10 | 79.33 | 54.90 | 55.20 | 6.40 | 0.99 |

**Description of Lights Controlled:**

| | |
|---|---|
| Located in Room #17 | |
| Lights are set to come on at 4:00 am and off at 11:00 pm? | |
| Energy Saver Set Point is 230 Volts | **UNIT WAS NOT IN BYPASS DURING THE SITE VISIT** |

## CSU Chancellor's Office

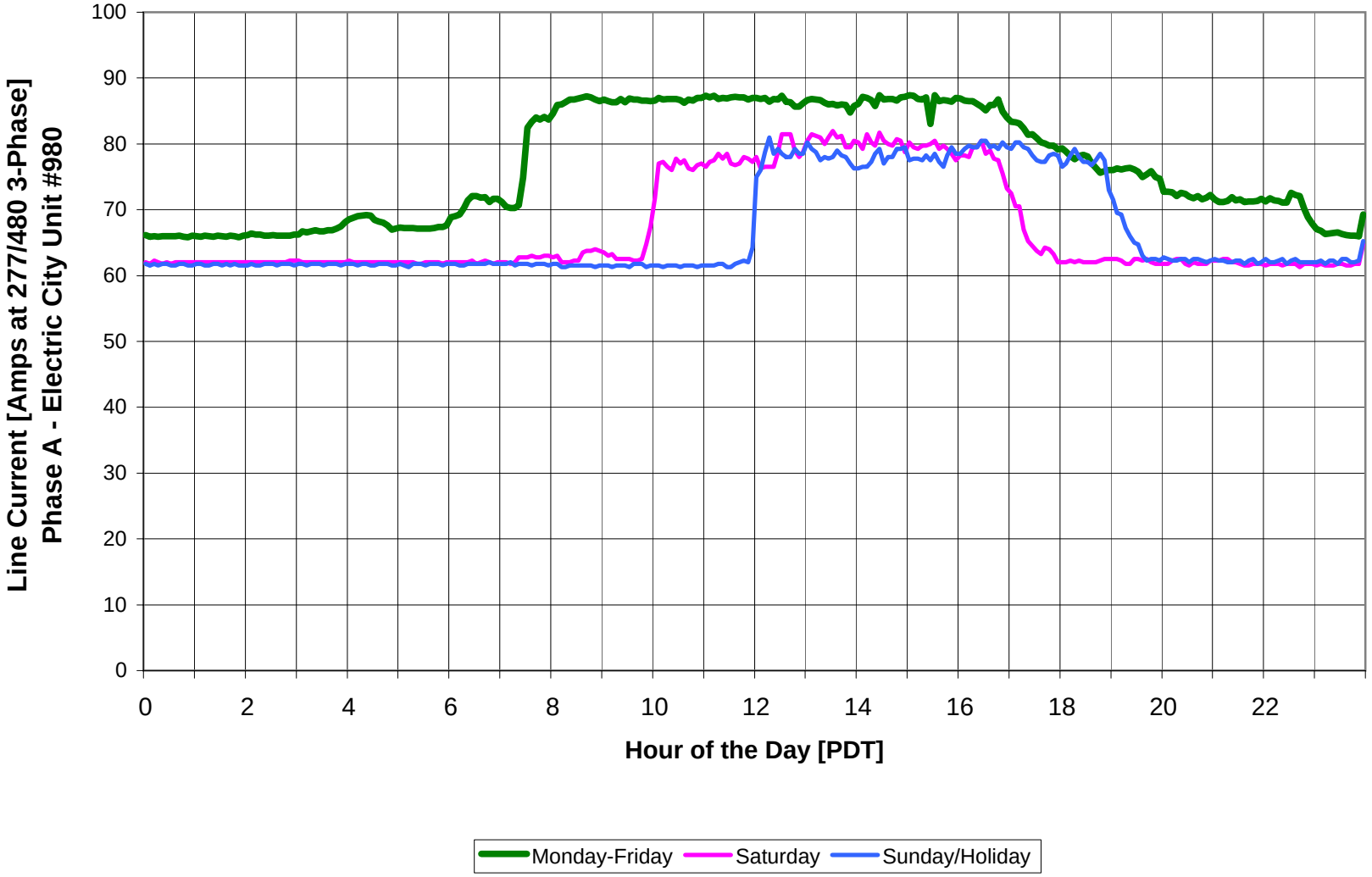
## *FU-8 Cal State Fullerton*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.3 | 97.40 | 26.10 | 16.70 | 5.60 | 0.98 |
| B | 272.6 | 83.80 | 22.60 | 22.90 | 3.50 | 0.99 |
| C | 273.1 | 62.50 | 16.70 | 17.00 | 3.10 | 0.98 |
| TOT/AVG | 273.00 | 81.23 | 65.40 | 56.60 | 12.20 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 271.0 | 96.50 | 25.60 | 26.20 | 5.50 | 0.98 |
| B | 269.8 | 82.50 | 21.90 | 22.20 | 3.40 | 0.99 |
| C | 270.5 | 62.60 | 19.70 | 16.90 | 3.10 | 0.98 |
| TOT/AVG | 270.43 | 80.53 | 67.20 | 65.30 | 12.00 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 273.0 | 67.60 | 55.10 | 55.50 | 6.30 | 0.99 |
| **Reduce Output** | 232.1 | 79.33 | 54.90 | 55.20 | 6.40 | 0.99 |
| **Full Input** | 273.0 | 81.23 | 65.40 | 56.60 | 12.20 | 0.98 |
| **Full Output** | 270.4 | 80.53 | 67.20 | 65.30 | 12.00 | 0.98 |
| **Power Savings** | | | **10.30** | | | |
| **Power % Savings** | | | **15.75%** | | | |

**Graph #8 CSU Fullerton Oct/Nov 2003**
**Unit FU-8, Library 2nd Floor Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *FU-9 Cal State Fullerton*

| | | | |
|---|---|---|---|
| Location: | Library North - 4th Floor Room 406 (Shared Feed) | Date Measured: | 11/25/2003 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 100 amp / #952 |
| Panel Fed By Energy Saver: | 3HA, 4HA | Datalogger #: | M-32 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 273.8 | 46.45 | 12.60 | 12.70 | 1.47 | 0.99 |
| B | 272.5 | 68.90 | 18.60 | 18.70 | 2.00 | 0.99 |
| C | 272.9 | 33.28 | 8.95 | 9.09 | 1.55 | 0.99 |
| TOT/AVG | 273.07 | 49.54 | 40.15 | 40.49 | 5.02 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 229.2 | 55.00 | 12.50 | 12.60 | 1.50 | 0.99 |
| B | 240.1 | 78.20 | 18.60 | 18.70 | 2.00 | 0.99 |
| C | 231.2 | 39.15 | 8.88 | 9.04 | 1.68 | 0.98 |
| TOT/AVG | 233.50 | 57.45 | 39.98 | 40.34 | 5.18 | 0.99 |

**Description of Lights Controlled:**

Located in Room #17, Energy Saver was set for 230-volt setpoint

Library lights Possible problem with "B" Phase card

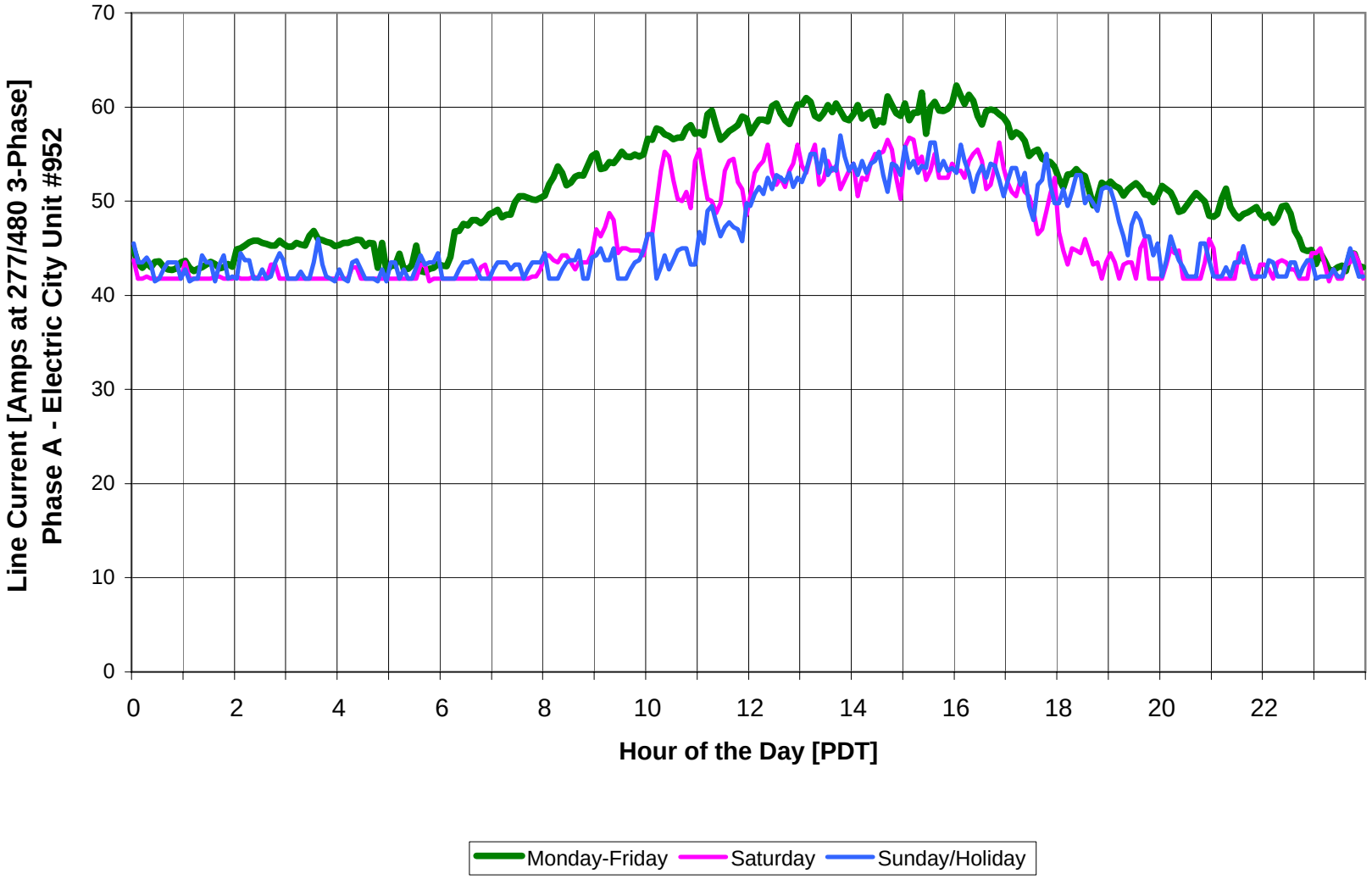
**UNIT WAS NOT IN BYPASS DURING THE SITE VISIT**

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.5 | 59.00 | 15.90 | 16.20 | 3.10 | 0.98 |
| B | 272.8 | 69.10 | 18.80 | 18.90 | 2.00 | 0.99 |
| C | 273.2 | 38.78 | 10.40 | 10.60 | 1.87 | 0.98 |
| TOT/AVG | 273.50 | 55.63 | 45.10 | 45.70 | 6.97 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.8 | 57.60 | 15.50 | 15.80 | 2.90 | 0.99 |
| B | 239.5 | 77.70 | 18.60 | 18.70 | 2.10 | 0.99 |
| C | 274.1 | 38.11 | 10.20 | 10.40 | 1.93 | 0.98 |
| TOT/AVG | 262.47 | 57.80 | 44.30 | 44.90 | 6.93 | 0.99 |

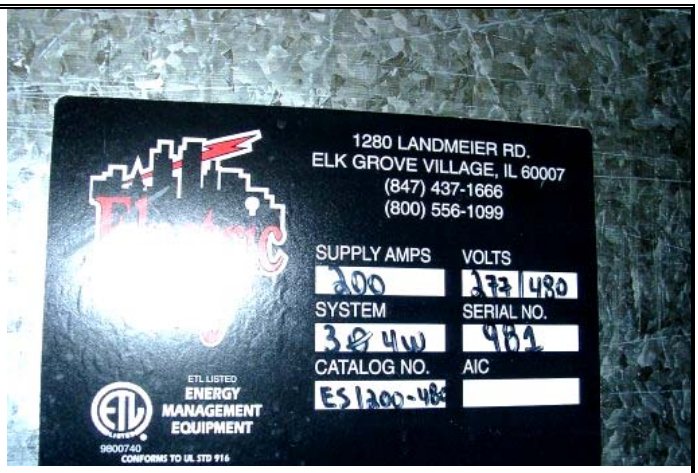
| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 273.1 | 49.54 | 40.15 | 40.49 | 5.02 | 0.99 |
| **Reduce Output** | 233.5 | 57.45 | 39.98 | 40.34 | 5.18 | 0.99 |
| **Full Input** | 273.5 | 55.63 | 45.10 | 45.70 | 6.97 | 0.98 |
| **Full Output** | 262.5 | 57.80 | 44.30 | 44.90 | 6.93 | 0.99 |
| **Power Savings** | | | **4.95** | | | |
| **Power % Savings** | | | **10.98%** | | | |

**Graph #9 CSU Fullerton Oct/Nov 2003**
**Unit FU-9, Library North Lighting**
**Average Daily Load Profile**



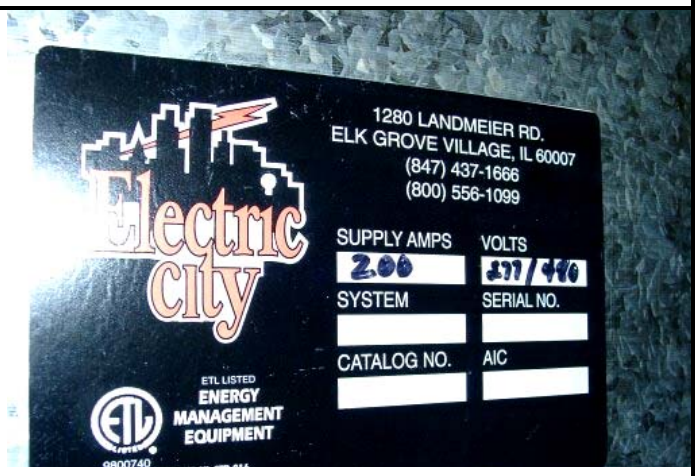
# *CSU Fullerton*
# *Energy Saver Units for Football Field*

Unit 981

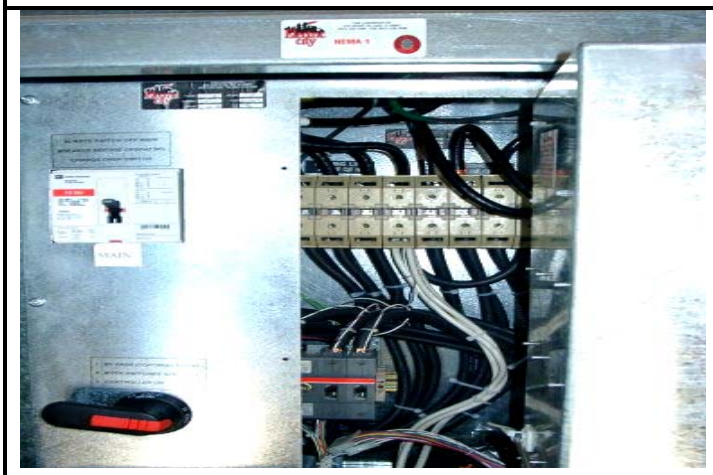



Nameplate for Unit 981

Unit 983




Nameplate for Unit 983



Unit 986


Nameplate for Unit 986

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSU Long Beach

## Energy Savings Summary

Two Energy Saver units were installed on the campus of the California State University at Long Beach (CSULB). Both of the units were installed to control lights in the parking structure.

The following table delineates the savings estimates for each Energy Saver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the Energy Saver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are presented below.

| CSULB Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Lights Controlled | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| LB-1a | 100 | Parking Structure | 49,920 | 72,708 |
| LB-1b | 80 | Parking Structure | 49,275 | 135,711 |
| **Total** | | **Long Beach Campus** | **99,195** | **208,419** |

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak (summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSULB Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| LB-1a | 100 | 12.00 | 8.30 | 8.30 |
| LB-1b | 80 | 11.25 | 17.01 | 12.49 |
| **Total** | | **23.25** | **25.31** | **20.79** |

The estimated annual energy savings, 208,419 kWh/yr, is 210% of the 99,195 kWh/yr reported in the CPUC project spreadsheet. The demand reduction estimate is slightly higher, and the on-peak demand reduction is almost as high. Connected loads were lower than assumed on unit LB-1a but higher on unit LB-1b. The lights in the parking structure for the most part operated 24 hours per day, which is twice as much than the operating hours assumed in the spreadsheet calculations (4160 or 4380 hours per year). This is why the measured energy savings is slightly more than double the original estimate.

Following are descriptions of each of the Energy Saver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## LB-1a. Parking Structure Lights

This 277/480-volt 100-amp unit is located in Room 16D on the first level of the parking structure. The Energy Saver unit output feeds panel A. The Energy Saver unit was set to reduce the voltage to the lights to 247 volts line-to-neutral. We recorded an average output voltage of 248.4 volts. No problems with the equipment were noted.

The input power was 40.80 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 49.10 kW, indicating that the power reduction was 8.30 kW, or 16.9% of the original load. The system operated at a 93% power factor in reduced-voltage mode and 94% power factor in full-voltage mode.

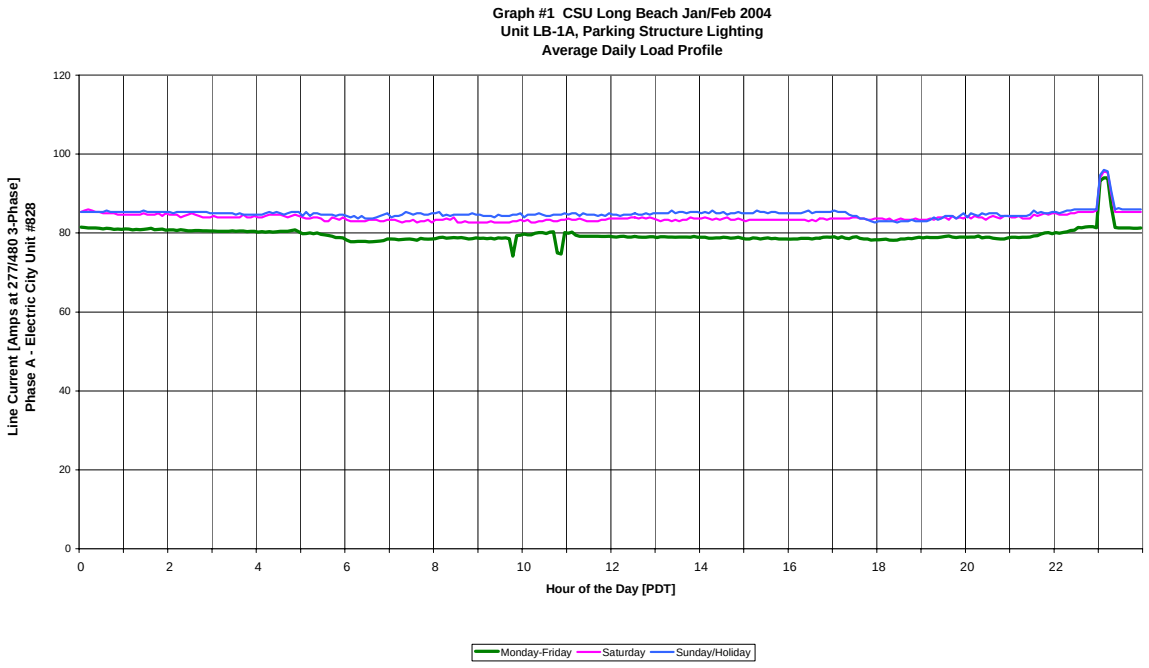
A datalogger was installed and recorded five-minute interval data from January 26 through February 18, 2004. The logger showed consistent operation of the lights.

The load profile also shows one consistent power spike close to midnight. (It does this to enable the HID lights to start properly.) The midnight spike is caused by the Energy Saver's routine of running at full voltage once each day.

The load profile indicates an equivalent full-load operating time of 8,760 hours per year. The resultant energy savings achieved by this Energy Saver unit is 72,708 kWh per year (8.30 kW * 8760 h/yr). The connected load reduction is 8.3 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 146% of the 49,920 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours of these lights is double the 12 hour/day assumption in the original estimate, but the load reduction is only 69% of the originally assumed value.

The load profile of this Energy Saver is shown in the graph below.




## LB-1b. Parking Structure Lights

This 277/480-volt 80-amp unit is also located in Room 16D on the first level of the parking structure. The Energy Saver unit output feeds panel B. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 232.6 volts. No problems with the equipment were noted.

The input power was 27.91 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 40.40 kW, indicating that the power reduction was 12.49 kW, or 30.9% of the original load. The system operated at a 91% power factor in reduced-voltage mode and 93% power factor in full-voltage mode.

These measurements were taken when the lights were in daytime operating mode. Higher loads occur at night when additional lights are on. The nighttime load is 136% of the daytime load, giving a power reduction of 17.0 kW during the night.

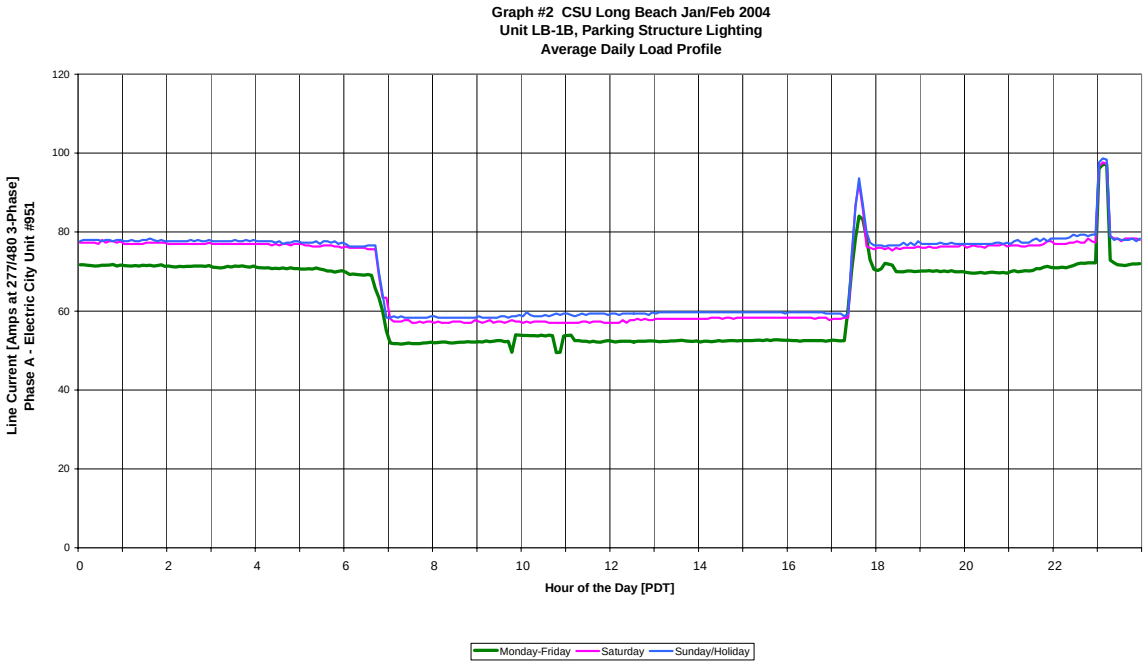
A datalogger was installed and recorded five-minute interval data from January 26 through February 18, 2004. The logger showed that the lights are operating 24 hours per day. Fewer lights are on from 7:00 a.m. until 5:00 p.m.

The load profile also shows two consistent power spikes, one at 5:45 p.m. and the other close to midnight. The afternoon spike is the caused by the Energy Saver shifting to full-voltage as a result of the new lights being turned on. (It does this to enable the HID lights to start properly.) The midnight spike is caused by the Energy Saver's routine of running at full voltage once each day.

The load profile indicates an equivalent full-load operating time of 7,983 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 135,711 kWh per year (17.0 kW * 7,983 h/yr). The connected load reduction is 17.0 kW, and the summer on-peak demand reduction is 12.49 because the lights will not be fully operating during the summer on-peak period. This value is very large compared to the 49,275 kWh/yr estimate on the CPUC spreadsheet. This is because the operating hours were approximately twice that of the assumed, and the load reduction was slightly higher.

The load profile of this Energy Saver is shown in the graph on the following page.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *LB-1A CSU Long Beach*

| | | | |
|---|---|---|---|
| Location: | Parking Level 1, Room 16D | Date Measured: | 1/26/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 100 amp / #828 |
| Panel Fed By Energy Saver: | A | Datalogger #: | V-11 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 278.4 | 69.70 | 18.20 | 19.40 | 6.70 | 0.94 |
| B | 278.7 | 41.01 | 10.50 | 11.40 | 4.47 | 0.92 |
| C | 278.1 | 47.00 | 12.10 | 13.00 | 4.90 | 0.93 |
| TOT/AVG | 278.40 | 52.57 | 40.80 | 43.80 | 16.07 | 0.93 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 249.2 | 77.20 | 18.00 | 19.20 | 6.70 | 0.94 |
| B | 246.7 | 46.60 | 10.60 | 11.50 | 4.30 | 0.93 |
| C | 249.3 | 52.30 | 11.80 | 12.80 | 5.20 | 0.92 |
| TOT/AVG | 248.40 | 58.70 | 40.40 | 43.50 | 16.20 | 0.93 |

**Description of Lights Controlled:**

247V Set Point

Readout claims 1.6% power savings

HPS Parking Garage Lights 275W

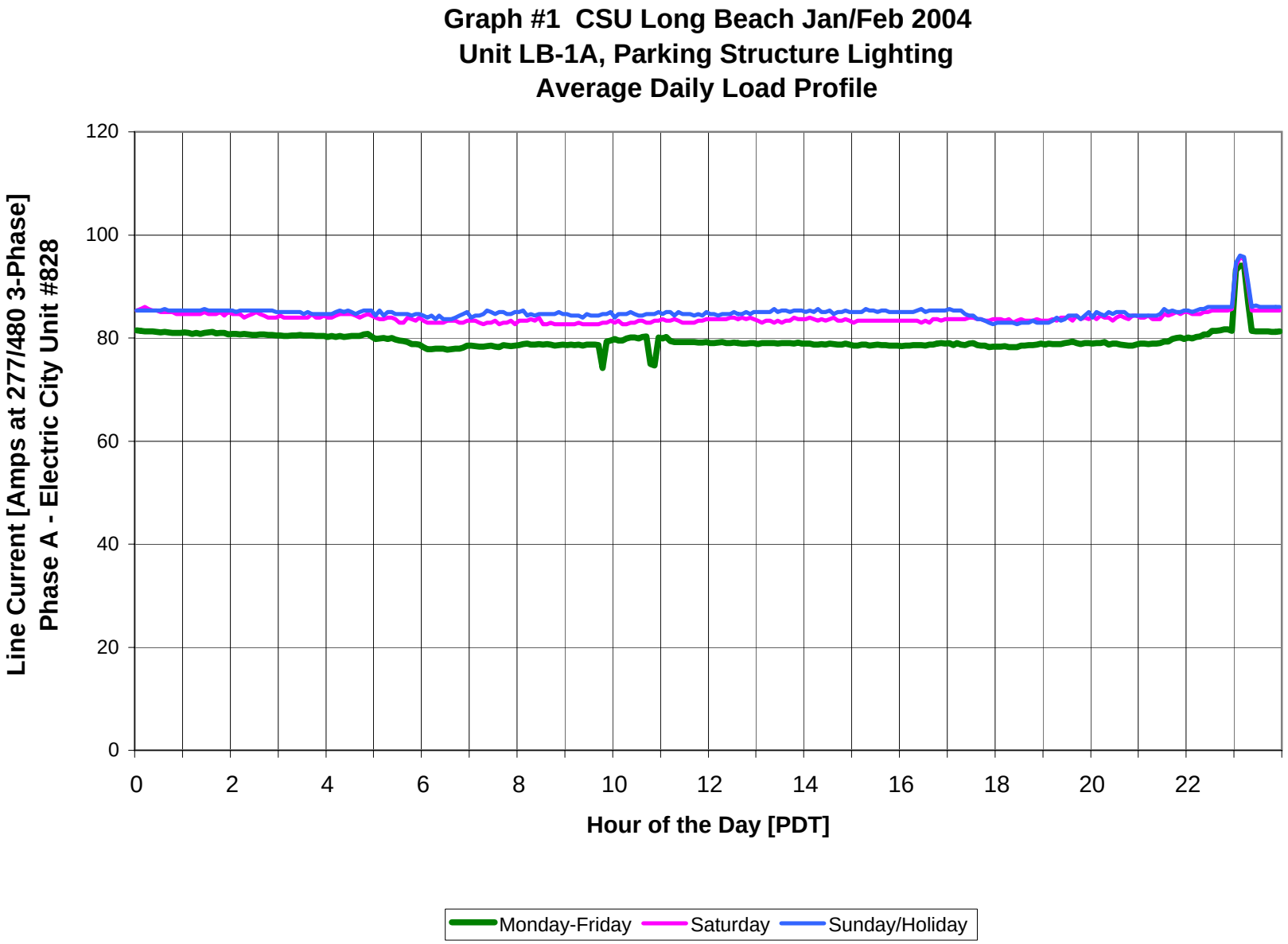
## CSU Chancellor's Office

## *LB-1A CSU Long Beach*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.4 | 81.90 | 21.70 | 22.80 | 7.20 | 0.95 |
| B | 279.2 | 50.30 | 13.20 | 13.00 | 4.90 | 0.94 |
| C | 278.5 | 54.70 | 14.20 | 15.20 | 5.40 | 0.93 |
| TOT/AVG | 278.37 | 62.30 | 49.10 | 51.00 | 17.50 | 0.94 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.9 | 81.70 | 21.20 | 22.40 | 7.30 | 0.95 |
| B | 274.4 | 51.20 | 13.20 | 14.10 | 4.90 | 0.94 |
| C | 273.4 | 55.50 | 14.20 | 15.20 | 5.30 | 0.93 |
| TOT/AVG | 274.23 | 62.80 | 48.60 | 51.70 | 17.50 | 0.94 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 278.4 | 52.57 | 40.80 | 43.80 | 16.07 | 0.93 |
| **Reduce Output** | 248.4 | 58.70 | 40.40 | 43.50 | 16.20 | 0.93 |
| **Full Input** | 278.4 | 62.30 | 49.10 | 51.00 | 17.50 | 0.94 |
| **Full Output** | 274.2 | 62.80 | 48.60 | 51.70 | 17.50 | 0.94 |
| **Power Savings** | | | **8.30** | | | |
| **Power % Savings** | | | **16.90%** | | | |


Graph #1 CSU Long Beach Jan/Feb 2004
Unit LB-1A, Parking Structure Lighting
Average Daily Load Profile
Line Current [Amps at 277/480 3-Phase]
Phase A - Electric City Unit #828
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
22
Hour of the Day [PDT]
Monday-Friday
Saturday
Sunday/Holiday

## CSU Chancellor's Office

## *LB-1B CSU Long Beach*

| | | | |
|---|---|---|---|
| Location: | Parking Level 1, Room 16D | Date Measured: | 1/26/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 80 amp / #951 |
| Panel Fed By Energy Saver: | B | Datalogger #: | **V-4** |

| Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.4 | 42.50 | 10.90 | 11.70 | 4.40 | 0.92 |
| B | 279.1 | 32.11 | 8.24 | 9.00 | 3.65 | 0.91 |
| C | 278.0 | 34.65 | 8.77 | 9.62 | 3.94 | 0.91 |
| TOT/AVG | 278.17 | 36.42 | 27.91 | 30.32 | 11.99 | 0.91 |

| Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 231.8 | 49.70 | 10.50 | 11.50 | 4.50 | 0.92 |
| B | 233.2 | 38.10 | 8.16 | 8.93 | 3.64 | 0.91 |
| C | 232.7 | 40.60 | 8.60 | 9.50 | 4.00 | 0.91 |
| TOT/AVG | 232.57 | 42.80 | 27.26 | 29.93 | 12.14 | 0.91 |

| **Description of Lights Controlled:** |
|---|
| 230V Set Point |
| HPS Parking Garage Lights 275W |
| |

## CSU Chancellor's Office

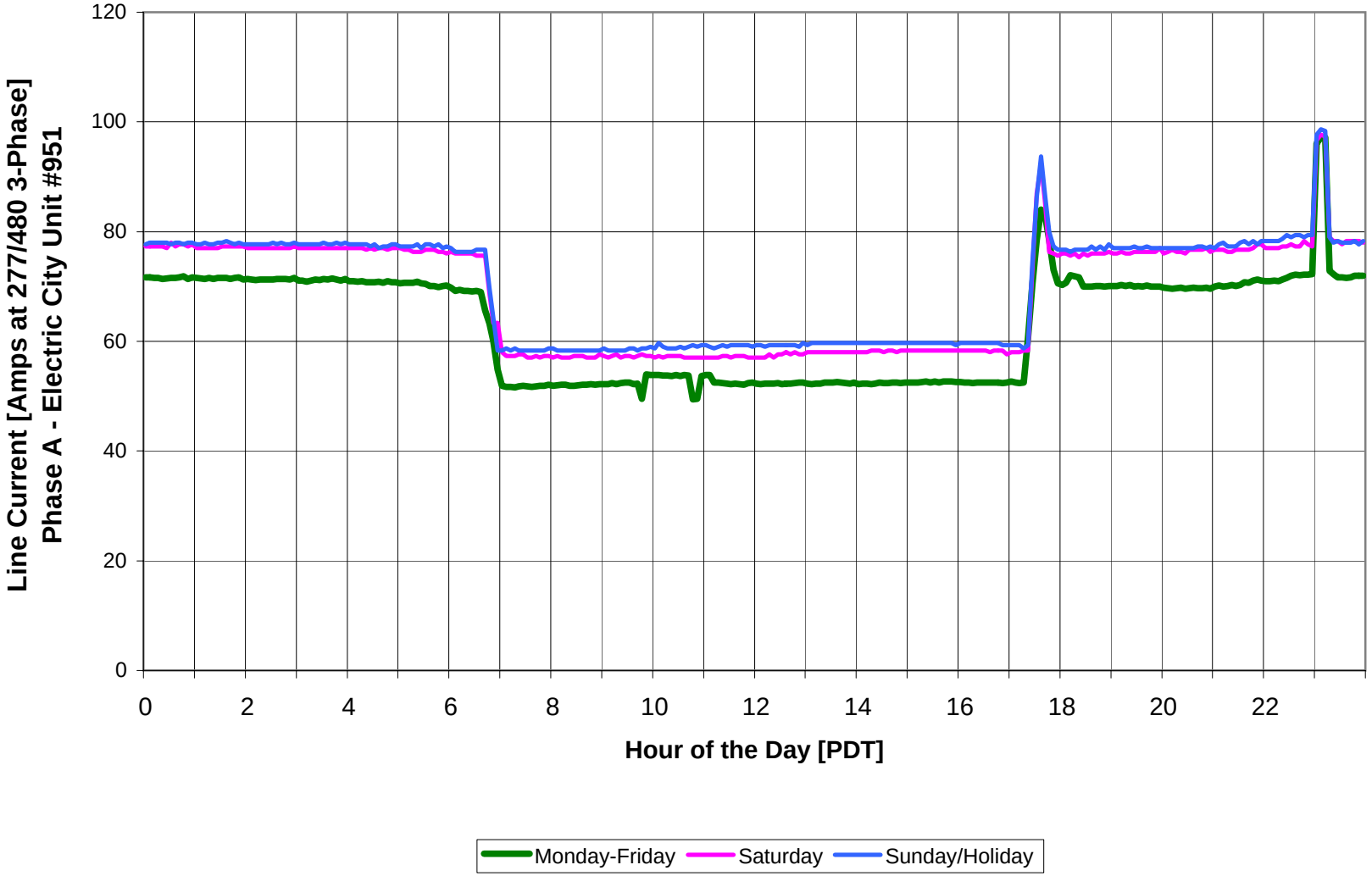
## *LB-1B CSU Long Beach*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.2 | 59.90 | 15.40 | 16.50 | 6.00 | 0.93 |
| B | 279.2 | 47.00 | 12.00 | 13.10 | 5.10 | 0.92 |
| C | 277.9 | 49.90 | 13.00 | 14.00 | 4.00 | 0.93 |
| TOT/AVG | 278.10 | 52.27 | 40.40 | 43.60 | 15.10 | 0.93 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.0 | 60.30 | 15.40 | 16.60 | 6.10 | 0.93 |
| B | 276.0 | 46.40 | 11.90 | 12.90 | 4.90 | 0.93 |
| C | 275.7 | 50.00 | 12.70 | 13.80 | 5.40 | 0.92 |
| TOT/AVG | 275.23 | 52.23 | 40.00 | 43.30 | 16.40 | 0.93 |

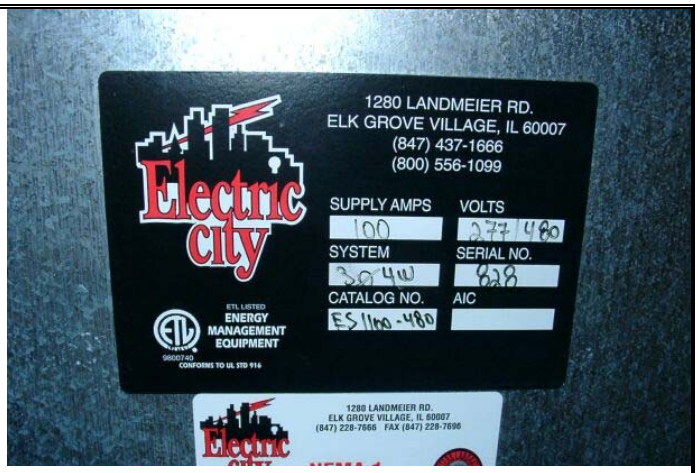
| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 278.2 | 36.42 | 27.91 | 30.32 | 11.99 | 0.91 |
| **Reduce Output** | 232.6 | 42.80 | 27.26 | 29.93 | 12.14 | 0.91 |
| **Full Input** | 278.1 | 52.27 | 40.40 | 43.60 | 15.10 | 0.93 |
| **Full Output** | 275.2 | 52.23 | 40.00 | 43.30 | 16.40 | 0.93 |
| **Power Savings** | | | **12.49** | | | |
| **Power % Savings** | | | **30.92%** | | | |

**Graph #2 CSU Long Beach Jan/Feb 2004**
**Unit LB-1B, Parking Structure Lighting**
**Average Daily Load Profile**



# *CSU Long Beach*
# *Energy Saver Units for Parking Structure*

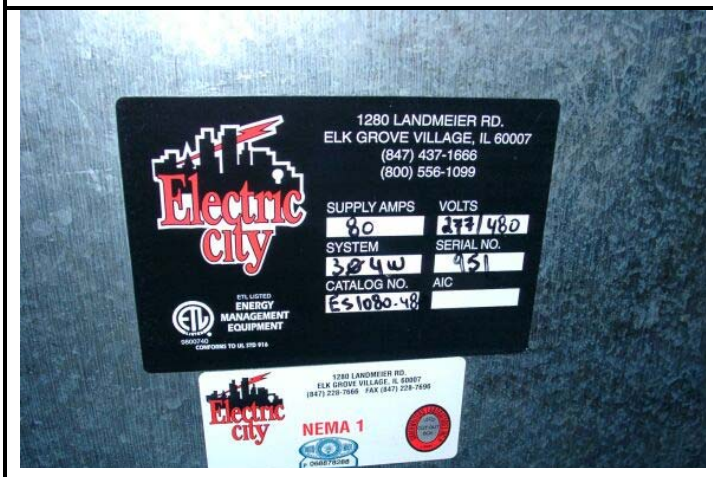

Unit 828




Nameplate for Unit 828

Meter for Unit 983


Unit 951




Nameplate for Unit 951

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSPU Pomona

## Energy Savings Summary

Two Energy Saver units were installed on the campus of the California State Polytechnic University at Pomona (CSPUP). One of the units was installed to control lights in the gymnasium. The second was installed to control outside lights in the rose garden.

The following table delineates the savings estimates for each Energy Saver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the Energy Saver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are presented below.

| CSPUP Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Lights Controlled | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| Pom-1 | 100 | Gymnasium | 49.920 | 43,461 |
| Pom-2 | 60 | Outside Rose Garden | 29,120 | 3,627 |
| **Total** | | **Pomona Campus** | **79,040** | **47,088** |

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak (summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSPUP Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| Pom-1 | 100 | 12.00 | 8.52 | 8.52 |
| Pom-2 | 60 | 7.00 | 0.84 | 0.00 |
| **Total** | | **19.00** | **9.36** | **8.52** |

The estimated annual energy savings, 47,088 kWh/yr, is 60% of the 79,040 kWh/yr reported in the CPUC project spreadsheet. The demand reduction estimates are less than half. Two factors contribute to the lower demand reductions. Unit #2 is a 208-volt unit, and the project spreadsheet calculations assumed a 480-volt unit. Connected loads were lower than assumed on both of the units. The operating hours of the gym offices were slightly higher than the operating hours assumed in the spreadsheet calculations (4160 or 4380 hours per year). This is why the measured energy savings is closer to the original estimate than the measured demand savings is.

Following are descriptions of each of the Energy Saver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## Pom-1. Gymnasium Room and Office Lights

This 277/480-volt 100-amp unit is located in Room 133 of the gym and controls room and office lights in the gym. The output of the Energy Saver unit feeds panel LB. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 232.9 volts. No problems with the equipment were noted.

The input power was 34.08 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 42.60 kW, indicating that the power reduction was 8.52 kW, or 20.0% of the original load. The system operated at a 99% power factor in reduced-voltage mode and near-unity power factor in full-voltage mode.

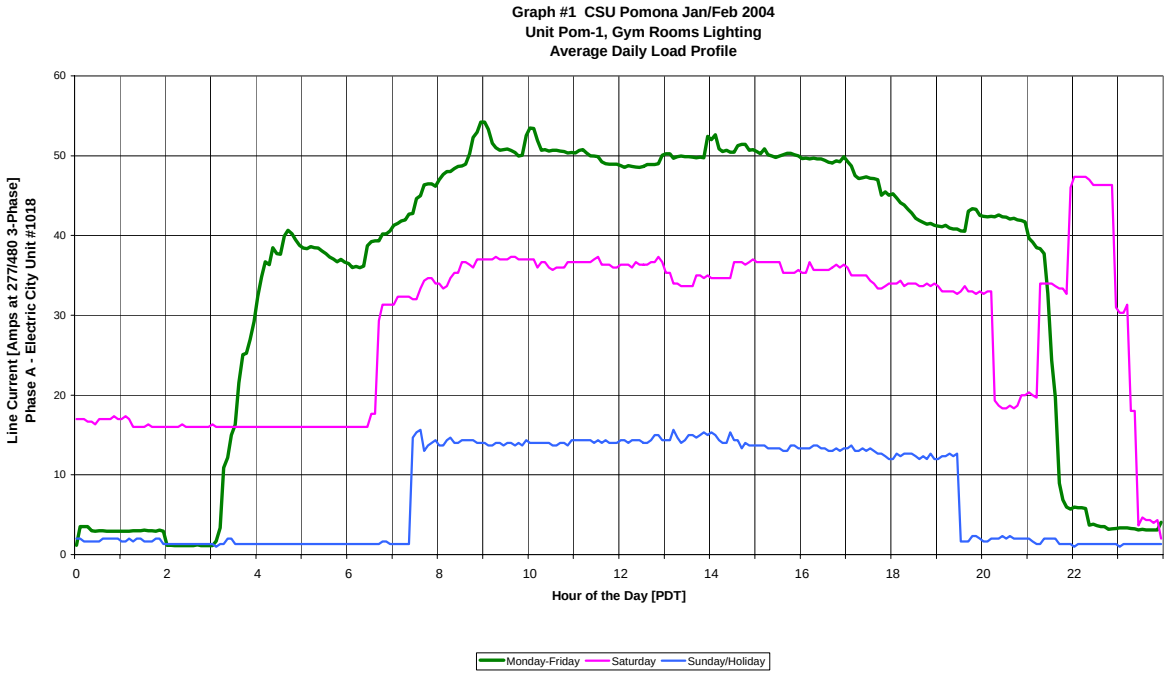
A datalogger was installed and recorded five-minute interval data from January 26 through February 18, 2004. The logger showed weekday lighting beginning early in the morning, rising later in the morning, and lasting until about 10:00 p.m. Saturday and Sunday use includes days with full lighting use and some days with no lighting use. There was one day when most of the lights were left on all night.

There was some variability in the light demand levels throughout the day because some office lights were individually controlled. The power readings were taken when almost all of the lights were on. The equivalent on/off operating time at this power level is 17.5 h/day on weekdays, 14.4 h/day on Saturdays, and 3.8 h/day on Sunday/holidays. The weeks monitored, however, include only times during academic quarters. The academic year includes a total of seven weeks between the four quarters. These lights are used on an as-needed basis, which will include break times, but to a lesser extent than during the academic quarters. We estimate that the usage during the weekdays of these seven weeks is represented by a profile somewhat between that recorded on Saturday and that recorded on Sunday. Based on a year represented by 216 "weekdays," 72 "Saturdays," and 77 "Sunday/holidays," we estimate annual operating hours to be 5,101.

The resultant energy savings achieved by this Energy Saver unit is 43,461 kWh per year (8.52 kW * 5101 h/yr). The connected load reduction is 8.52 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 87% of the 49,920 kWh/yr estimate on the CPUC spreadsheet. The equivalent operating hours of these lights is slightly higher than the 12 hour/day assumption in the original estimate, but the load reduction is only 71% of the originally assumed value.

The load profile of this Energy Saver is shown in the graph below.



## Pom-2. Outside Rose Garden

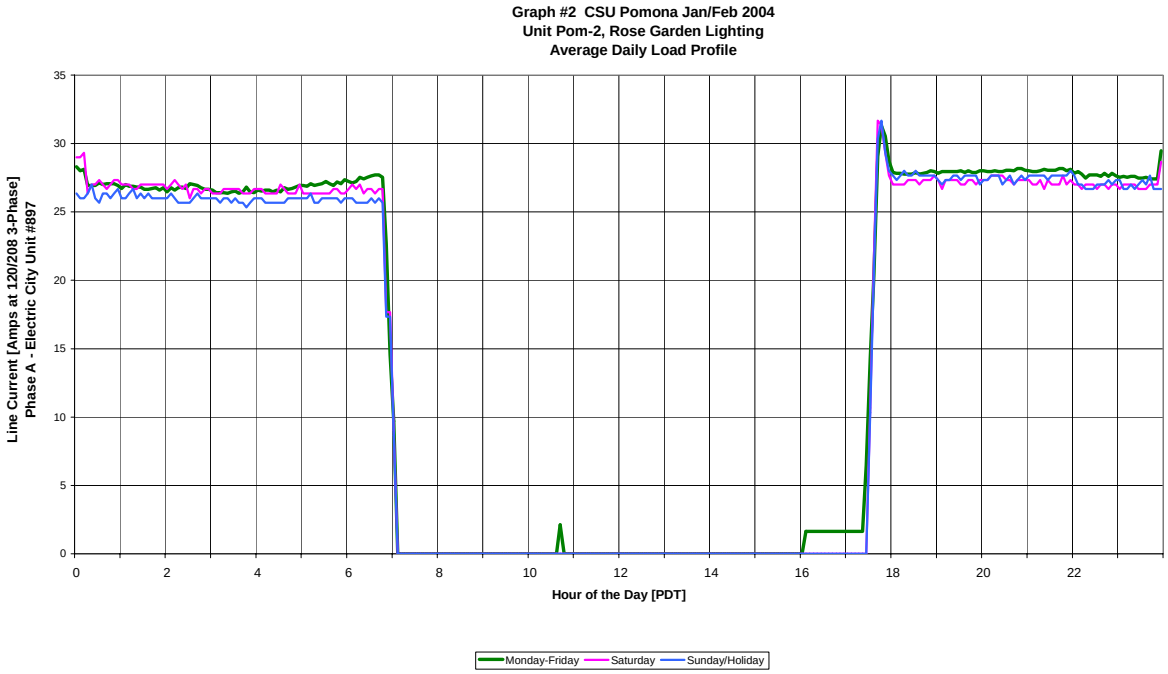
This 120/208-volt 60-amp unit is located in the rose garden and controls the HID lights in the garden. The output of the Energy Saver unit feeds panel 1L1A. The Energy Saver unit was set to reduce the voltage to the lights to 100 volts line-to-neutral. We recorded an average output voltage of 102.7 volts. No problems with the equipment were noted.

The input power was 7.05 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 7.89 kW, indicating that the power reduction was 0.84 kW, or 10.6% of the original load. They system operated at a 85% power factor in reduced-voltage mode and 92% power factor in full-voltage mode.

A datalogger was installed and recorded five-minute interval data from January 26 through February 18, 2004. The logger showed that the lights turn on at dusk and off at dawn. The actual off-time gets earlier and the on-time gets later as the year advances toward spring. These off and on times tracked very closely the official sunrise and sunset times for Pomona, with the lights shutting off a few minutes after sunrise and turning on a few minutes after sunset. Pomona has approximately 4,442 hours per year from sunrise to sunset, leaving 4,318 hours of "night." We use this value for the operating hours of the garden lights.

The resultant energy savings achieved by this Energy Saver unit is 3,627 kWh per year (0.84 kW * 4318 h/yr). The connected load reduction is 0.84 kW, and the summer on-peak demand reduction is zero because the lights will not be operating during the summer on-peak period. This value is very small compared to the 29,120 kWh/yr estimate on the CPUC spreadsheet. Although the operating hours were approximately the same as assumed, the load reduction was much lower. The load reduction is lower because this system is a 120-volt system and it is not fully loaded.

The load profile of this Energy Saver is shown in the graph on the following page.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *Pom-1 CSU Pomona*

| | | | |
|---|---|---|---|
| Location: | Gym 1 Electric Room 133 | Date Measured: | 1/26/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 100 amp / #1018 |
| Panel Fed By Energy Saver: | LB | Datalogger #: | **E-6** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 283.9 | 53.00 | 14.70 | 14.80 | 1.65 | 0.99 |
| B | 284.8 | 36.43 | 10.30 | 10.40 | 1.35 | 0.99 |
| C | 284.6 | 32.14 | 9.08 | 9.14 | 1.00 | 0.99 |
| TOT/AVG | 284.43 | 40.52 | 34.08 | 34.34 | 4.00 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 232.3 | 61.90 | 14.30 | 14.40 | 1.70 | 0.99 |
| B | 233.3 | 44.35 | 10.30 | 10.40 | 1.27 | 0.99 |
| C | 233.2 | 38.56 | 8.96 | 9.03 | 1.04 | 0.99 |
| TOT/AVG | 232.93 | 48.27 | 33.56 | 33.83 | 4.01 | 0.99 |

**Description of Lights Controlled:**

230V Set Point

Room Lights in gym building

## CSU Chancellor's Office

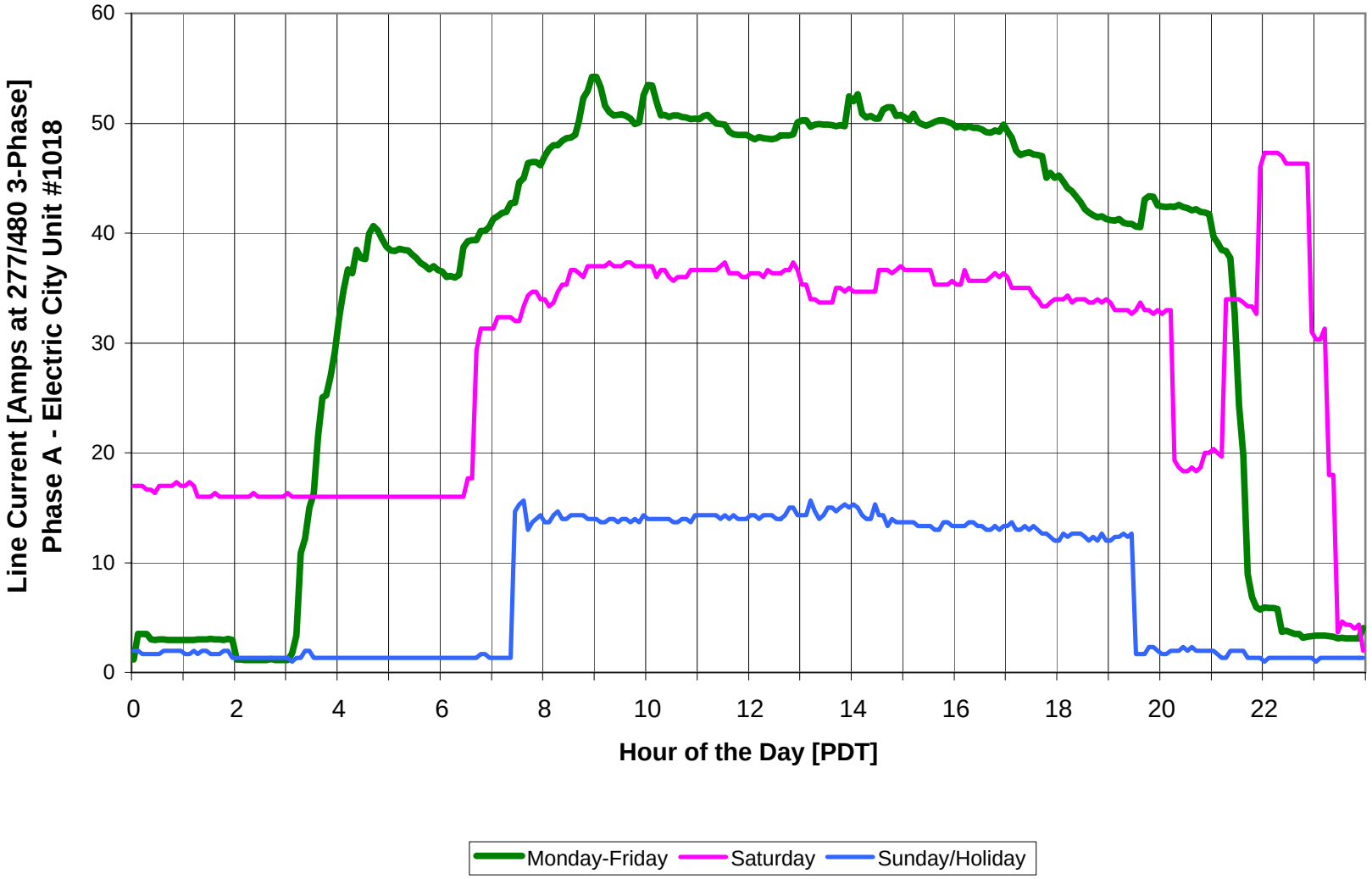
## *Pom-1 CSU Pomona*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 285.0 | 65.00 | 18.40 | 18.50 | 1.90 | 1.00 |
| B | 285.3 | 45.13 | 12.80 | 12.90 | 1.51 | 0.99 |
| C | 285.2 | 40.10 | 11.40 | 11.40 | 1.12 | 1.00 |
| TOT/AVG | 285.17 | 50.08 | 42.60 | 42.80 | 4.53 | 1.00 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.7 | 65.70 | 18.10 | 18.20 | 1.90 | 1.00 |
| B | 275.0 | 46.08 | 12.60 | 12.70 | 1.44 | 0.99 |
| C | 278.7 | 40.74 | 11.30 | 11.30 | 1.18 | 1.00 |
| TOT/AVG | 276.80 | 50.84 | 42.00 | 42.20 | 4.52 | 1.00 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 284.4 | 40.52 | 34.08 | 34.34 | 4.00 | 0.99 |
| **Reduce Output** | 232.9 | 48.27 | 33.56 | 33.83 | 4.01 | 0.99 |
| **Full Input** | 285.2 | 50.08 | 42.60 | 42.80 | 4.53 | 1.00 |
| **Full Output** | 276.8 | 50.84 | 42.00 | 42.20 | 4.52 | 1.00 |
| **Power Savings** | | | **8.52** | | | |
| **Power % Savings** | | | **20.00%** | | | |

**Graph #1 CSU Pomona Jan/Feb 2004**
**Unit Pom-1, Gym Rooms Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *Pom-2 CSU Pomona*

| | | | |
|---|---|---|---|
| Location: | Rose Garden - External Area | Date Measured: | 1/26/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60 amp / #897 |
| Panel Fed By Energy Saver: | 1L1A | Datalogger #: | **M-12** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 121.5 | 26.15 | 2.67 | 3.18 | 1.71 | 0.84 |
| B | 122.1 | 23.02 | 2.40 | 2.80 | 1.45 | 0.86 |
| C | 121.3 | 19.00 | 1.98 | 2.30 | 1.18 | 0.86 |
| TOT/AVG | 121.63 | 22.72 | 7.05 | 8.28 | 4.34 | 0.85 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 102.8 | 30.91 | 2.64 | 3.17 | 1.77 | 0.83 |
| B | 102.2 | 27.17 | 2.35 | 2.77 | 1.48 | 0.85 |
| C | 103.0 | 22.18 | 1.96 | 2.26 | 1.12 | 0.87 |
| TOT/AVG | 102.67 | 26.75 | 6.95 | 8.20 | 4.37 | 0.85 |

**Description of Lights Controlled:**

100V Set Point

14.7% Savings from meter

## CSU Chancellor's Office

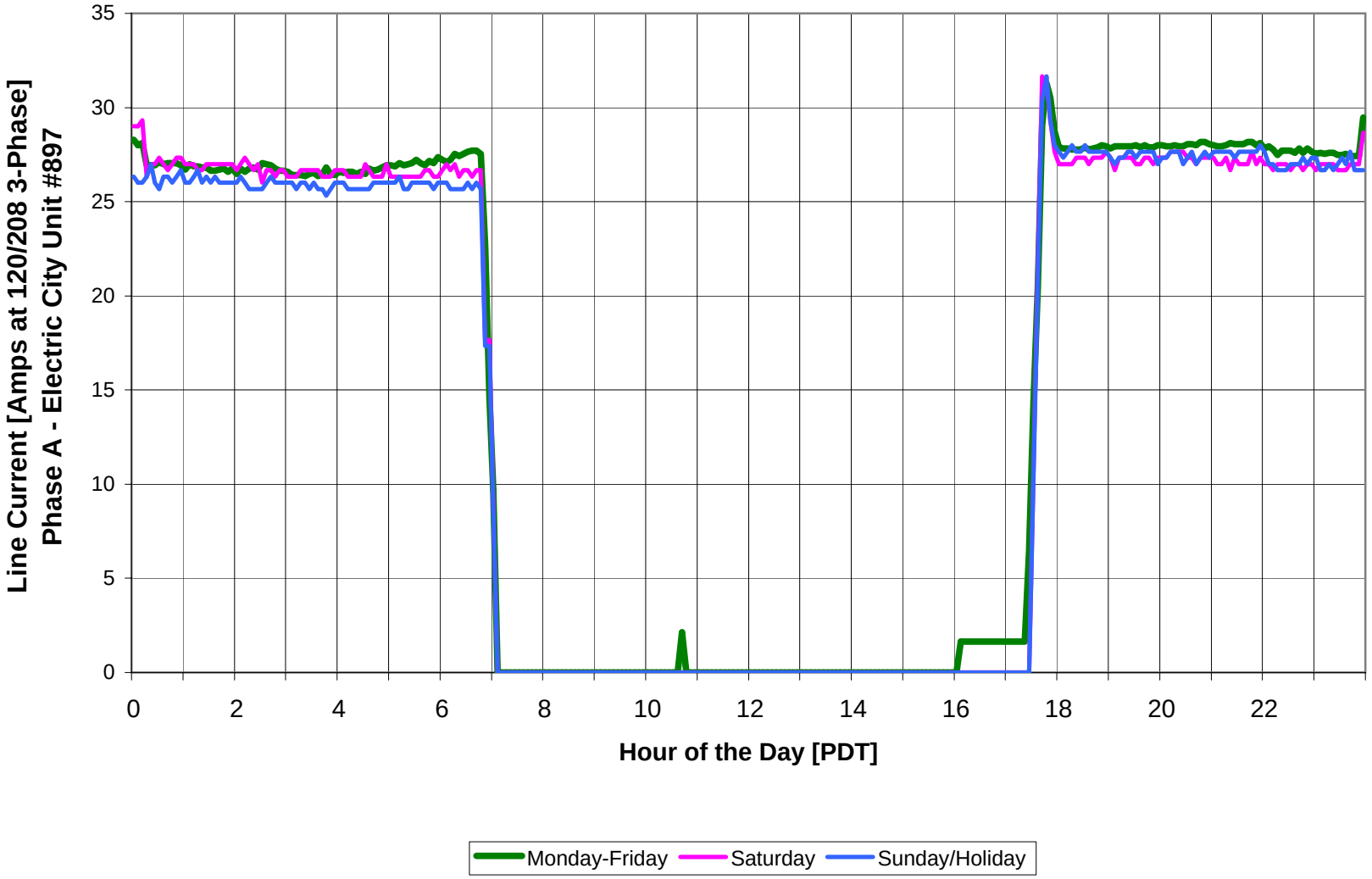
## *Pom-2 CSU Pomona*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 121.0 | 21.57 | 2.45 | 2.61 | 0.90 | 0.94 |
| B | 121.1 | 27.55 | 2.97 | 3.33 | 1.51 | 0.89 |
| C | 120.3 | 22.17 | 2.47 | 2.67 | 1.01 | 0.93 |
| TOT/AVG | 120.80 | 23.76 | 7.89 | 8.61 | 3.42 | 0.92 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 115.9 | 22.31 | 2.44 | 2.60 | 0.91 | 0.94 |
| B | 116.3 | 28.51 | 2.95 | 3.31 | 1.48 | 0.89 |
| C | 116.8 | 22.53 | 2.45 | 2.66 | 1.04 | 0.92 |
| TOT/AVG | 116.33 | 24.45 | 7.84 | 8.57 | 3.43 | 0.92 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 121.6 | 22.72 | 7.05 | 8.28 | 4.34 | 0.85 |
| **Reduce Output** | 102.7 | 26.75 | 6.95 | 8.20 | 4.37 | 0.85 |
| **Full Input** | 120.8 | 23.76 | 7.89 | 8.61 | 3.42 | 0.92 |
| **Full Output** | 116.3 | 24.45 | 7.84 | 8.57 | 3.43 | 0.92 |
| **Power Savings** | | | **0.84** | | | |
| **Power % Savings** | | | **10.65%** | | | |

**Graph #2 CSU Pomona Jan/Feb 2004**
**Unit Pom-2, Rose Garden Lighting**
**Average Daily Load Profile**



# *CSU Pomona*
# *Energy Saver Units*


Gym Unit 1018


Nameplate for Unit 1018

Rose Garden Unit 897


Nameplate for Unit 897

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSU San Bernardino

## Energy Savings Summary

Six Energy Saver units were installed on the campus of the California State University at San Bernardino (CSUSB). Five of the units were installed to control lights in the library. The sixth was installed in the gymnasium.

The following table delineates the savings estimates for each Energy Saver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the Energy Saver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are presented below.

| CSUSB Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Lights Controlled | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| SB-1 | 60 | Library Floors 2-3 | 29,120 | 30,406 |
| SB-2 | 60 | Library Floors 2-3 | 29,120 | 29,864 |
| SB-3 | 60 | Library Floors 4-5 | 29,120 | 40,705 |
| SB-4 | 40 | Library Downstairs Offices | 24,638 | 14,071 |
| SD-5 | 40 | Library Downstairs Offices | 24,638 | 17,344 |
| SB-6 | 40 | Gym Floor | 24,638 | 15,673 |
| **Total** | | **San Bernardino Campus** | **161,274** | **148,063** |

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak (summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSUSB Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| SB-1 | 60 | 7.000 | 6.29 | 6.29 |
| SB-2 | 60 | 7.000 | 5.85 | 5.85 |
| SB-3 | 60 | 7.000 | 7.67 | 7.67 |
| SB-4 | 40 | 5.625 | 2.94 | 2.94 |
| SD-5 | 40 | 5.625 | 3.02 | 3.02 |
| SB-6 | 40 | 5.625 | 3.44 | 3.44 |
| **Total** | | **37.875** | **29.21** | **29.21** |

The estimated annual energy savings, 148,063 kWh/yr, is 8% less than the 161,274 kWh/yr reported in the CPUC project spreadsheet. The demand reduction estimates, however, are 22% less. This is because of two factors with competing effects on savings. The lights in the library tended to operate slightly longer than the operating hours assumed in the spreadsheet calculations (4160 or 4380 hours per year). On the other hand, the spreadsheet calculations assumed each Energy Saver system was loaded at a higher portion of its rated load than these units in fact were. Although the demand (and therefore the demand reduction) is lower, the somewhat extended operating hours produced additional energy savings.

Following are descriptions of each of the Energy Saver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## SB-1. Library Main Area, Floors 2-3

This 277/480-volt 60-amp unit is located in Room 314 of the library and controls lights in the main library area on the 2nd and 3rd floors. The output of the Energy Saver unit feeds panels L2A and L3A. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 232.2 volts. No problems with the equipment were noted. At the time of our initial visit, power readings, and meter installation, the library was in the process of a comprehensive re-

lamping project in which burned out lamps were being replaced by campus maintenance personnel.

The input power was 16.26 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 20.60 kW, indicating that the power reduction was 4.34 kW, or 21.1% of the original load. The system operated at a 99% power factor in reduced-voltage mode and 98% power factor in full-voltage mode.

A datalogger was installed and recorded five-minute interval data from January 21 through February 17, 2004. The logger showed lighting use profiles that were coordinated with library operating hours. Highest use was from 7:00 a.m. until 5:00 p.m. on weekdays, but significant use was also recorded from 3:00 a.m. until 11:00 p.m. weekdays as well as Saturday during the day and Sunday during the afternoon and evening. The drop in demand on weekdays at 5:00 is actually caused by the library shutting down completely each Friday at 5:00. During Monday through Thursday, full lighting continues until 11:00 p.m. A small load representing continuously operating emergency lights was also recorded.

The datalogger also demonstrates that once the re-lamping project was completed, the full lighting load was 145% of the load that was actually on at the time the power readings were taken. The power reduction of the unit when the lights are all on is therefore 6.29 kW.

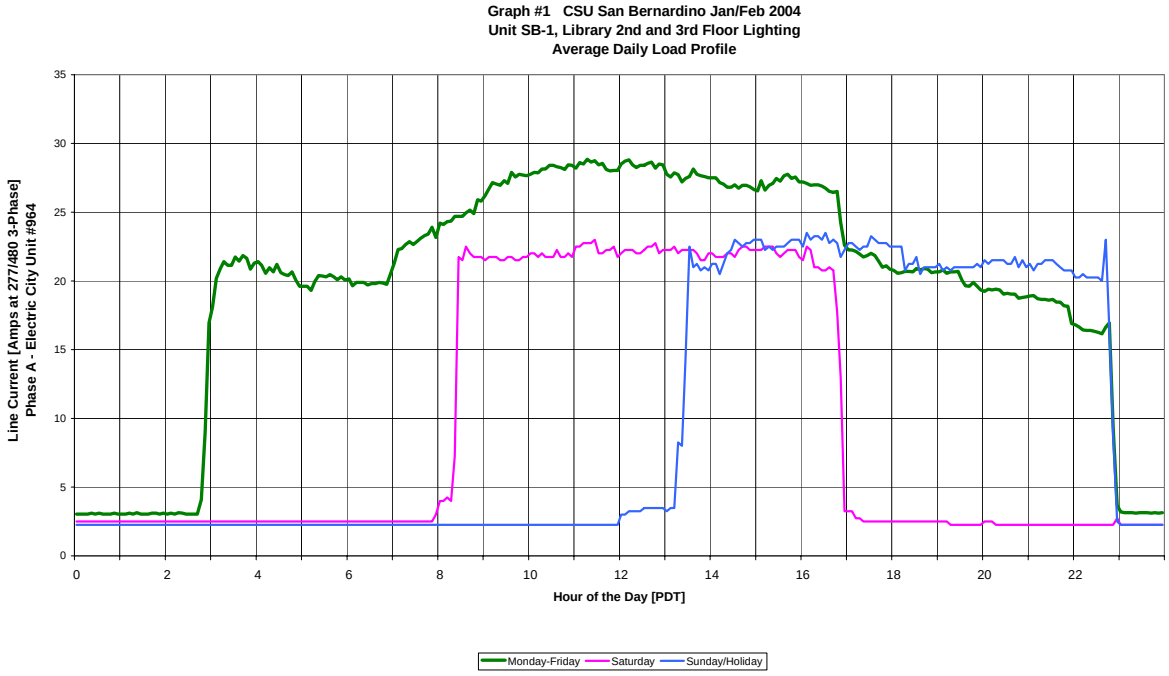
The load profile indicates an equivalent full-load operating time of 15.8 h/day on weekdays, 7.4 h/day on Saturdays, and 7.9 h/day on Sunday/holidays, resulting in an equivalent 4,834 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 30,406 kWh per year (6.29 kW * 4834 h/yr). The connected load reduction is 6.29 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is very close to the 29,120 kWh/yr estimate on the CPUC spreadsheet. Both the equivalent operating hours and the load reduction were similar to those assumed on the spreadsheet.

The school operates 12 months per year. The library does operate on a slightly altered schedule during finals week, when it runs longer hours, and during break periods, when it has shortened hours. These changes tend to counteract each other. Additionally, the library staff does not necessarily keep changed hours. Furthermore, the lower lighting operation observed prior to re-lamping during the first week of our monitoring was incorporated in the calculation of full-load-equivalent operating hours used to calculate the savings, which will also compensate for lower use during break times. The minor scheduling changes are not determined to produce annual hours significantly different from those extrapolated from our four-week monitoring period.

The load profile of this Energy Saver is shown in the graph below.




## SB-2. Library Main Area, Floors 2-3

This 277/480-volt 60-amp unit is located in Room 317 of the library and controls lights in the main library area on the 2nd and 3rd floors. The output of the Energy Saver unit feeds panels L2B and L3B. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 229.2 volts. No problems with the equipment were noted. At the time of our initial visit, power readings, and meter installation, the library was in the process of a comprehensive re-lamping project in which burned out lamps were being replaced by campus maintenance personnel.

The input power was 17.67 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 22.84 kW, indicating that the power reduction was 4.87 kW, or 21.7% of the original load. They system operated at a 98% power factor in both reduced-voltage and full-voltage mode.

A datalogger was installed and recorded five-minute interval data from January 21 through February 17, 2004. The logger showed lighting use profiles that were coordinated with library operating hours. Highest use was from noon to 3:00 p.m. on weekdays, but generally the lights were used from 3:00 a.m. until 11:00 p.m. weekdays as well as Saturday during the day and Sunday during the afternoon and evening. The drop in demand on weekdays at 5:00 is actually caused by the library shutting down completely each Friday at 5:00. During Monday through Thursday, full lighting continues until 11:00 p.m. A small load representing continuously operating emergency lights was also recorded.

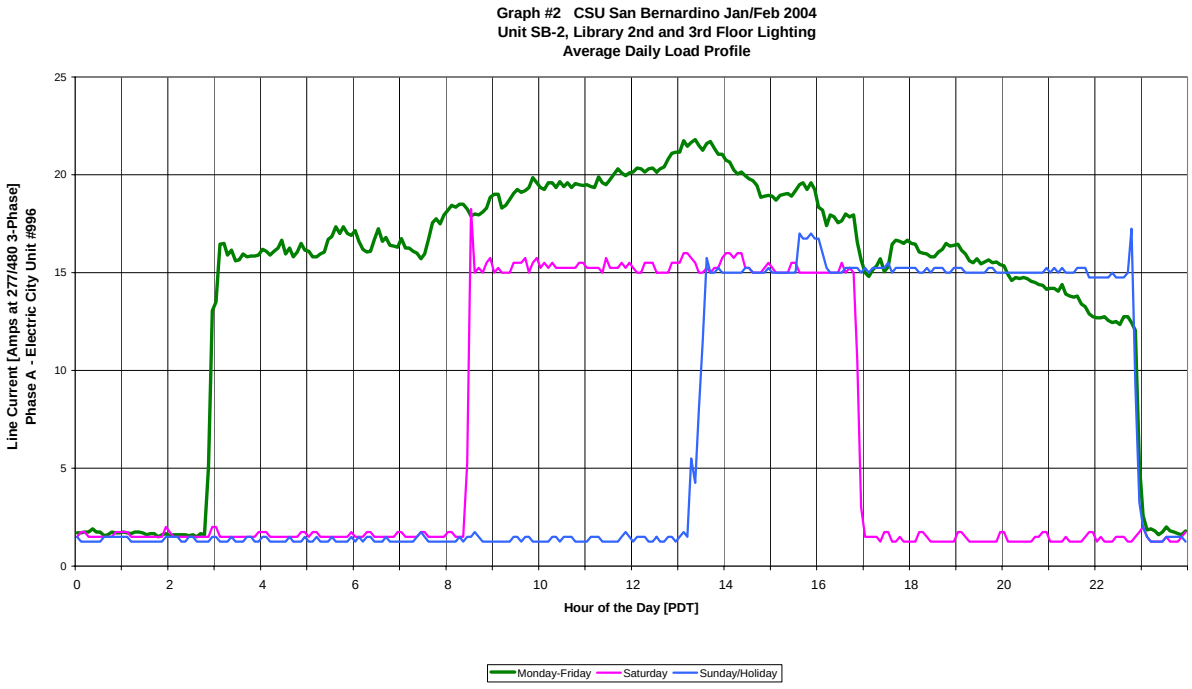
The datalogger also demonstrates that once the re-lamping project was completed, the full lighting load was 120% of the load that was actually on at the time the power readings were taken. The power reduction of the unit when the lights are all on is therefore 5.85 kW.

The load profile indicates an equivalent full-load operating time of 16.9 h/day on weekdays, 7.8 h/day on Saturdays, and 7.9 h/day on Sunday/holidays, resulting in an equivalent 5,105 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. This is roughly the same as the equivalent full-load operating time of SB-1 (4,834 h/yr), which is on the same floors of the library, but controls a slightly different mix of individual areas. The effects of the library's annual schedule were discussed in the section on Unit SB-1 above.

The resultant energy savings achieved by this Energy Saver unit is 29,864 kWh per year (5.85 kW * 5105 h/yr). The connected load reduction is 5.85 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is very close to the 29,120 kWh/yr estimate on the CPUC spreadsheet. Both the equivalent operating hours and the load reduction were similar to those assumed on the spreadsheet.

The load profile of this Energy Saver is shown in the graph below.



## SB-3. Library Main Area, Floors 4-5

This 277/480-volt 60-amp unit is located in Room 517 of the library and controls lights in the main library area on the 4th and 5th floors. It also controls the lights in rooms 500 to 524. The output of the Energy Saver unit feeds panels L4B and L5B. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 229.1 volts. No problems with the equipment were noted.

The input power was 27.67 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 35.34 kW, indicating that the power reduction was 7.67 kW, or 21.7% of the original load. The system operated at a 99% power factor in both reduced-voltage and full-voltage mode.

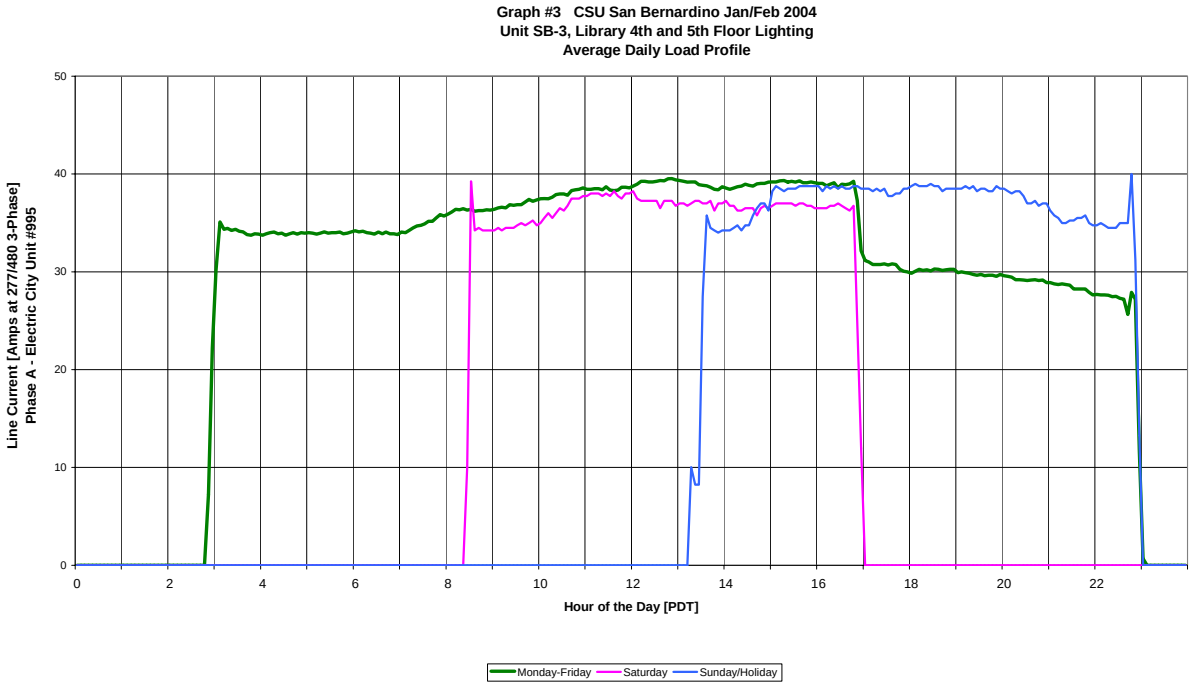
A datalogger was installed and recorded five-minute interval data from January 21 through February 17, 2004. The logger showed lighting use profiles that were coordinated with library operating hours. The lights operated from 3:00 a.m. until 11:00 p.m. weekdays except Fridays when they shut off at 4:50 p.m. They also operated Saturday during the day and Sunday during the afternoon and evening. The drop in demand on weekdays about 5:00 is actually caused by the library shutting down completely each Friday.

The load profile indicates an equivalent full-load operating time of 17.4 h/day on weekdays, 7.8 h/day on Saturdays, and 8.4 h/day on Sunday/holidays, resulting in an equivalent 5,307 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. This is roughly the same as the equivalent full-load operating time of SB-1 (4,834 h/yr) and SB-2 (5,105 h/yr) on the second and third floors. The effective hours are slightly longer on these floors because there is less partial operation of the lighting system. The effects of the library's annual schedule were discussed in the section on Unit SB-1 above.

The resultant energy savings achieved by this Energy Saver unit is 40,705 kWh per year (7.67 kW * 5307 h/yr). The connected load reduction is 7.67 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is higher than the 29,120 kWh/yr estimate on the CPUC spreadsheet. Both the equivalent operating hours and the load reduction were higher than those assumed on the spreadsheet.

The load profile of this Energy Saver is shown in the graph below.




## SB-4. Library First Floor Office Area

This 277/480-volt 40-amp unit is located in Room M2 of the library and controls lights in the first floor office areas of the library. The output of the Energy Saver unit feeds panel L1B. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 231.0 volts. No problems with the equipment were noted.

The input power was 11.72 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 14.66 kW, indicating that the power reduction was 2.94 kW, or 20.0% of the original load. The system operated at a 99% power factor in both reduced-voltage and full-voltage mode.

A datalogger was installed and recorded five-minute interval data from January 21 through February 17, 2004. The logger showed lighting use profiles that were coordinated with library operating hours and very similar to the profiles of the other systems in the library.

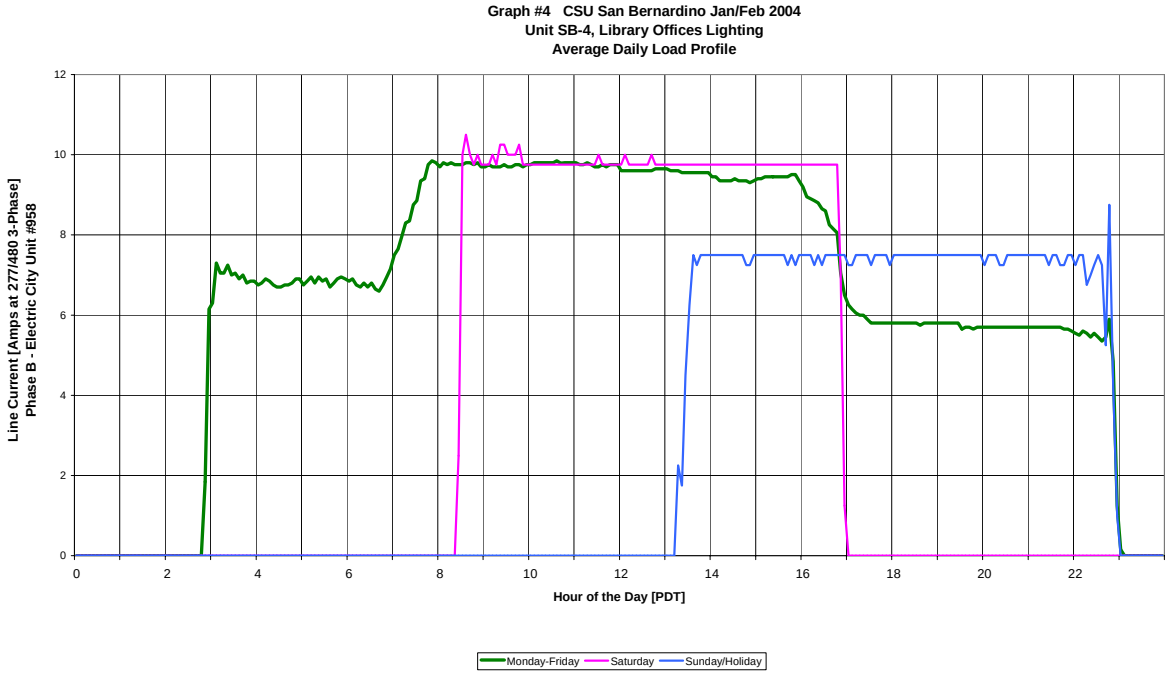
The load profile indicates an equivalent full-load operating time of 15.6 h/day on weekdays, 8.2 h/day on Saturdays, and 7.0 h/day on Sunday/holidays, resulting in an equivalent 4,786 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. This is slightly less than the equivalent hours on the main library floors because of occasional partial use of the office lights.

The resultant energy savings achieved by this Energy Saver unit is 14,071 kWh per year (2.94 kW * 4786 h/yr). The connected load reduction is 2.94 kW, and the

summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is only 72% of the 19,413 kWh/yr estimate on the CPUC spreadsheet because the connected load was less than that assumed on the spreadsheet.

The load profile of this Energy Saver is shown in the graph below.




## SB-5. Library First Floor Office Area

This 277/480-volt 40-amp unit is located in Room M3 of the library and controls lights in the first floor office areas of the library. The output of the Energy Saver unit feeds panel L1A. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 227.6 volts. No problems with the equipment were noted.

The input power was 11.82 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 14.84 kW, indicating that the power reduction was 3.02 kW, or 20.4% of the original load. The system operated at a 99% power factor in both reduced-voltage and full-voltage mode.

A datalogger was installed and recorded five-minute interval data from January 21 through February 17, 2004. The logger showed lighting use profiles that were coordinated with library operating hours and very similar to the profiles of the other systems in the library.

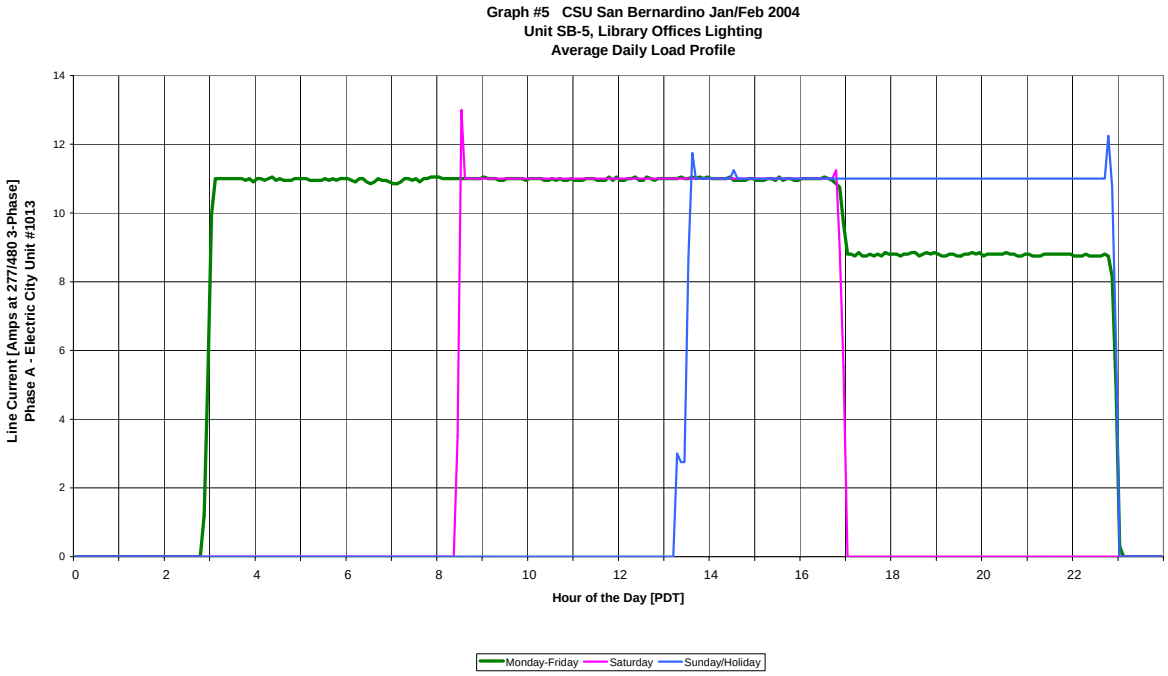
The load profile indicates an equivalent full-load operating time of 18.8 h/day on weekdays, 8.5 h/day on Saturdays, and 9.5 h/day on Sunday/holidays, resulting in an equivalent 5,743 hours per year. If the lights ran this amount of time at the full capacity

and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 17,344 kWh per year (3.02 kW * 5743 h/yr). The connected load reduction is 3.02 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 89% of the 19,413 kWh/yr estimate on the CPUC spreadsheet. The connected load was less than that assumed on the spreadsheet but the operating hours were also longer than those assume.

The load profile of this Energy Saver is shown in the graph below.




## SB-6. Gym Floor

This 277/480-volt 40-amp unit is located in the electrical room of the gym and controls lights on the gym floor. It feeds the HA contactors. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. We recorded an average output voltage of 231.3 volts. No problems with the equipment were noted.

The input power was 15.02 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 18.46 kW, indicating that the power reduction was 3.44 kW, or 18.6% of the original load. The system operated at a 99% power factor in both reduced-voltage and full-voltage mode.

A datalogger was installed and recorded five-minute interval data from January 21 through February 17, 2004. The data demonstrate that the gym was typically lighted

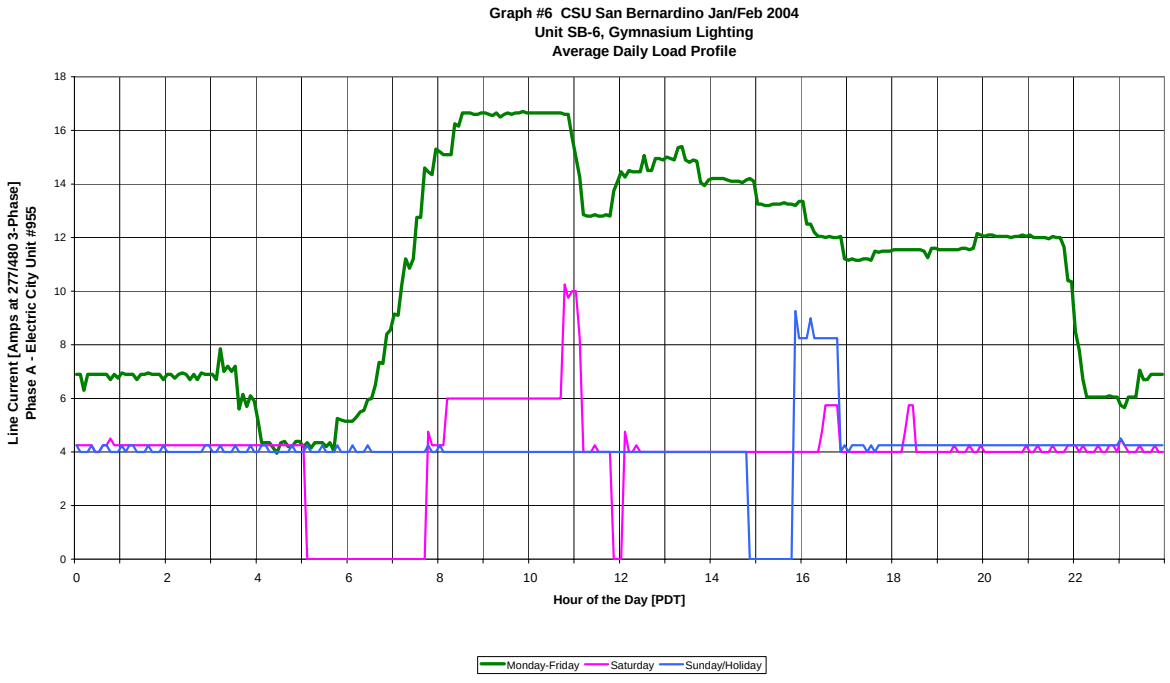
from about 7:00 a.m. until 10:00 p.m. A portion of the lights were often, but not always, left on all night. The lights were used some Saturdays and some Sundays, but not always. Usually weekend use involved full lighting, but partial lighting was occasionally observed. We believe that the lighting patterns observed during the monitoring period are typical of the school year.

The load profile indicates an equivalent full-load operating time of 15.5 h/day on weekdays, 5.7 h/day on Saturdays, and 5.9 h/day on Sunday/holidays, resulting in an equivalent 4,556 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 15,673 kWh per year (3.44 kW * 4556 h/yr). The connected load reduction is 3.44 kW, and the summer on-peak demand reduction is the same because the lights will most likely be fully operating during the summer on-peak period.

This value is 81% of the 19,413 kWh/yr estimate on the CPUC spreadsheet. The connected load was less than that assumed on the spreadsheet while the operating hours were also longer than those assume.

The load profile of this Energy Saver is shown in the graph below.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *SB-1 CSU San Bernardino*

| | | | |
|---|---|---|---|
| Location: | Library, Room 314 | Date Measured: | 1/20/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60 amp / #964 |
| Panel Fed By Energy Saver: | Panels L2A, L3A | Datalogger #: | **V-8** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 275.4 | 23.26 | 6.31 | 6.41 | 1.12 | 0.99 |
| B | 276.0 | 18.95 | 5.14 | 5.23 | 0.99 | 0.98 |
| C | 277.0 | 17.65 | 4.81 | 4.89 | 0.84 | 0.99 |
| TOT/AVG | 276.13 | 19.95 | 16.26 | 16.53 | 2.95 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 233.6 | 27.84 | 6.42 | 6.51 | 1.11 | 0.99 |
| B | 231.2 | 22.67 | 5.11 | 5.24 | 1.14 | 0.98 |
| C | 231.7 | 20.31 | 4.62 | 4.70 | 0.87 | 0.98 |
| TOT/AVG | 232.17 | 23.61 | 16.15 | 16.45 | 3.12 | 0.98 |

**Description of Lights Controlled:**

Controls the 2nd and 3rd floor library lights.

Energy Saver set for 230 volts  Claim 28.7% savings

**UNIT WAS NOT IN BYPASS DURING THE SITE VISIT**

## CSU Chancellor's Office

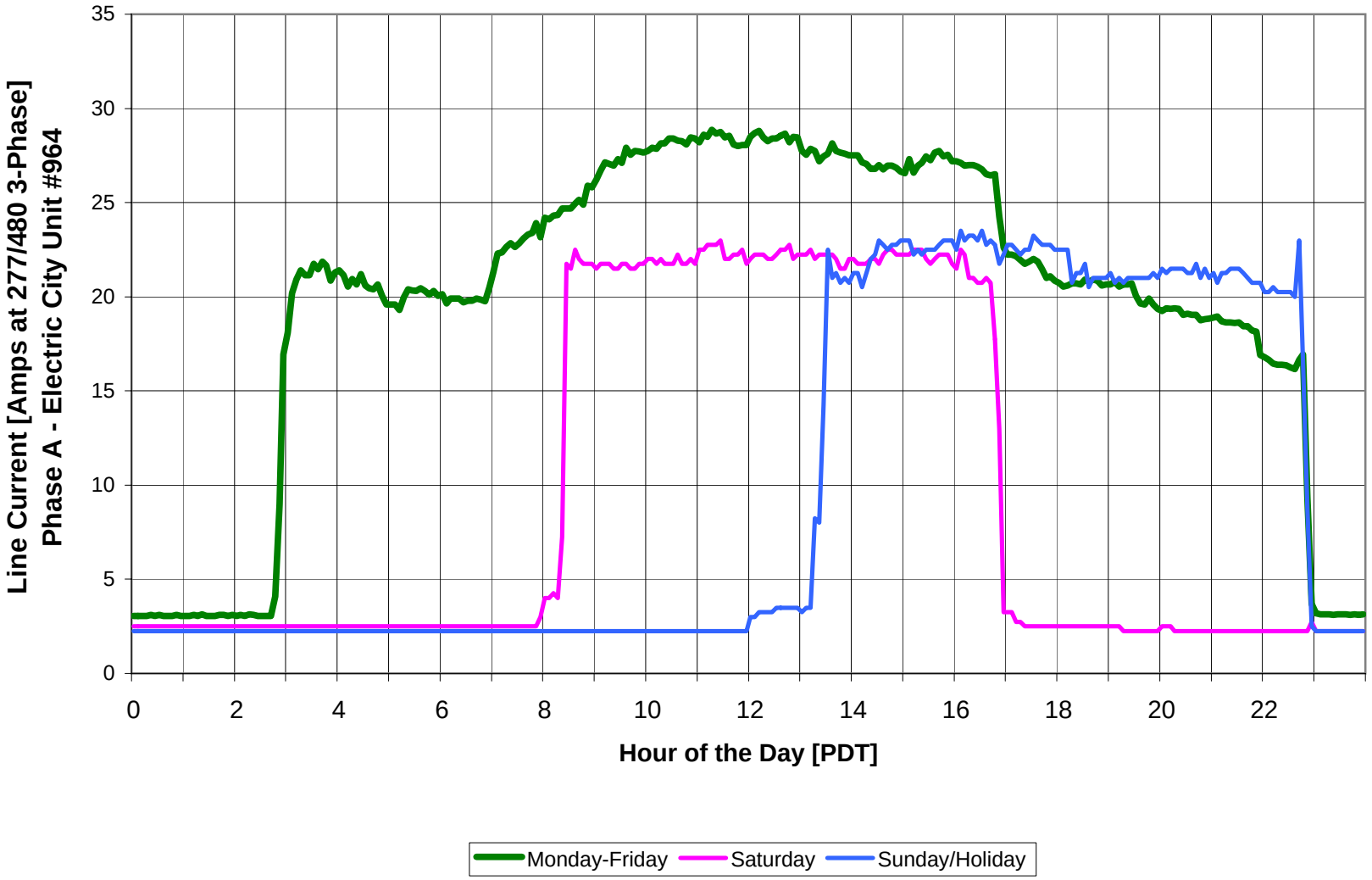
## *SB-1 CSU San Bernardino*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.6 | 29.80 | 8.06 | 8.24 | 1.71 | 0.98 |
| B | 277.4 | 24.05 | 6.57 | 6.67 | 1.17 | 0.98 |
| C | 278.1 | 21.99 | 5.97 | 6.10 | 1.22 | 0.98 |
| TOT/AVG | 277.37 | 25.28 | 20.60 | 21.01 | 4.10 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 278.0 | 29.46 | 8.05 | 8.26 | 1.81 | 0.98 |
| B | 277.8 | 23.68 | 6.48 | 6.58 | 1.14 | 0.99 |
| C | 279.6 | 21.79 | 5.97 | 6.08 | 1.15 | 0.98 |
| TOT/AVG | 278.47 | 24.98 | 20.50 | 20.92 | 4.10 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 276.1 | 19.95 | 16.26 | 16.53 | 2.95 | 0.99 |
| **Reduce Output** | 232.2 | 23.61 | 16.15 | 16.45 | 3.12 | 0.98 |
| **Full Input** | 277.4 | 25.28 | 20.60 | 21.01 | 4.10 | 0.98 |
| **Full Output** | 278.5 | 24.98 | 20.50 | 20.92 | 4.10 | 0.98 |
| **Power Savings** | | | **4.34** | | | |
| **Power % Savings** | | | **21.07%** | | | |

**Graph #1 CSU San Bernardino Jan/Feb 2004**
**Unit SB-1, Library 2nd and 3rd Floor Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SB-2 CSU San Bernardino*

| | | | |
|---|---|---|---|
| Location: | Library, Room 317 | Date Measured: | 1/20/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60 amp / #996 |
| Panel Fed By Energy Saver: | L2B, L3B | Datalogger #: | **M-11** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 273.6 | 21.36 | 5.74 | 5.85 | 1.14 | 0.98 |
| B | 274.4 | 23.73 | 6.38 | 6.51 | 1.31 | 0.98 |
| C | 275.5 | 19.99 | 5.44 | 5.51 | 0.90 | 0.99 |
| TOT/AVG | 274.50 | 21.69 | 17.56 | 17.87 | 3.35 | 0.98 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 230.4 | 25.67 | 5.82 | 5.92 | 1.06 | 0.98 |
| B | 228.2 | 29.26 | 6.53 | 6.69 | 1.44 | 0.98 |
| C | 228.9 | 23.63 | 5.32 | 5.41 | 0.96 | 0.98 |
| TOT/AVG | 229.17 | 26.19 | 17.67 | 18.02 | 3.46 | 0.98 |

**Description of Lights Controlled:**

2nd and 3rd floor lights. Set Point of the Energy Saver Unit was 230-Volts

Claims 24% savings 38 Footcandles to 44 footcandles after switched to full power

**UNIT WAS NOT IN BYPASS DURING THE SITE VISIT**

## CSU Chancellor's Office

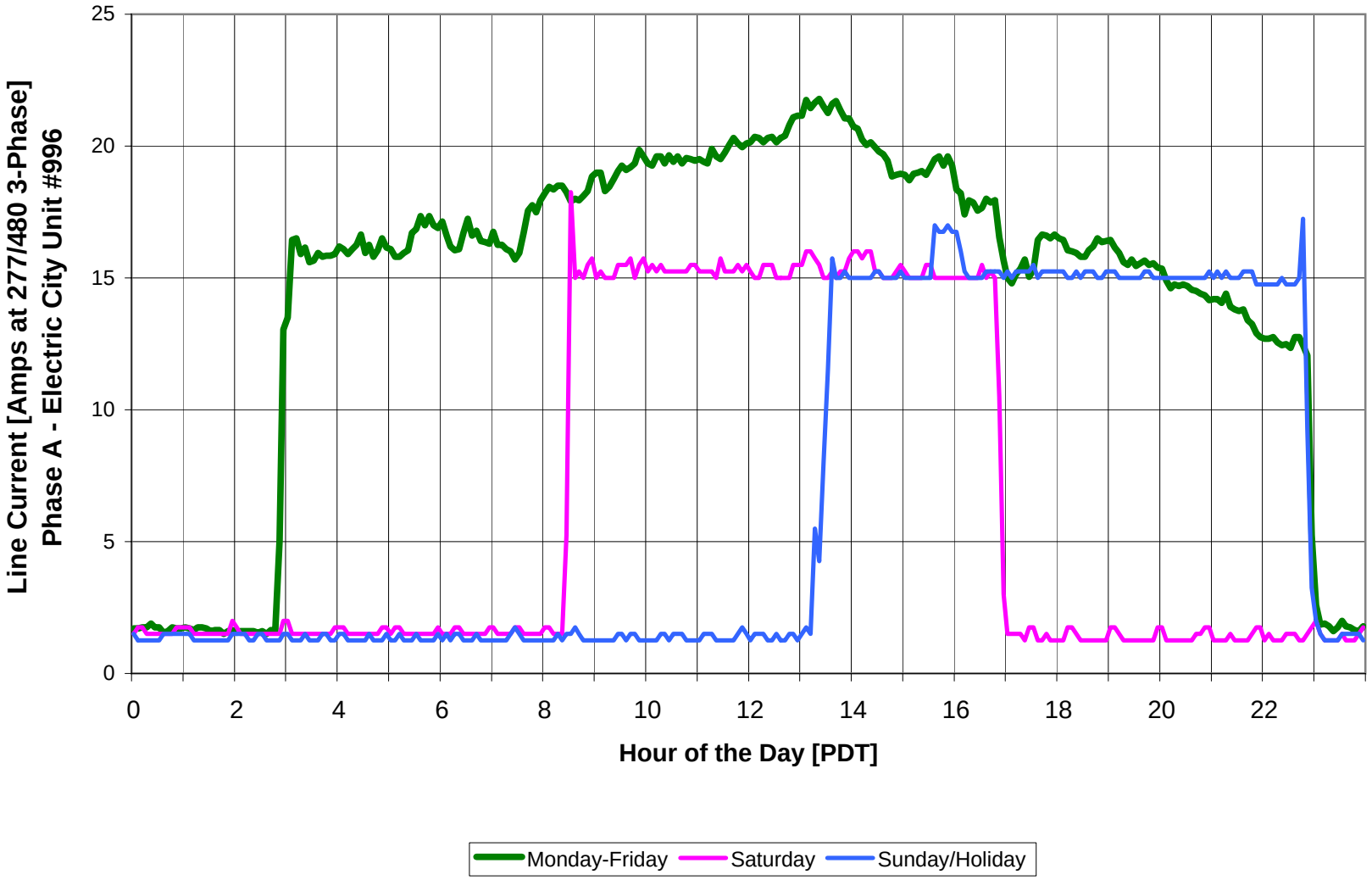
## *SB-2 CSU San Bernardino*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.8 | 26.91 | 7.24 | 7.36 | 1.30 | 0.98 |
| B | 274.3 | 31.00 | 8.37 | 8.49 | 1.44 | 0.99 |
| C | 275.3 | 25.31 | 6.82 | 6.97 | 1.47 | 0.98 |
| TOT/AVG | 274.47 | 27.74 | 22.43 | 22.82 | 4.21 | 0.98 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.6 | 27.20 | 7.43 | 7.56 | 1.43 | 0.98 |
| B | 277.9 | 31.54 | 8.63 | 8.76 | 1.51 | 0.99 |
| C | 276.7 | 25.06 | 6.78 | 6.94 | 1.49 | 0.98 |
| TOT/AVG | 277.40 | 27.93 | 22.84 | 23.26 | 4.43 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 274.5 | 21.69 | 17.56 | 17.87 | 3.35 | 0.98 |
| **Reduce Output** | 229.2 | 26.19 | 17.67 | 18.02 | 3.46 | 0.98 |
| **Full Input** | 274.5 | 27.74 | 22.43 | 22.82 | 4.21 | 0.98 |
| **Full Output** | 277.4 | 27.93 | 22.84 | 23.26 | 4.43 | 0.98 |
| **Power Savings** | | | **4.87** | | | |
| **Power % Savings** | | | **21.71%** | | | |

**Graph #2 CSU San Bernardino Jan/Feb 2004**
**Unit SB-2, Library 2nd and 3rd Floor Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SB-3 CSU San Bernardino*

| | | | |
|---|---|---|---|
| Location: | Library, Room 517 | Date Measured: | 1/20/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 60 amp / #995 |
| Panel Fed By Energy Saver: | Panel L4B, L5B | Datalogger #: | **M-18** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 274.2 | 41.70 | 11.30 | 11.40 | 1.76 | 0.99 |
| B | 275.3 | 33.21 | 9.02 | 9.14 | 1.49 | 0.99 |
| C | 275.8 | 26.98 | 7.35 | 7.45 | 1.22 | 0.99 |
| TOT/AVG | 275.10 | 33.96 | 27.67 | 27.99 | 4.47 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 229.4 | 50.18 | 11.40 | 11.50 | 1.65 | 0.99 |
| B | 228.3 | 40.07 | 9.03 | 9.17 | 1.66 | 0.98 |
| C | 229.5 | 31.85 | 7.20 | 7.31 | 1.26 | 0.99 |
| TOT/AVG | 229.07 | 40.70 | 27.63 | 27.98 | 4.57 | 0.99 |

**Description of Lights Controlled:**

Set Point 230V

Readout claims 17.1% Savings

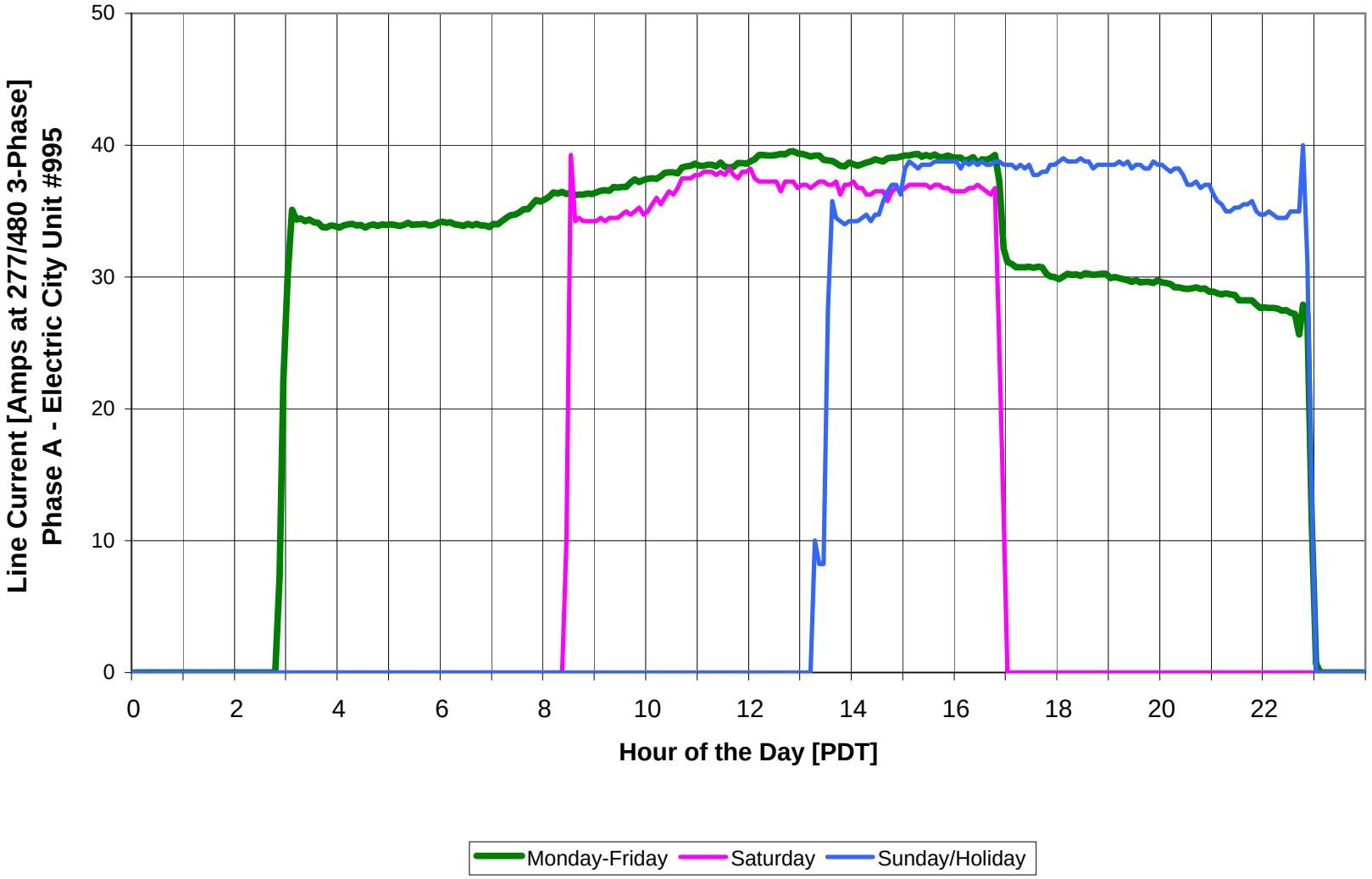
4th & 5th Floor Library lights including rooms 500-524

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 275.0 | 51.96 | 14.10 | 14.30 | 2.23 | 0.99 |
| B | 276.3 | 44.40 | 12.10 | 12.30 | 2.17 | 0.98 |
| C | 277.2 | 33.46 | 9.14 | 9.28 | 1.61 | 0.99 |
| TOT/AVG | 276.17 | 43.27 | 35.34 | 35.88 | 6.01 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.0 | 51.95 | 14.20 | 14.40 | 2.36 | 0.99 |
| B | 275.3 | 44.53 | 12.00 | 12.20 | 2.21 | 0.98 |
| C | 277.2 | 33.64 | 9.14 | 9.31 | 1.75 | 0.98 |
| TOT/AVG | 276.50 | 43.37 | 35.34 | 35.91 | 6.32 | 0.98 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 275.1 | 33.96 | 27.67 | 27.99 | 4.47 | 0.99 |
| **Reduce Output** | 229.1 | 40.70 | 27.63 | 27.98 | 4.57 | 0.99 |
| **Full Input** | 276.2 | 43.27 | 35.34 | 35.88 | 6.01 | 0.99 |
| **Full Output** | 276.5 | 43.37 | 35.34 | 35.91 | 6.32 | 0.98 |
| **Power Savings** | | | **7.67** | | | |
| **Power % Savings** | | | **21.70%** | | | |

**Graph #3 CSU San Bernardino Jan/Feb 2004**
**Unit SB-3, Library 4th and 5th Floor Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SB-4 CSU San Bernardino*

| | | | |
|---|---|---|---|
| Location: | Library, Room M2 | Date Measured: | 1/20/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40 amp / #958 |
| Panel Fed By Energy Saver: | Panel L1B | Datalogger #: | **G-6** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 275.8 | 18.76 | 5.12 | 5.18 | 0.79 | 0.99 |
| B | 276.7 | 12.23 | 3.30 | 3.38 | 0.76 | 0.98 |
| C | 277.1 | 11.95 | 3.30 | 3.31 | 0.35 | 0.99 |
| TOT/AVG | 276.53 | 14.31 | 11.72 | 11.87 | 1.90 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.8 | 22.10 | 5.06 | 5.11 | 0.71 | 0.99 |
| B | 230.3 | 14.82 | 3.31 | 3.42 | 0.84 | 0.97 |
| C | 231.0 | 14.76 | 3.39 | 3.41 | 0.35 | 1.00 |
| TOT/AVG | 231.03 | 17.23 | 11.76 | 11.94 | 1.90 | 0.99 |

**Description of Lights Controlled:**

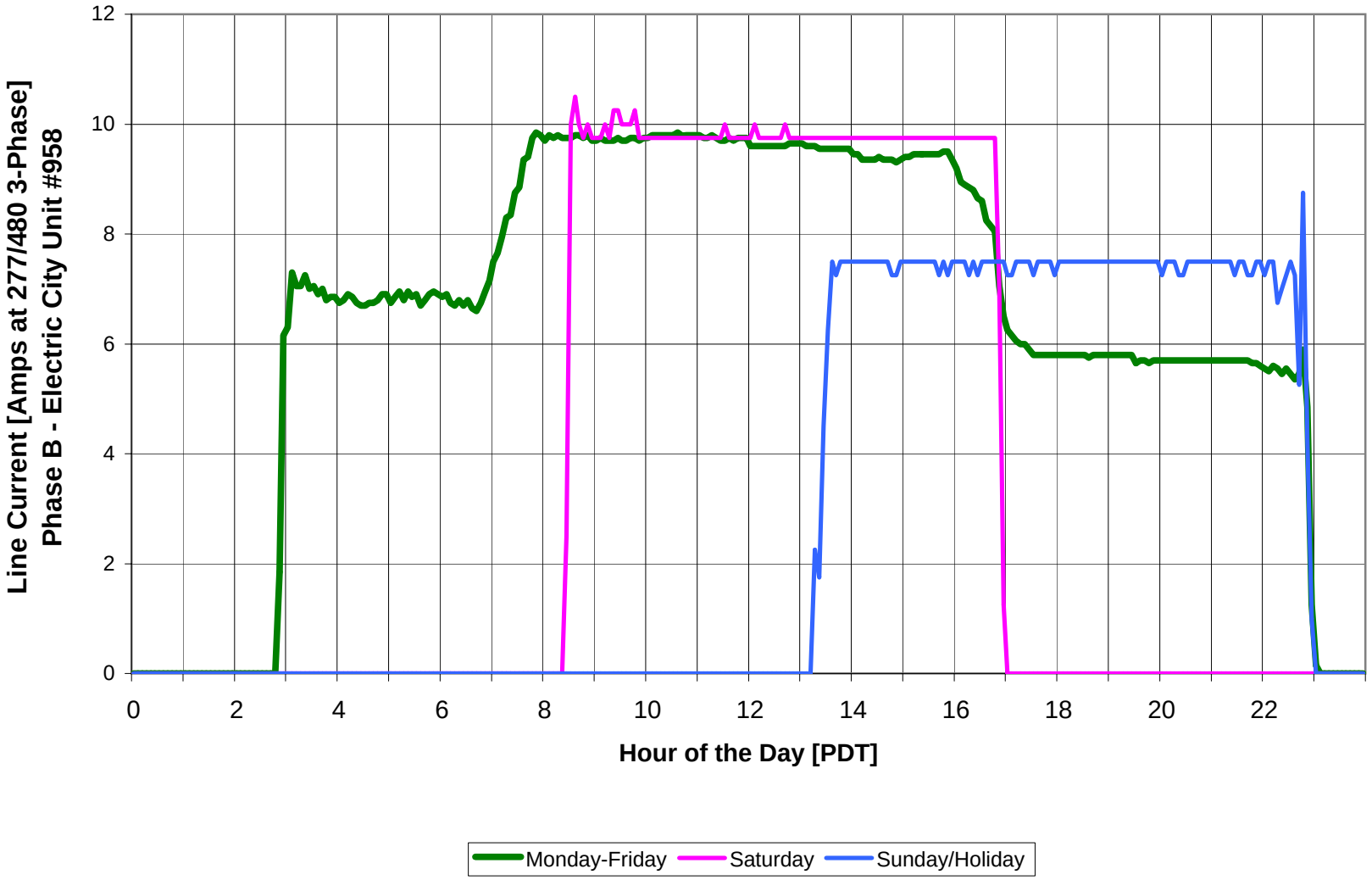
Floor 1 Library Lights (offices)

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.7 | 23.27 | 6.36 | 6.42 | 0.85 | 0.99 |
| B | 277.3 | 15.26 | 4.17 | 4.23 | 0.69 | 0.99 |
| C | 279.3 | 15.08 | 4.13 | 4.16 | 0.52 | 0.99 |
| TOT/AVG | 277.77 | 17.87 | 14.66 | 14.81 | 2.06 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.1 | 23.15 | 6.28 | 6.34 | 0.88 | 0.99 |
| B | 272.8 | 15.93 | 4.29 | 4.35 | 0.68 | 0.99 |
| C | 273.7 | 15.29 | 4.18 | 4.21 | 0.52 | 0.99 |
| TOT/AVG | 273.53 | 18.12 | 14.75 | 14.90 | 2.08 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 276.5 | 14.31 | 11.72 | 11.87 | 1.90 | 0.99 |
| **Reduce Output** | 231.0 | 17.23 | 11.76 | 11.94 | 1.90 | 0.99 |
| **Full Input** | 277.8 | 17.87 | 14.66 | 14.81 | 2.06 | 0.99 |
| **Full Output** | 273.5 | 18.12 | 14.75 | 14.90 | 2.08 | 0.99 |
| **Power Savings** | | | **2.94** | | | |
| **Power % Savings** | | | **20.05%** | | | |

**Graph #4 CSU San Bernardino Jan/Feb 2004**
**Unit SB-4, Library Offices Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SB-5 CSU San Bernardino*

| | | | |
|---|---|---|---|
| Location: | Library, Room M3 | Date Measured: | 1/20/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40 amp / #1013 |
| Panel Fed By Energy Saver: | L1A | Datalogger #: | **M-21** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 277.8 | 14.83 | 4.07 | 4.12 | 0.67 | 0.99 |
| B | 278.4 | 12.44 | 3.38 | 3.40 | 0.82 | 0.97 |
| C | 278.2 | 15.79 | 4.37 | 4.39 | 0.40 | 1.00 |
| TOT/AVG | 278.13 | 14.35 | 11.82 | 11.91 | 1.89 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 230.3 | 17.96 | 4.09 | 4.14 | 0.62 | 0.99 |
| B | 223.6 | 15.30 | 3.30 | 3.42 | 0.91 | 0.96 |
| C | 229.0 | 18.98 | 4.34 | 4.35 | 0.40 | 1.00 |
| TOT/AVG | 227.63 | 17.41 | 11.73 | 11.91 | 1.93 | 0.98 |

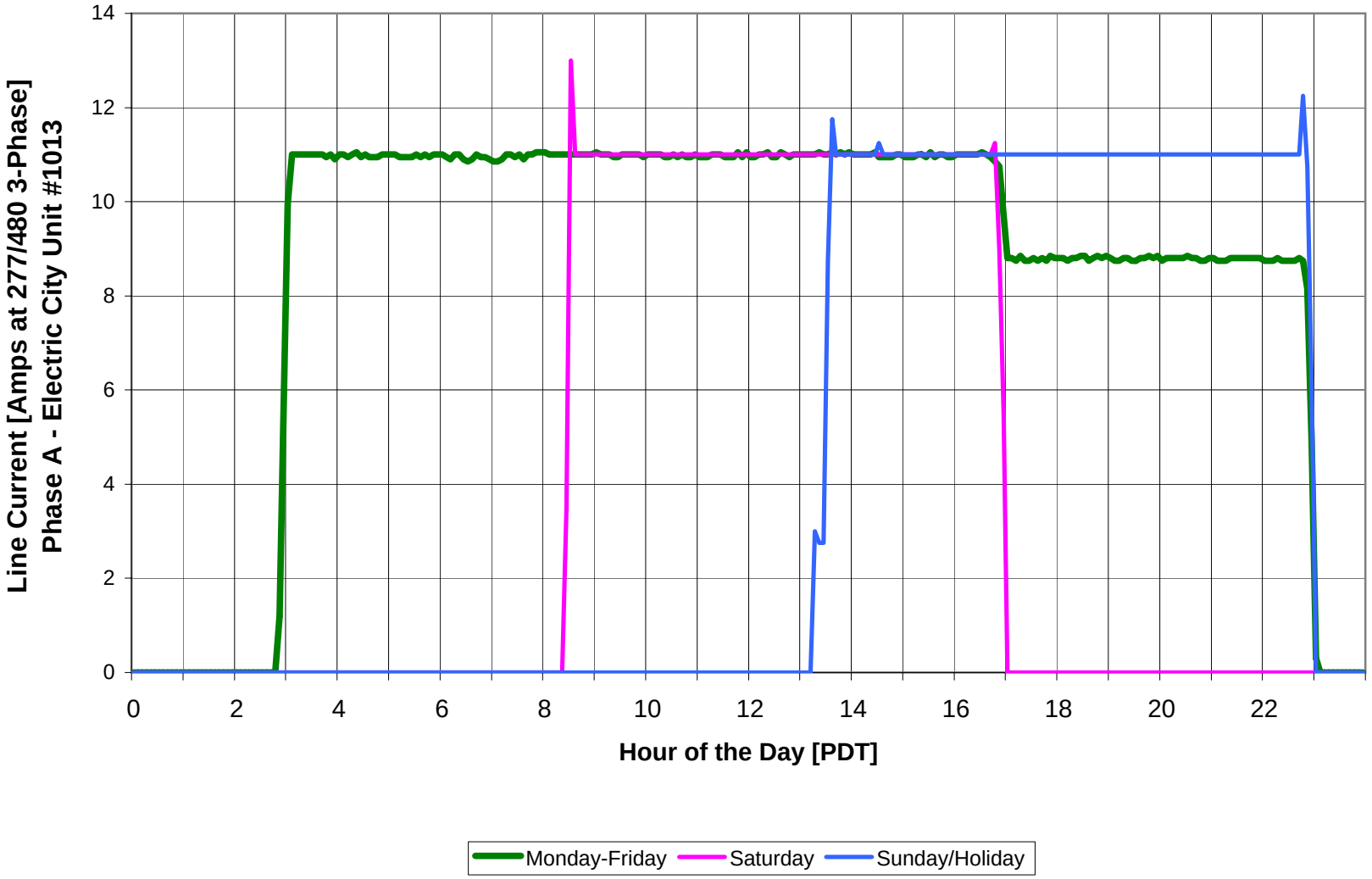
| **Description of Lights Controlled:** |
|---|
| 230V Set Point |
| Readout claims 15.8% Saving |
| Big office area lights |

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 278.7 | 18.62 | 5.13 | 5.18 | 0.71 | 0.99 |
| B | 278.8 | 15.54 | 4.27 | 4.33 | 0.70 | 0.99 |
| C | 278.4 | 19.62 | 5.44 | 5.46 | 0.56 | 1.00 |
| TOT/AVG | 278.63 | 17.93 | 14.84 | 14.97 | 1.97 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.6 | 19.25 | 5.29 | 5.34 | 0.74 | 0.99 |
| B | 271.3 | 15.95 | 4.26 | 4.33 | 0.75 | 0.99 |
| C | 273.9 | 20.01 | 5.47 | 5.50 | 0.59 | 0.99 |
| TOT/AVG | 274.27 | 18.40 | 15.02 | 15.17 | 2.08 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 278.1 | 14.35 | 11.82 | 11.91 | 1.89 | 0.99 |
| **Reduce Output** | 227.6 | 17.41 | 11.73 | 11.91 | 1.93 | 0.98 |
| **Full Input** | 278.6 | 17.93 | 14.84 | 14.97 | 1.97 | 0.99 |
| **Full Output** | 274.3 | 18.40 | 15.02 | 15.17 | 2.08 | 0.99 |
| **Power Savings** | | | **3.02** | | | |
| **Power % Savings** | | | **20.35%** | | | |

**Graph #5 CSU San Bernardino Jan/Feb 2004**
**Unit SB-5, Library Offices Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SB-6 CSU San Bernardino*

| | | | |
|---|---|---|---|
| Location: | Gym Electrical Room Gym Floor | Date Measured: | 1/20/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40 amp / #955 |
| Panel Fed By Energy Saver: | HA Contactors | Datalogger #: | **V-9** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 269.5 | 18.22 | 4.74 | 4.91 | 1.27 | 0.97 |
| B | 271.3 | 18.97 | 4.98 | 5.95 | 1.33 | 0.97 |
| C | 270.3 | 20.27 | 5.30 | 5.48 | 1.37 | 0.97 |
| TOT/AVG | 270.37 | 19.15 | 15.02 | 16.34 | 3.97 | 0.97 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 231.7 | 21.07 | 4.71 | 4.88 | 1.28 | 0.97 |
| B | 230.7 | 22.21 | 4.96 | 5.12 | 1.28 | 0.97 |
| C | 231.7 | 23.19 | 5.19 | 5.37 | 1.40 | 0.97 |
| TOT/AVG | 231.37 | 22.16 | 14.86 | 15.37 | 3.96 | 0.97 |

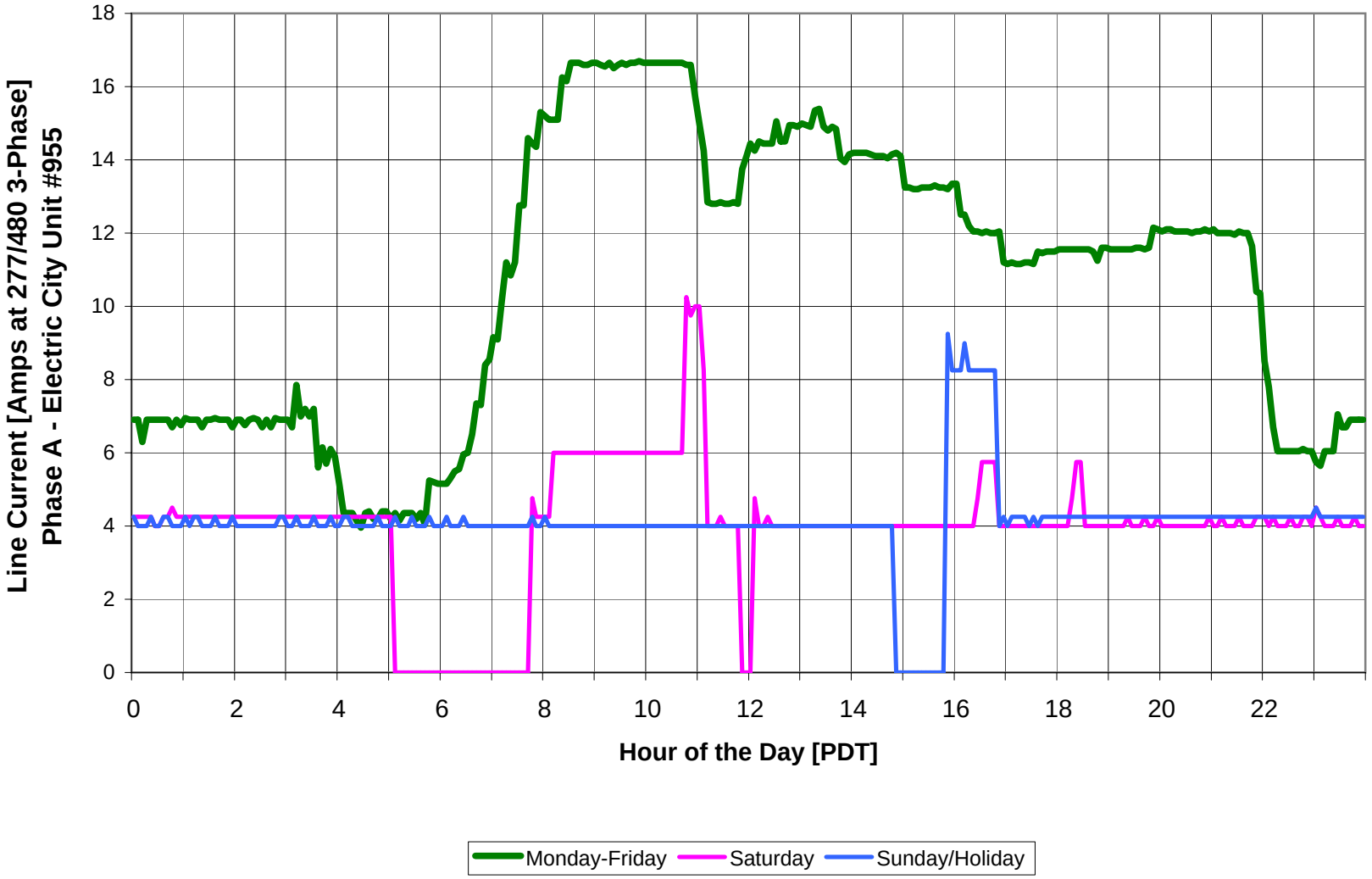
| **Description of Lights Controlled:** |
|---|
| 230V Set Point |
| Readout claims 16% power savings |
| Gym Lights |

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 268.2 | 22.31 | 5.90 | 5.98 | 1.01 | 0.99 |
| B | 270.1 | 23.05 | 6.12 | 6.20 | 1.05 | 0.99 |
| C | 268.8 | 24.44 | 6.44 | 6.53 | 1.06 | 0.99 |
| TOT/AVG | 269.03 | 23.27 | 18.46 | 18.71 | 3.12 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 275.1 | 22.78 | 6.04 | 6.12 | 1.00 | 0.99 |
| B | 276.1 | 22.68 | 6.19 | 8.26 | 1.02 | 0.99 |
| C | 276.8 | 23.67 | 6.44 | 4.52 | 1.52 | 0.99 |
| TOT/AVG | 276.00 | 23.04 | 18.67 | 18.90 | 3.54 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 270.4 | 19.15 | 15.02 | 16.34 | 3.97 | 0.97 |
| **Reduce Output** | 231.4 | 22.16 | 14.86 | 15.37 | 3.96 | 0.97 |
| **Full Input** | 269.0 | 23.27 | 18.46 | 18.71 | 3.12 | 0.99 |
| **Full Output** | 276.0 | 23.04 | 18.67 | 18.90 | 3.54 | 0.99 |
| **Power Savings** | | | **3.44** | | | |
| **Power % Savings** | | | **18.63%** | | | |

**Graph #6 CSU San Bernardino Jan/Feb 2004**
**Unit SB-6, Gymnasium Lighting**
**Average Daily Load Profile**



# *CSU San Bernardino*
# *Energy Saver Units*

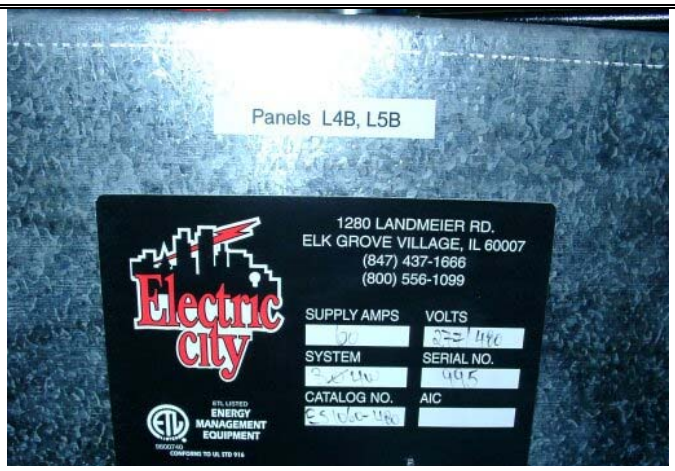
Library 3rd Floor Unit 964 With Datalogger Installed


Nameplate for Unit 964

Library 3rd Floor Unit 996 With Datalogger Installed


Nameplate for Unit 996

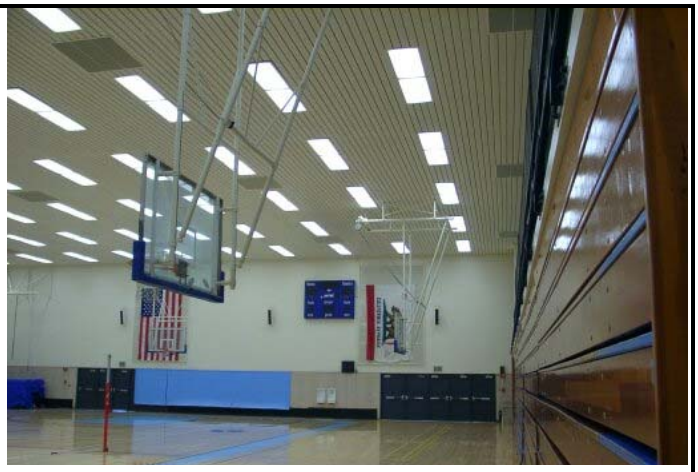
Library 5th Floor Unit 995 With Datalogger Installed




Nameplate for Unit 995

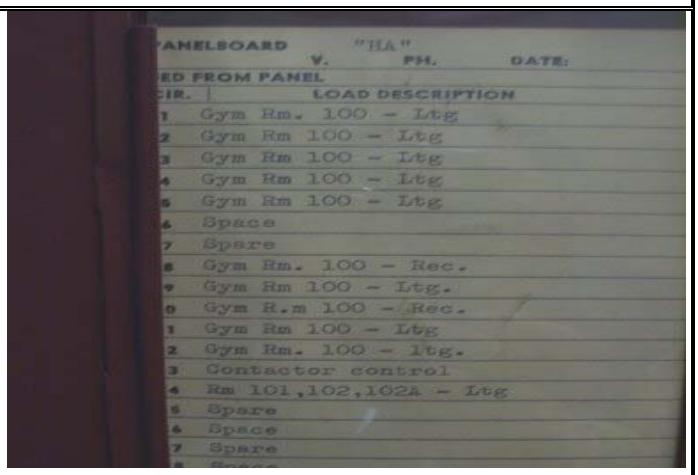
# *CSU San Bernardino*
# *Energy Saver Units*

Gym Lights



Gym Lights

Gym Lights Breaker Panel




Gym Lights Breaker Panel Legend

Gym Unit 955 With Datalogger Installed

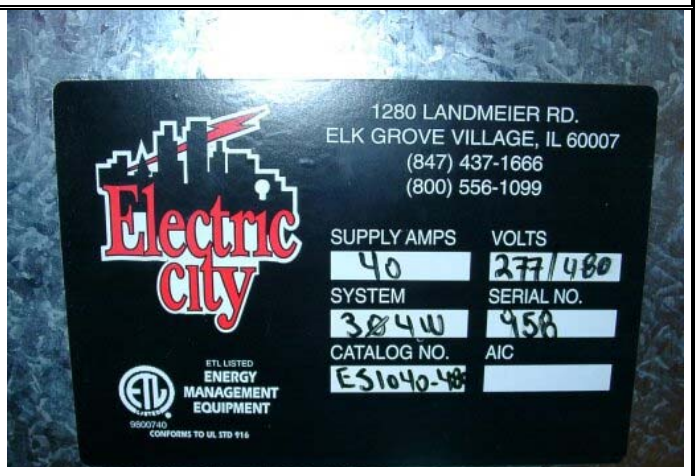

Nameplate for Unit 955

# *CSU San Bernardino*
# *Energy Saver Units*

Library Mech. Room Unit 1013 With Datalogger Installed


Nameplate for Unit 1013

Library Unit 958 With Datalogger Installed




Nameplate for Unit 958

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSU San Diego

## Energy Savings Summary

Five Energy Saver units were installed on the campus of the California State University at San Diego (CSUSD). All five of the units were installed to control lights in parking structures.

The following table delineates the savings estimates for each Energy Saver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the Energy Saver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are presented below.

| CSUSD Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Location | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| SD-1 | 150 | Parking Structure #4 | 74,880 | 128,197 |
| SD-2a | 120 | Parking Structure #1 | 58,240 | 52,436 |
| SD-2b | 150 | Parking Structure #1 | 74,880 | 80,104 |
| SD-3 | 80 | Parking Structure #5 | 49,275 | 90,228 |
| SD-4 | 80 | Parking Structure #6 | 49,275 | 55,422 |
| **Total** | | **San Diego Campus** | **306,550** | **406,387** |

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak (summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSUSD Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| SD-1 | 150 | 18.00 | 17.0 | 10.7 |
| SD-2a | 120 | 14.00 | 6.5 | 5.3 |
| SD-2b | 150 | 18.00 | 9.4 | 8.5 |
| SD-3 | 80 | 11.25 | 10.3 | 10.3 |
| SD-4 | 80 | 11.25 | 7.3 | 5.3 |
| **Total** | | **72.50** | **50.5** | **40.1** |

The estimated annual energy savings, 406,387 kWh/yr, is 33% greater than the 306,550 kWh/yr reported in the CPUC project spreadsheet. The demand reduction estimates, however, are less. This is because of two factors with competing effects on savings. The lights in these parking lots tended, for the most part, to operate 24 hours per day, and the operating hours assumed in the spreadsheet calculations are about 12 hours per day (4160 or 4380 hours per year). On the other hand, the spreadsheet calculations assumed each Energy Saver system was loaded at a higher portion of its rated load than these units in fact were. Although the demand (and therefore the demand reduction) is lower, the greatly extended operating hours produced energy savings higher than originally estimated.

Following are descriptions of each of the Energy Saver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## SD-1. Parking Structure #4

This 277/480-volt 150-amp unit controls all the high-pressure sodium lights in parking structure #4. The Energy Saver unit output feeds panel ES4. The Energy Saver unit was set to reduce the voltage to the lights to 257 volts line-to-neutral. It had been set to 230V, but this caused lights to burn out according to campus facilities personnel. No other problems were noted.

We measured actual output voltages averaging 258.5 volts. The input power was 37.7 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the

unit drew 48.4 kW, indicating that the power reduction was 10.7 kW, or 22.1% of the original load. The system operated at a 91% power factor in both full- and reduced-load modes.

These measurements were taken when the lights were in daytime operating mode. Higher loads occur at night when additional lights are on. The nighttime load is 159% of the daytime load, giving a power reduction of 17.0 kW during the night.

A datalogger was installed and recorded five-minute interval data from January 21 through February 10, 2004. The logger showed consistent operation of the lights, with a portion of them being on continuously and a portion of them being shut off from 6:40 a.m. until 4:15 p.m. This pattern is consistent seven days per week.

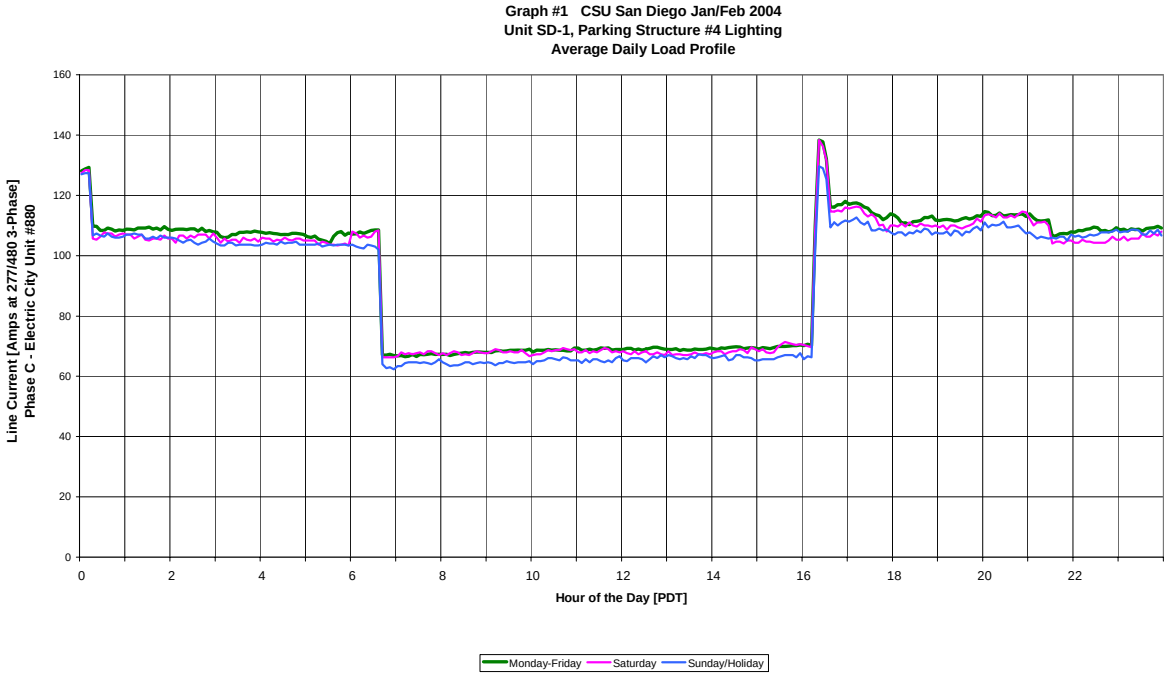
The load profile also shows two consistent power spikes, one at 4:15 p.m. and the other at midnight. The afternoon spike is the caused by the Energy Saver shifting to full-voltage as a result of the new lights being turned on. (It does this to enable the HID lights to start properly.) The midnight spike is caused by the Energy Saver's routine of running at full voltage once each day.

The load profile indicates an equivalent full-load operating time of 7,541 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern.

The resultant energy savings achieved by this Energy Saver unit is 128,197 kWh per year (17.0 kW * 7541 h/yr). The connected load reduction is 17.0 kW, and the summer on-peak demand reduction is 10.7 kW because the lights will not be fully operating during the summer on-peak period. (There is some question as to whether the timer is reset during the summer, but we assume it is not because the local electricians thought that this parking structure's timer was not being used at all, which is clearly not the case.)

This value is significantly greater than the 74,880 kWh/yr estimate on the CPUC spreadsheet. This is because the operating hours measured was significantly greater than those assumed on the spreadsheet. The measured demand reduction is slightly lower than that assumed in the spreadsheet because the unit is not operating at rated capacity.

The load profile of this Energy Saver is shown in the following graph.




## SD-2a. Parking Structure #1

This 120/208-volt 120-amp unit controls high-pressure sodium lights in parking structure #1. The Energy Saver unit output feeds panel ES1B. The Energy Saver unit was set to reduce the voltage to the lights to 108 volts line-to-neutral. No installation or operational problems were noted.

We measured actual output voltages averaging 107.6 volts. The input power was 16.8 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 22.1 kW, indicating that the power reduction was 5.3 kW, or 24% of the original load. The system operated at a 93% power factor in both full- and reduced-load modes.

These measurements were taken when the lights were in daytime operating mode. Higher loads occur at night when additional lights are on. The nighttime load is 122% of the daytime load, giving a power reduction of 6.5 kW during the night.

A datalogger was installed and recorded five-minute interval data from January 21 through February 10, 2004. The logger showed consistent operation of the lights, with a portion of them being on continuously and a portion of them being shut off during the day. A portion of lights shut off gradually between 6:00 and 6:40 a.m. and again turned on between 4:10 and 4:40 p.m., being controlled by several photocells. This pattern is consistent seven days per week.

The load profile also shows two consistent power spikes, one at 4:30 p.m. and the other at 11:00 p.m. The afternoon spike is the caused by the Energy Saver shifting to

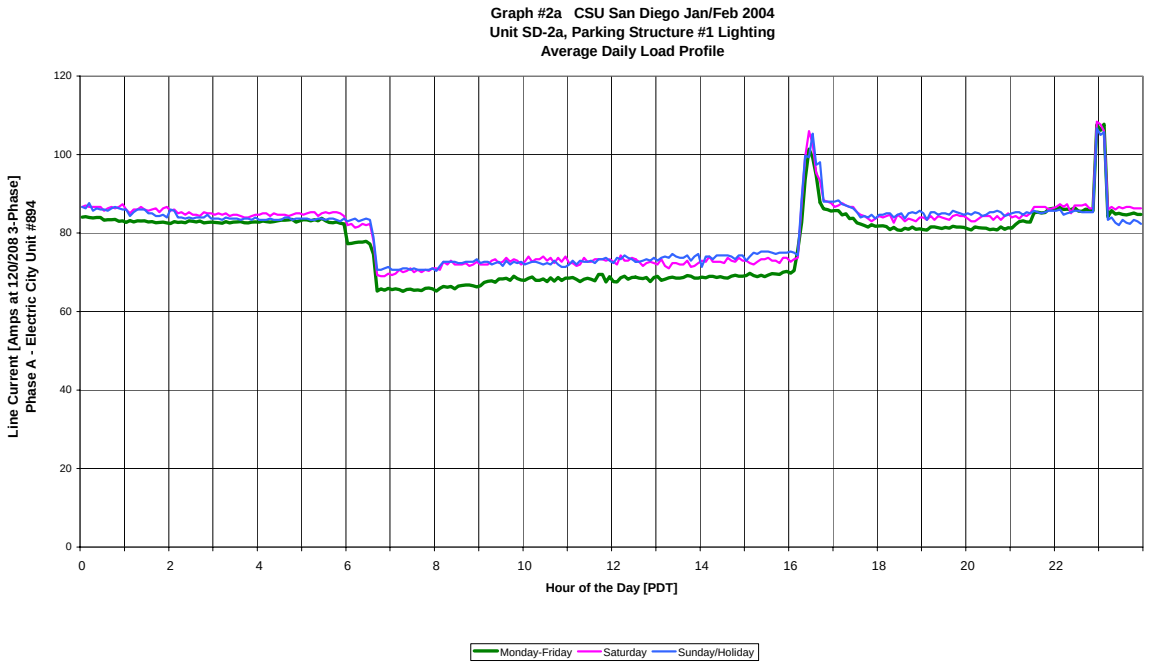
full-voltage as a result of the new lights being turned on. (It does this to enable the HID lights to start properly.) The late night spike is caused by the Energy Saver's routine of running at full voltage once each day.

The load profile indicates an equivalent full-load operating time of 22.4 hours per day, or 8,181 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. Because a portion of the lights are controlled by photocells and were monitored during the winter, this estimate is high. Summer equivalent full-load operating times are estimated at about 21.8 hours per day. An average of these values, 22.1 hours per day, results in an equivalent annual full-load operating time of 8,067 hours per year. This value was used to represent these lights.

The resultant energy savings achieved by this Energy Saver unit is 52,436 kWh per year (6.5 kW * 8067 h/yr). The connected load reduction is 6.5 kW, and the summer on-peak demand reduction is 5.3 kW because the lights will not be fully operating during the summer on-peak period.

This value is slightly lower than the 58,240 kWh/yr estimate on the CPUC spreadsheet. Even though the operating hours measured are significantly greater than those assumed in the calculation of the original per-unit energy savings, these values assumed a 277/480-volt unit, and this particular unit operates at 120/208 volts. This is also why the measured demand reduction values are significantly less than those reported in the spreadsheet.

The load profile of this Energy Saver is shown in the graph below.



## SD-2b. Parking Structure #1

This 120/208-volt 150-amp unit also controls high-pressure sodium lights in parking structure #1. The Energy Saver unit output feeds panel ES1A. The Energy Saver unit was set to reduce the voltage to the lights to 110 volts line-to-neutral. No installation or operational problems were noted.

The input power was 27.6 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 36.1 kW, indicating that the power reduction was 8.5 kW, or 24% of the original load. The system operated at a 92% power factor in both full- and reduced-load modes.

These measurements were taken when the lights were in daytime operating mode. Slightly higher loads occur at night when additional lights are on. The nighttime load is 111% of the daytime load, giving a power reduction of 9.4 kW during the night.

A datalogger was installed and recorded five-minute interval data from January 21 through February 10, 2004. The logger showed consistent operation of the lights, with a portion of them being on continuously and a portion of them being shut off during the day. About 10% of lights shut off in the morning and again turned on in the late afternoon. This pattern is consistent seven days per week.

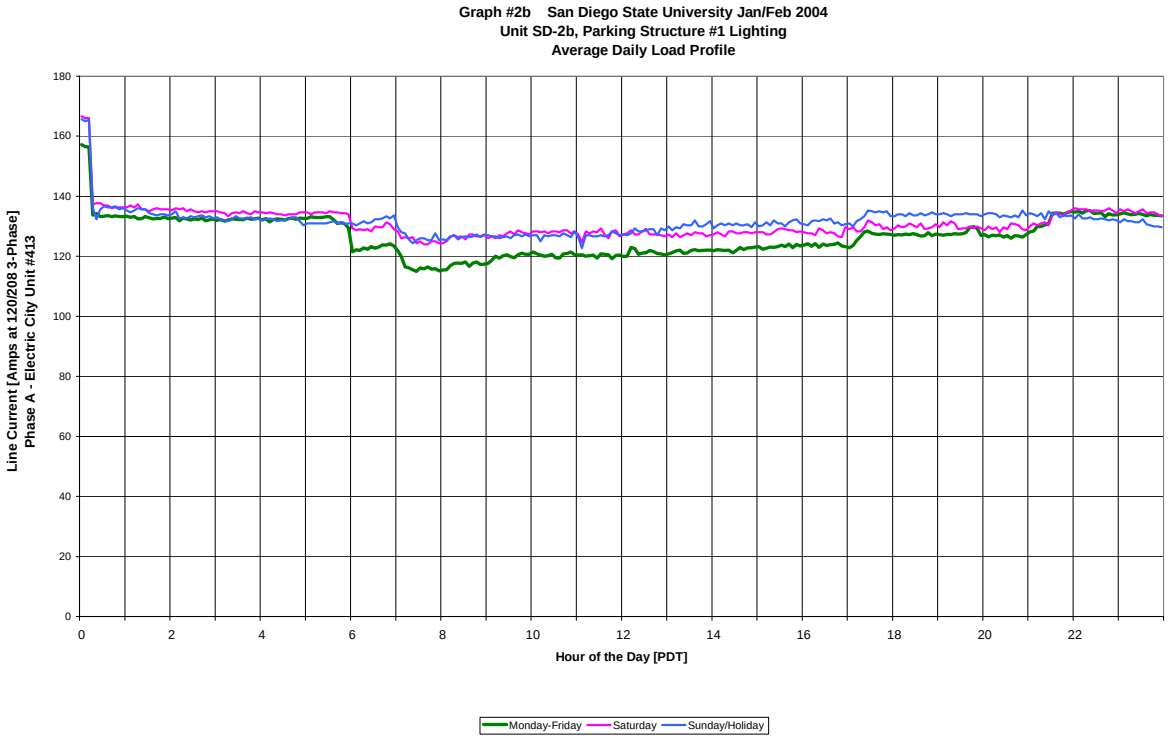
The load profile also shows a consistent power spike at midnight. This late night spike is caused by the Energy Saver's routine of running at full voltage once each day. This system did not show a spike in the afternoon when the lights turned back on because there was not a sufficient portion of lights to cause the Energy Saver to reset to full voltage.

The load profile indicates an equivalent full-load operating time of 23.2 hours per day, or 8,472 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. Because a portion of the lights are controlled by photocells and were monitored during the winter, this estimate is high. Summer equivalent full-load operating times are estimated at about 23.0 hours per day. An average of these values, 23.1 hours per day, results in an equivalent annual full-load operating time of 8,432 hours per year. This value was used to represent these lights.

The resultant energy savings achieved by this Energy Saver unit is 80,104 kWh per year (9.4 kW * 8432 h/yr). The connected load reduction is 9.4 kW, and the summer on-peak demand reduction is 8.5 kW because the lights will not be fully operating during the summer on-peak period.

This value is slightly higher than the 74,880 kWh/yr estimate on the CPUC spreadsheet. The operating hours measured is significantly greater than those assumed in the calculation of the original per-unit energy savings. This more than compensated for the fact that the spreadsheet assumed a 277/480-volt unit while this particular unit operates at 120/208 volts. The voltage difference is also why the measured demand reduction values are significantly less than those reported in the spreadsheet.

The data collected by the datalogger indicated that the unit did not operate in power reduction mode on Tuesdays. This was reported to CSU and the installation contractor and is assumed to be fixed by reprogramming the unit. The load profiles were created by eliminating these days from the data. The load profile of this Energy Saver is shown in the graph below.




## SD-3. Parking Structure #5

This 277/480-volt 80-amp unit also controls high-pressure sodium lights in parking structure #1. The Energy Saver unit output feeds panel ES-5. The Energy Saver unit was set to reduce the voltage to the lights to 230 volts line-to-neutral. The unit was on bypass mode during our first visit (meter installation), so the power readings were taken at the second visit when the dataloggers were removed. No other installation or operational problems were noted.

We measured output voltages averaging 233 volts line-to-neutral. The input power was 18.9 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 29.2 kW, indicating that the power reduction was 10.3 kW, or 35% of the original load. The system operated at an 86% power factor in reduced-load mode and 88% in full-load mode.

These measurements were taken during the daytime, but operation did not change from day to night, so the 10.3 kW load reduction is the value used to calculate the energy savings.

A datalogger was installed and recorded five-minute interval data from January 21 through February 10, 2004. The logger showed continuous operation of the lights, 24 hours per day. This pattern is consistent seven days per week. There was some variation in current draw between day and night hours, but these changes were small, gradual, and not fully consistent from day to day. They are caused by variations in supply voltage and ambient temperature, rather than operational changes in the lighting system.

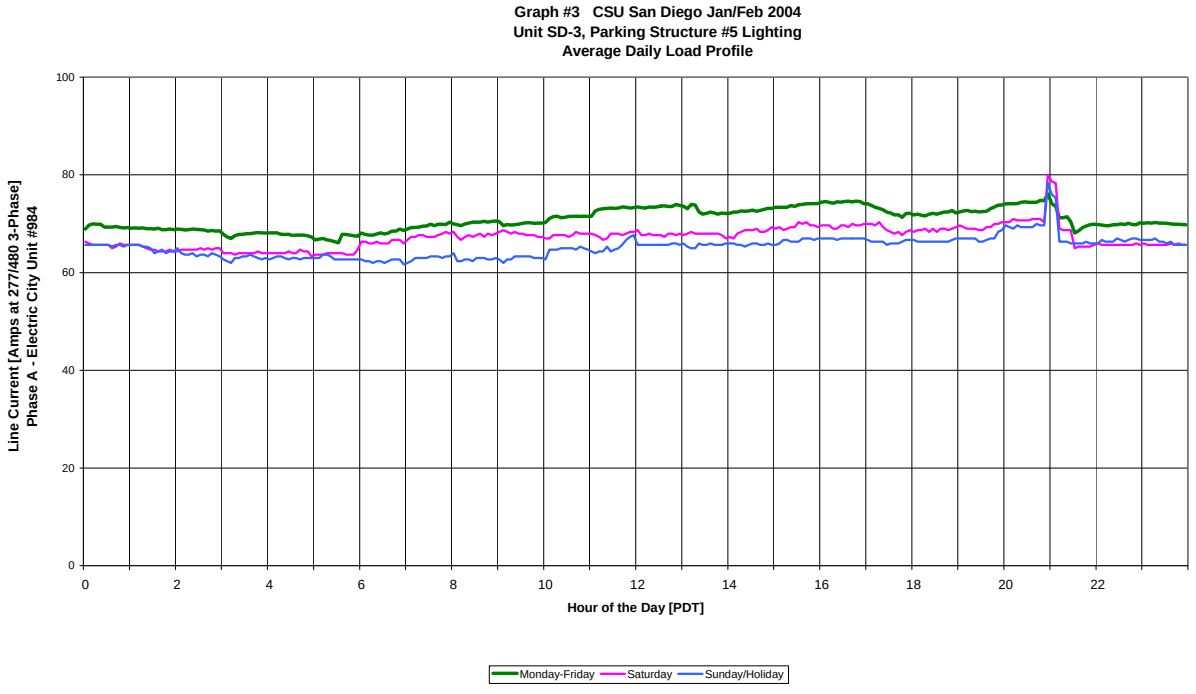
The load profile also shows a consistent power spike at 9:00 p.m. This late night spike is caused by the Energy Saver's routine of running at full voltage once each day.

The load profile indicates an equivalent full-load operating time of 24 hours per day, or 8,760 hours per year.

The resultant energy savings achieved by this Energy Saver unit is 90,228 kWh per year (10.3 kW * 8760 h/yr). The connected load reduction is 10.3 kW, which is also the summer on-peak demand reduction because the lights operate continuously.

This value is 83% higher than the 49,275 kWh/yr estimate on the CPUC spreadsheet. The operating hours measured is significantly greater than those assumed in the calculation of the original per-unit energy savings. Although the unit was not quite as loaded as assumed in the spreadsheet, the extra operating hours more than compensated for the loading reduction. The original high loading assumption is why the measured demand reduction values are slightly less than those reported in the spreadsheet.

The load profile of this Energy Saver is shown in the graph below.



## SD-4. Parking Structure #4

This 277/480-volt 80-amp unit controls all the lights in parking structure #6. The Energy Saver unit output feeds panel ES6 and HP2. The Energy Saver unit was set to reduce the voltage to the lights to 255 volts line-to-neutral. No installation or operational problems were noted.

We measured actual output voltages averaging 255.0 volts. The input power was 28.1 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 33.4 kW, indicating that the power reduction was 5.3 kW, or 15.9% of the original load. The system operated at an 86% power factor in reduced-load mode and 87% in full-load mode.

These measurements were taken when the lights were in daytime operating mode. Higher loads occur at night when additional lights are on. The nighttime load is 140% of the daytime load, giving a power reduction of 7.3 kW during the night.

A datalogger was installed and recorded five-minute interval data from January 21 through February 10, 2004. The logger showed consistent operation of the lights, with two additional sets of lights operating during evening and night hours. One additional set of lights ran from 5:00 p.m. until 7:00 a.m., and another set of night-lights ran from 9:00 p.m. until 6:00 a.m.

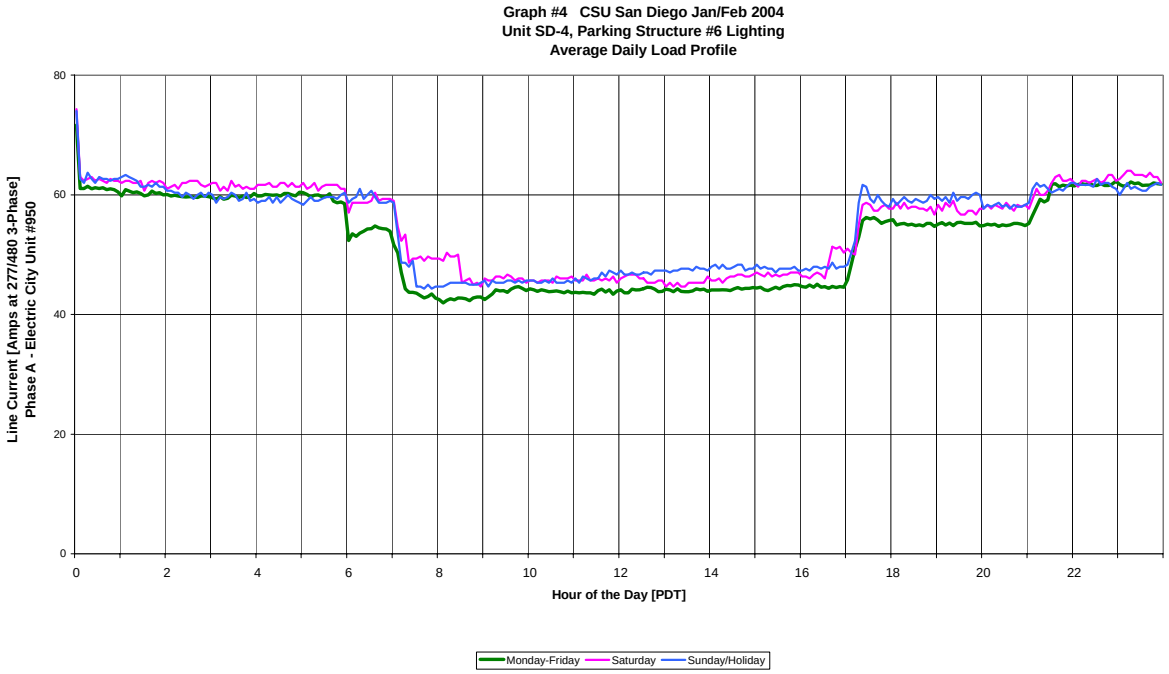
The load profile also shows two consistent power spikes, one after 4:00 p.m. and the other at midnight. The afternoon spike is the caused by the Energy Saver shifting to full-voltage as a result of the new lights being turned on. (It does this to enable the HID lights to start properly.) The midnight spike is caused by the Energy Saver's routine of running at full voltage once each day.

The load profile indicates an equivalent full-load operating time of 21.1 hours per day, or 7,686 hours per year. If the lights ran this amount of time at the full capacity and then shut off for the rest of the year, they would use the same amount of energy as the present pattern. Because a portion of the lights are controlled to operate during evening hours only and we monitored the system during the winter, this estimate is high. Summer equivalent full-load operating times are estimated at about 20.5 hours per day. An average of these values, 20.8 hours per day, results in an equivalent annual full-load operating time of 7,592 hours per year. This value was used to represent these lights.

The resultant energy savings achieved by this Energy Saver unit is 55,422 kWh per year (7.3 kW * 7592 h/yr). The connected load reduction is 7.3 kW, and the summer on-peak demand reduction is 5.3 kW because the lights will not be fully operating during the summer on-peak period.

This value is 12% greater than the 49,275 kWh/yr estimate on the CPUC spreadsheet. This is because the operating hours measured was significantly greater than those assumed on the spreadsheet. However, the measured demand reduction is significantly lower than that assumed in the spreadsheet because the unit is not operating at rated capacity. The extra hours and lower demand tended to negate each other.

The load profile of this Energy Saver is shown in the graph below.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *SD-1 San Diego State University*

| | | | |
|---|---|---|---|
| Location: | Parking Structure #4 - main elect room | Date Measured: | 1/21/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 150 amp / #880 |
| Panel Fed By Energy Saver: | ES4 | Datalogger #: | MOJ1 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 276.0 | 40.70 | 10.10 | 11.20 | 4.70 | 0.91 |
| B | 275.8 | 55.20 | 13.80 | 15.30 | 6.50 | 0.91 |
| C | 275.3 | 54.40 | 13.80 | 15.00 | 6.00 | 0.92 |
| TOT/AVG | 275.70 | 50.10 | 37.70 | 41.50 | 17.20 | 0.91 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 259.2 | 53.30 | 12.80 | 13.90 | 5.60 | 0.92 |
| B | 257.8 | 58.80 | 13.30 | 15.00 | 7.00 | 0.88 |
| C | 258.6 | 56.30 | 13.30 | 14.50 | 5.80 | 0.92 |
| TOT/AVG | 258.53 | 56.13 | 39.40 | 43.40 | 18.40 | 0.91 |

**Description of Lights Controlled:**

257V Set Point

Readout claims 51.1% power savings

**Parking Structure Lights on 24-7 (High Pressure Sodium Lights)**

## CSU Chancellor's Office

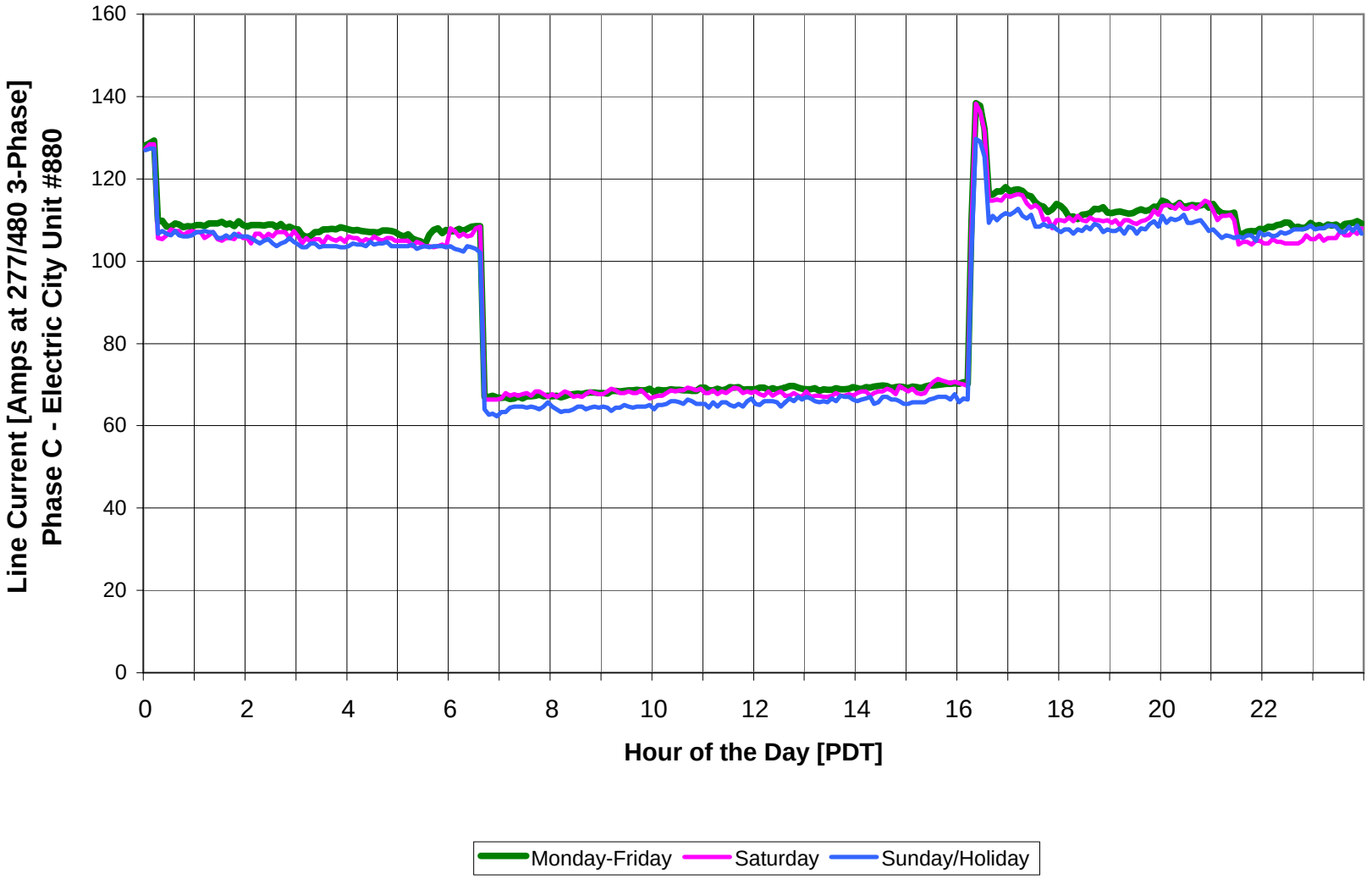
## *SD-1 San Diego State University*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.2 | 61.80 | 15.80 | 17.00 | 6.20 | 0.93 |
| B | 272.7 | 66.00 | 16.40 | 18.00 | 7.60 | 0.91 |
| C | 273.0 | 64.00 | 16.20 | 17.60 | 6.90 | 0.92 |
| TOT/AVG | 273.30 | 63.93 | 48.40 | 52.60 | 20.70 | 0.92 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 279.5 | 60.20 | 15.40 | 16.80 | 6.60 | 0.93 |
| B | 278.2 | 65.00 | 16.30 | 18.10 | 7.90 | 0.90 |
| C | 278.9 | 61.60 | 15.60 | 17.10 | 7.10 | 0.91 |
| TOT/AVG | 278.87 | 62.27 | 47.30 | 52.00 | 21.60 | 0.91 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 275.7 | 50.10 | 37.70 | 41.50 | 17.20 | 0.91 |
| **Reduce Output** | 258.5 | 56.13 | 39.40 | 43.40 | 18.40 | 0.91 |
| **Full Input** | 273.3 | 63.93 | 48.40 | 52.60 | 20.70 | 0.92 |
| **Full Output** | 278.9 | 62.27 | 47.30 | 52.00 | 21.60 | 0.91 |
| **Power Savings** | | | **10.70** | | | |
| **Power % Savings** | | | **22.11%** | | | |

**Graph #1 San Diego State University Jan/Feb 2004**
**Unit SD-1, Parking Structure #4 Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SD-2a San Diego State University*

| | | | |
|---|---|---|---|
| Location: | Parking Structure #1 main elect room | Date Measured: | 1/21/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 120 amp / #894 |
| Panel Fed By Energy Saver: | ES1B | Datalogger #: | **M-23** |

Measured at ES1B Disconnect Switch

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 120.7 | 61.00 | 6.50 | 6.90 | 2.50 | 0.93 |
| B | 120.3 | 49.40 | 5.80 | 6.00 | 1.70 | 0.96 |
| C | 120.9 | 41.10 | 4.50 | 4.90 | 1.70 | 0.94 |
| TOT/AVG | 120.63 | 50.50 | 16.80 | 17.80 | 5.90 | 0.94 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 108.2 | | | | | |
| B | 107.4 | | | | | |
| C | 107.2 | | | | | |
| TOT/AVG | 107.60 | | | | | |

**Description of Lights Controlled:**

Set Point at 108V

Readout claims 22.7% Saving

HPS Lights 24-7

Unable to take readings on energy saver unit because wires were too close together.

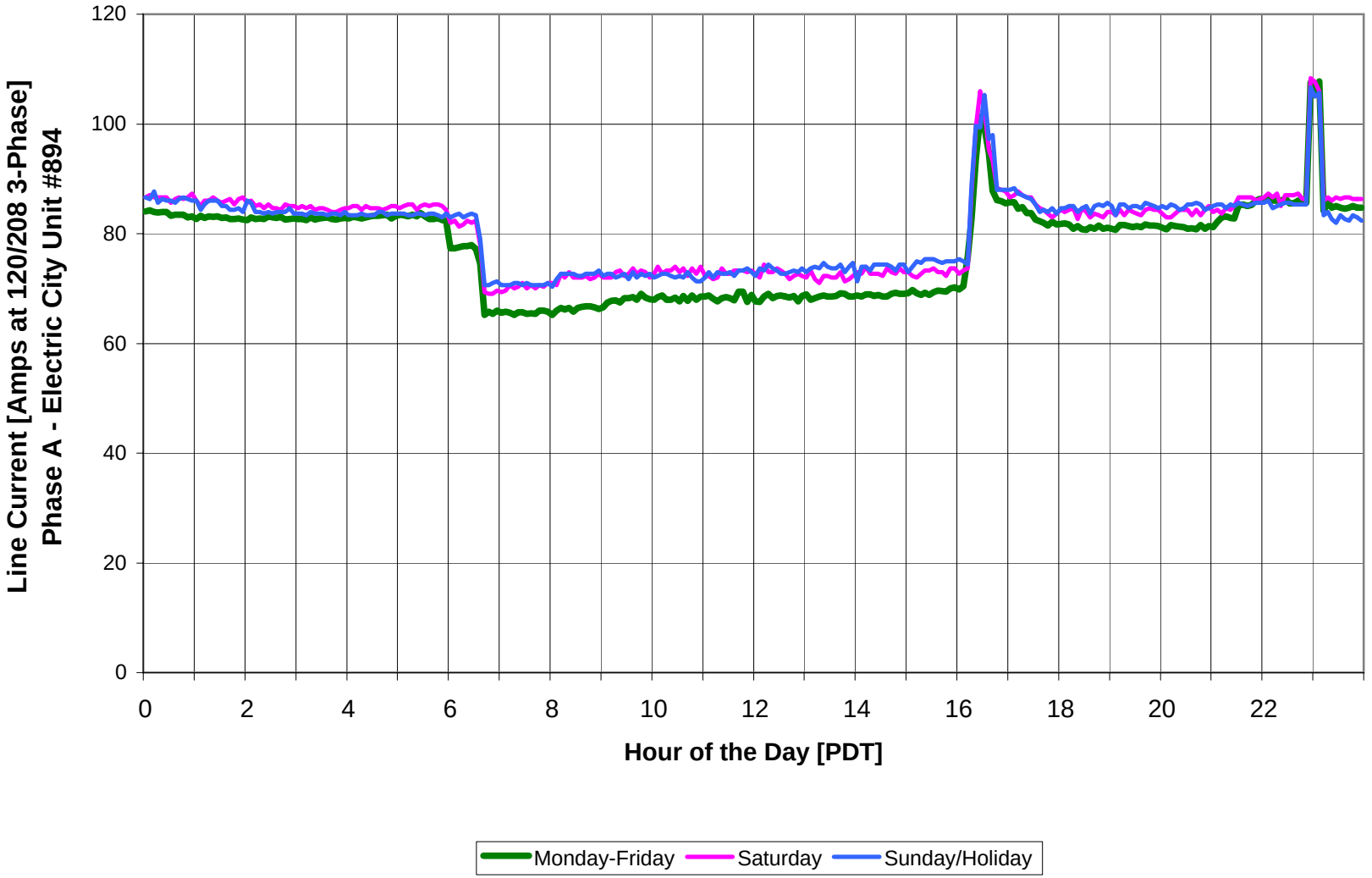
**CSU Chancellor's Office** *SD-2a San Diego State University*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 120.5 | 77.70 | 8.50 | 9.30 | 3.80 | 0.91 |
| B | 121.0 | 64.00 | 7.40 | 7.80 | 2.40 | 0.95 |
| C | 120.9 | 55.80 | 6.20 | 6.80 | 2.60 | 0.92 |
| TOT/AVG | 120.80 | 65.83 | 22.10 | 23.90 | 8.80 | 0.93 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| TOT/AVG | | | | | | |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 120.6 | 50.50 | 16.80 | 17.80 | 5.90 | 0.94 |
| **Reduce Output** | 107.6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Full Input** | 120.8 | 65.83 | 22.10 | 23.90 | 8.80 | 0.93 |
| **Full Output** | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Power Savings** | | | **5.30** | | | |
| **Power % Savings** | | | **23.98%** | | | |

**Graph #2a San Diego State University Jan/Feb 2004**
**Unit SD-2a, Parking Structure #1 Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SD-2b San Diego State University*

| | | | |
|---|---|---|---|
| Location: | Parking Structure #1 main elect room | Date Measured: | 1/21/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 150 amp / #413 |
| Panel Fed By Energy Saver: | ES1A | Datalogger #: | M-32 |

All input power reduced voltage data from ES1A disconnect.

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 119.6 | 95.30 | 11.00 | 11.80 | 4.10 | 0.94 |
| B | 120.7 | 78.90 | 8.90 | 9.50 | 3.50 | 0.93 |
| C | 120.7 | 71.90 | 7.70 | 8.40 | 3.10 | 0.93 |
| TOT/AVG | 120.33 | 82.03 | 27.60 | 29.70 | 10.70 | 0.93 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| TOT/AVG | | | | | | |

**Description of Lights Controlled:**

Voltage Set Point is 110V

During the final inspection, while verifying voltage setpoints we scrolled through the menu and noted that the setpoint changed to 90 volts, which was very low. We notified Al about this and he will look into it.

Upon leaving we noticed many lights off. It's unknown whether or not **we** caused the setpoint to change.

## CSU Chancellor's Office

## *SD-2b San Diego State University*

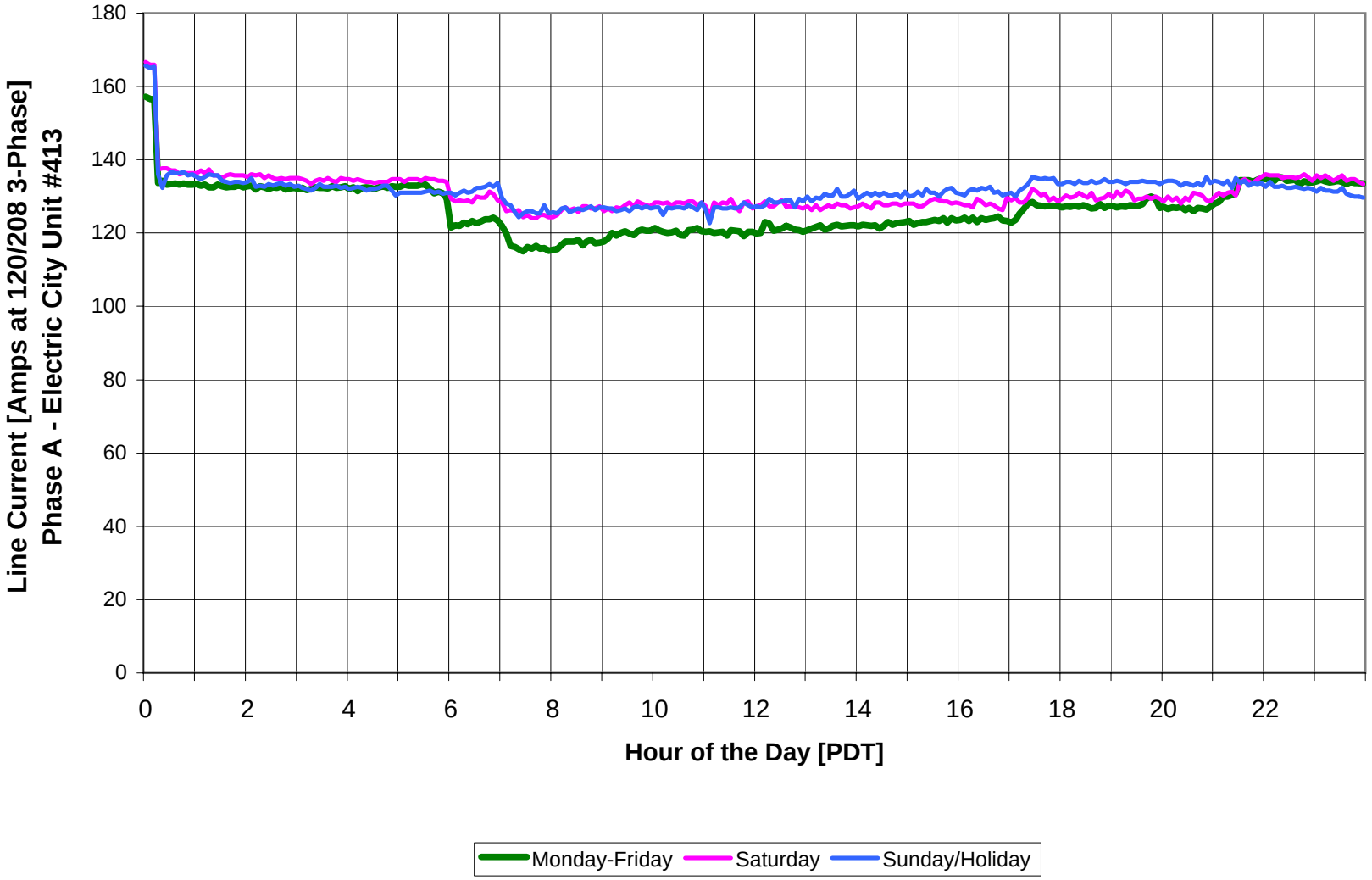
| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 119.7 | 125.40 | 13.80 | 15.00 | 5.70 | 0.93 |
| B | 120.9 | 102.40 | 11.90 | 12.00 | 4.80 | 0.92 |
| C | 120.8 | 94.10 | 10.40 | 11.40 | 4.60 | 0.91 |
| TOT/AVG | 120.47 | 107.30 | 36.10 | 38.40 | 15.10 | 0.92 |

Output power readings taken from ES1A Disconnect

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | | | | | | |
| B | | | | | | |
| C | | | | | | |
| TOT/AVG | | | | | | |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 120.3 | 82.03 | 27.60 | 29.70 | 10.70 | 0.93 |
| **Reduce Output** | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Full Input** | 120.5 | 107.30 | 36.10 | 38.40 | 15.10 | 0.92 |
| **Full Output** | 0.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Power Savings** | | | **8.50** | | | |
| **Power % Savings** | | | **23.55%** | | | |

**Graph #2b San Diego State University Jan/Feb 2004**
**Unit SD-2b, Parking Structure #1 Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SD-3 San Diego State University*

| | | | |
|---|---|---|---|
| Location: | Parking Structure #5 main elect | Date Measured: | 2/10/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 80 amp / #984 |
| Panel Fed By Energy Saver: | ES5 | Datalogger #: | M-15 |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 274.3 | 40.00 | 9.40 | 11.10 | 5.80 | 0.85 |
| B | 276.1 | 28.72 | 6.60 | 7.95 | 4.43 | 0.83 |
| C | 275.9 | 12.96 | 2.93 | 3.57 | 2.05 | 0.82 |
| TOT/AVG | 275.43 | 27.23 | 18.93 | 22.62 | 12.28 | 0.83 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 235.5 | 46.90 | 9.30 | 11.10 | 5.90 | 0.85 |
| B | 232.1 | 34.01 | 6.39 | 7.90 | 4.64 | 0.81 |
| C | 232.0 | 15.44 | 2.94 | 3.55 | 2.00 | 0.83 |
| TOT/AVG | 233.20 | 32.12 | 18.63 | 22.55 | 12.54 | 0.83 |

| **Description of Lights Controlled:** |
|---|
| Set Point 230V |
| Unit is now running. |
| Parking structure HID lighting HPS |

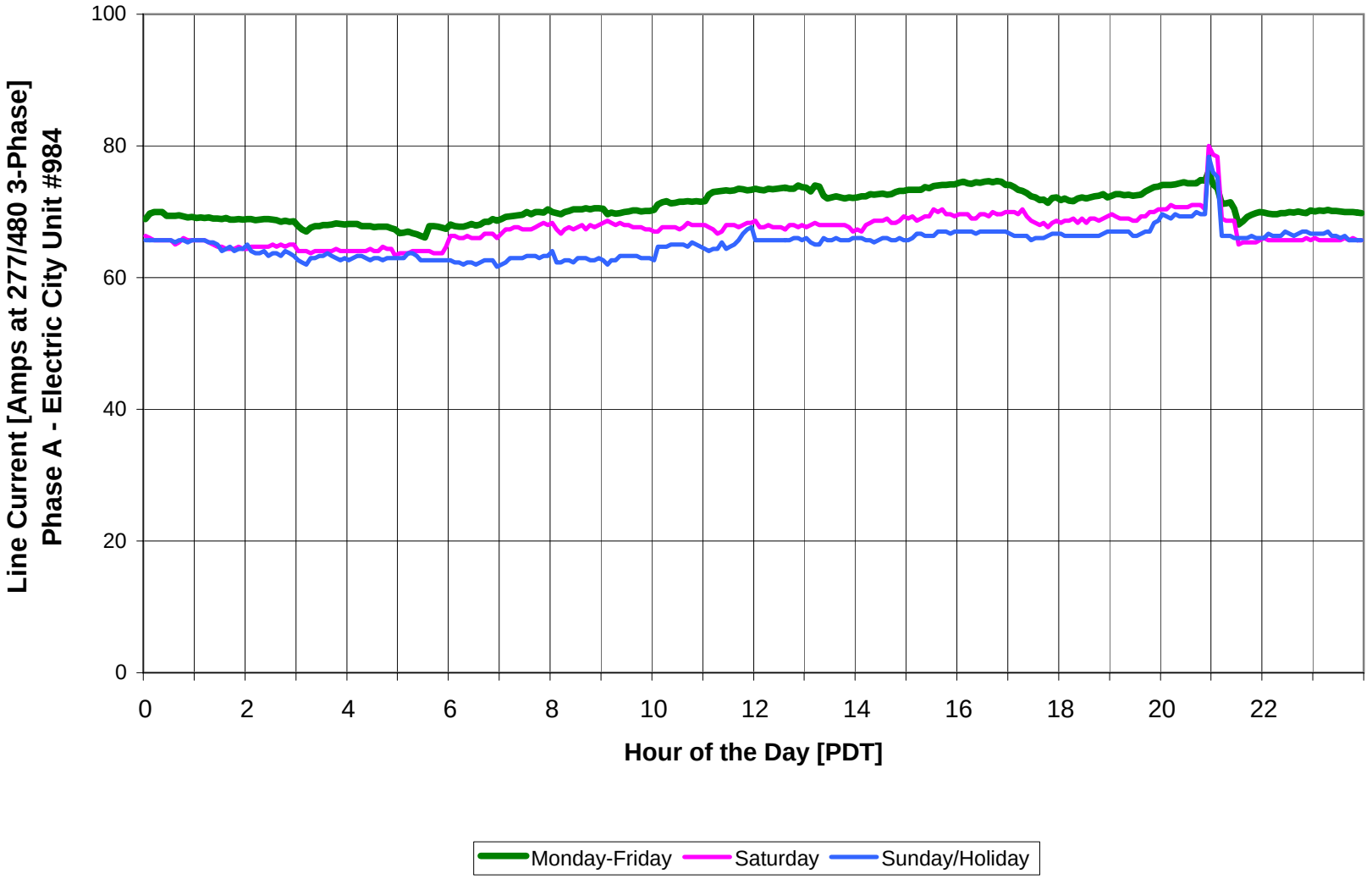
**CSU Chancellor's Office** *SD-3 San Diego State University*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.7 | 57.70 | 14.20 | 16.00 | 7.30 | 0.89 |
| B | 277.0 | 43.30 | 10.50 | 12.00 | 5.80 | 0.88 |
| C | 276.2 | 19.26 | 4.55 | 5.31 | 2.75 | 0.86 |
| TOT/AVG | 275.97 | 40.09 | 29.25 | 33.31 | 15.85 | 0.88 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 283.0 | 58.40 | 14.30 | 16.50 | 8.20 | 0.87 |
| B | 276.9 | 41.40 | 9.90 | 11.50 | 5.90 | 0.86 |
| C | 279.7 | 18.73 | 4.52 | 5.25 | 2.68 | 0.86 |
| TOT/AVG | 279.87 | 39.51 | 28.72 | 33.25 | 16.78 | 0.86 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 275.4 | 27.23 | 18.93 | 22.62 | 12.28 | 0.83 |
| **Reduce Output** | 233.2 | 32.12 | 18.63 | 22.55 | 12.54 | 0.83 |
| **Full Input** | 276.0 | 40.09 | 29.25 | 33.31 | 15.85 | 0.88 |
| **Full Output** | 279.9 | 39.51 | 28.72 | 33.25 | 16.78 | 0.86 |
| **Power Savings** | | | **10.32** | | | |
| **Power % Savings** | | | **35.28%** | | | |

**Graph #3 San Diego State University Jan/Feb 2004**
**Unit SD-3, Parking Structure #5 Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SD-4 San Diego State University*

| | | | |
|---|---|---|---|
| Location: | Parking Structure #6 Room 1st level elec room | Date Measured: | 1/21/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 80 amp / #950 |
| Panel Fed By Energy Saver: | ES-6, HP-2 | Datalogger #: | **M-6** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 281.3 | 37.52 | 9.10 | 10.60 | 5.43 | 0.86 |
| B | 281.3 | 37.85 | 9.10 | 10.60 | 5.48 | 0.86 |
| C | 280.7 | 40.75 | 9.90 | 11.50 | 5.80 | 0.86 |
| TOT/AVG | 281.10 | 38.71 | 28.10 | 32.70 | 16.71 | 0.86 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 256.2 | 41.08 | 8.80 | 10.50 | 5.75 | 0.84 |
| B | 253.8 | 42.10 | 9.20 | 10.60 | 5.30 | 0.87 |
| C | 254.9 | 43.70 | 9.50 | 11.10 | 5.80 | 0.85 |
| TOT/AVG | 254.97 | 42.29 | 27.50 | 32.20 | 16.85 | 0.85 |

**Description of Lights Controlled:**

Set Point at 255V

Meter claims 11.5% savings

## CSU Chancellor's Office

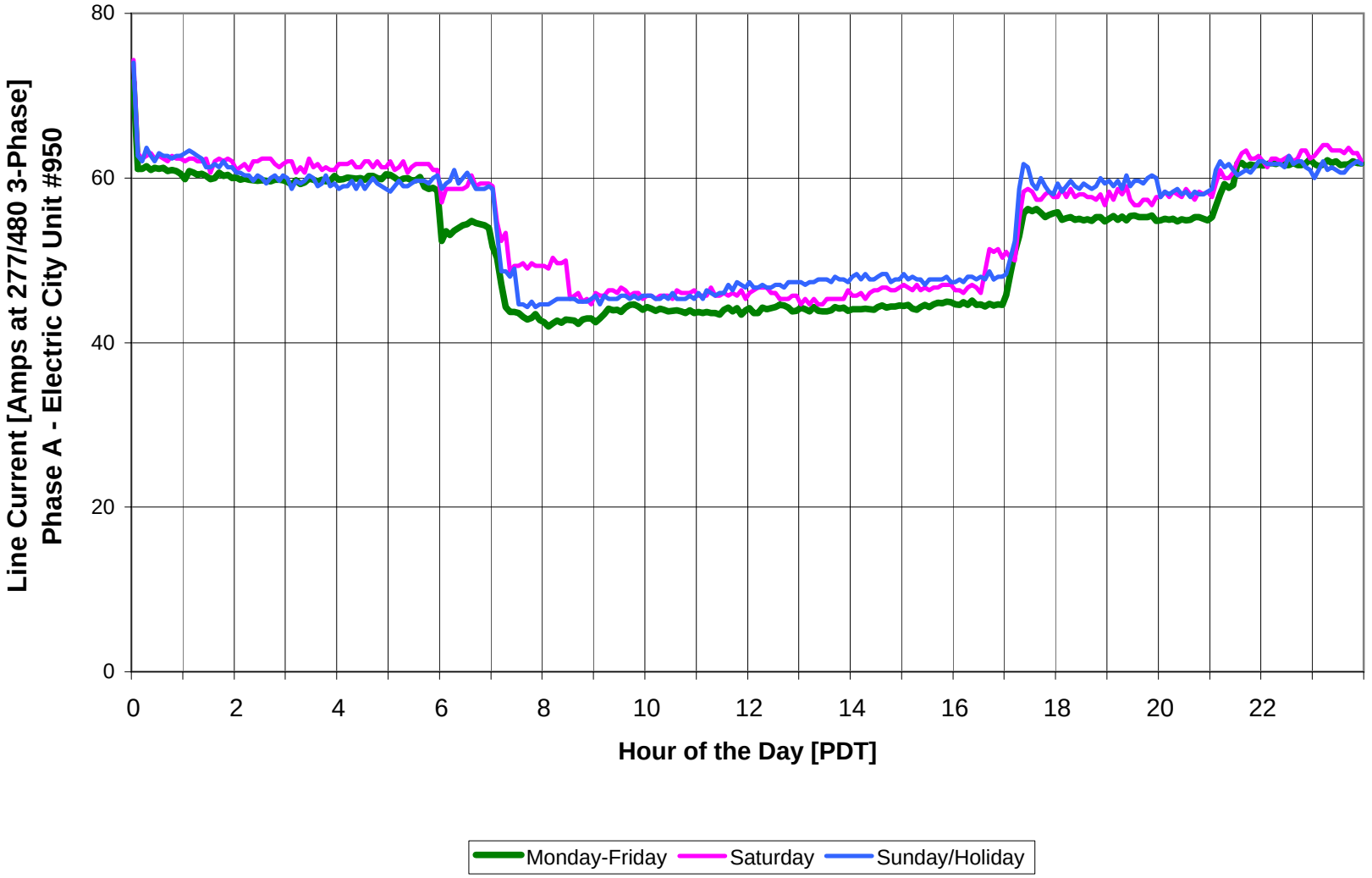
## *SD-4 San Diego State University*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 280.9 | 44.10 | 10.70 | 12.40 | 6.20 | 0.87 |
| B | 281.1 | 44.90 | 11.10 | 12.60 | 6.00 | 0.88 |
| C | 280.3 | 47.40 | 11.60 | 13.30 | 6.60 | 0.87 |
| TOT/AVG | 280.77 | 45.47 | 33.40 | 38.30 | 18.80 | 0.87 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.5 | 44.80 | 10.40 | 12.40 | 6.60 | 0.85 |
| B | 276.0 | 46.10 | 11.00 | 12.70 | 6.40 | 0.87 |
| C | 275.9 | 47.90 | 11.40 | 13.20 | 6.60 | 0.87 |
| TOT/AVG | 276.13 | 46.27 | 32.80 | 38.30 | 19.60 | 0.86 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 281.1 | 38.71 | 28.10 | 32.70 | 16.71 | 0.86 |
| **Reduce Output** | 255.0 | 42.29 | 27.50 | 32.20 | 16.85 | 0.85 |
| **Full Input** | 280.8 | 45.47 | 33.40 | 38.30 | 18.80 | 0.87 |
| **Full Output** | 276.1 | 46.27 | 32.80 | 38.30 | 19.60 | 0.86 |
| **Power Savings** | | | **5.30** | | | |
| **Power % Savings** | | | **15.87%** | | | |

**Graph #4 San Diego State University Jan/Feb 2004**
**Unit SD-4, Parking Structure #6 Lighting**
**Average Daily Load Profile**



# *CSU San Diego*
# *Energy Saver Units for Parking Structures*


Parking Structure #1 Unit 413


Nameplate for Unit 413

Disconnect for Unit 413

Disconnect for Unit 894

Parking Structure #1 Unit 894

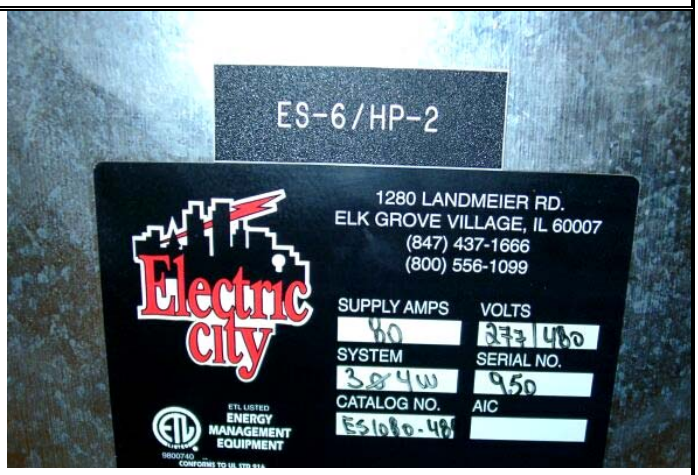

Nameplate for Unit 894

# *CSU San Diego*
# *Energy Saver Units for Parking Structures*

Parking Structure #4 Unit 880


Nameplate for Unit 880


Parking Structure #6 Unit 950




Nameplate for Unit 950


Parking Structure #5 Unit 984


Nameplate for Unit 984

# California State University Chancellor's Office
# 2002-03 Energy Efficiency Program #311BC-02
# CSU San Marcos

## Energy Savings Summary

Four Energy Saver units were installed on the campus of the California State University at San Marcos (CSUSM). Two of the units were installed to control lights in parking lots. The other two were installed in the library.

The following table delineates the savings estimates for each Energy Saver unit. The *ex-ante* savings reported to the CPUC on the program spreadsheets are compared with the ex-post savings estimates calculated from our measurement and verification analysis. The spreadsheet values are based on a pre-determined energy savings estimate for each size of unit. These calculations are described in the introductory section of this report. Our measured savings are based upon the metered power reduction of the Energy Saver unit and the operating hours of the lights it controls. The details of these calculations for each of the units are presented below.

| CSUSM Annual Energy Savings Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | Location | *Ex-Ante* CPUC Spreadsheet Savings (kWh) | Aloha Systems Measured Savings (kWh) |
| SM-1 | 80 | Parking Lot B | 49,275 | 7,883 |
| SM-2 | 40 | Parking Structure #1 | 24,638 | 18,667 |
| SM-3a | 120 | Library | 58,240 | 0* |
| SM-3b | 150 | Library | 74,880 | 0* |
| **Total** | | **San Marcos Campus** | **207,033** | **26,550*** |

*The total will become 173,584 if the campus staff relocates the two library units to a similar facility that has regular ballasts.

The table on the following page presents the demand reductions associated with the units. The ex-ante spreadsheet demand reductions reported to the CPUC are based upon the size of the unit. Aloha Systems measured the actual demand reduction of each of the units, calculated by comparing the demand of the operating unit with the demand of the lights when the unit is in bypass mode. Finally, we estimated the coincident peak (summer weekday afternoon) load reduction capability of the system by means of the load profile.

| CSUSM Demand Reduction Estimates | | | | |
|---|---|---|---|---|
| Energy Saver Unit | Unit Size (Amps) | *Ex-Ante* CPUC Spreadsheet Demand Reduction (kW) | Aloha Systems Measured Connected Load Reduction (kW) | Aloha Systems Estimated Summer On-Peak Demand Reduction (kW) |
| SM-1 | 80 | 11.250 | 1.63 | 0.00 |
| SM-2 | 40 | 5.625 | 3.86 | 0.00 |
| SM-3a | 120 | 14.000 | 0.00* | 0.00* |
| SM-3b | 150 | 18.000 | 0.00* | 0.00* |
| **Total** | | **48.875** | **5.49*** | **0.00*** |

The estimated annual energy savings, 26,550 kWh/yr, is 13% of the 207,033 kWh/yr reported in the CPUC project spreadsheet. This is caused by lower demand reduction estimates for the parking lot units, *but most especially by the universal voltage ballasts in the new library fixtures that counteract the energy-saving ability of the Energy Saver units.*

CSUSM staff is aware of the ballast problem and know that the two units in the library are not saving energy. They are developing plans to relocate the units to another similar area with regular ballasts that will enable them to save energy. When this happens, if the new area is similar in load and operating schedule to the library where they are presently installed, these two units will save 73,517 kWh each. This additional 157,034 kWh/year will bring the campus total up to 173,584, or 86% of the original estimate.

Following are descriptions of each of the Energy Saver units and the lighting systems they control, along with our analysis of their energy savings and demand reduction.

Meter reading information and full-page copies of the load profiles follow the descriptive narrative.

## SM-1. Parking Lot B

This 120/208-volt 80-amp unit controls the lights in parking lot B. The Energy Saver unit is located on a concrete pad adjacent the switchgear. The Energy Saver unit was set to reduce the voltage to the lights to 110 volts line-to-neutral. No operational, installation, or equipment problems were noted, although further reduction in the set-point voltage would achieve greater savings and would most likely be effective with these lights.

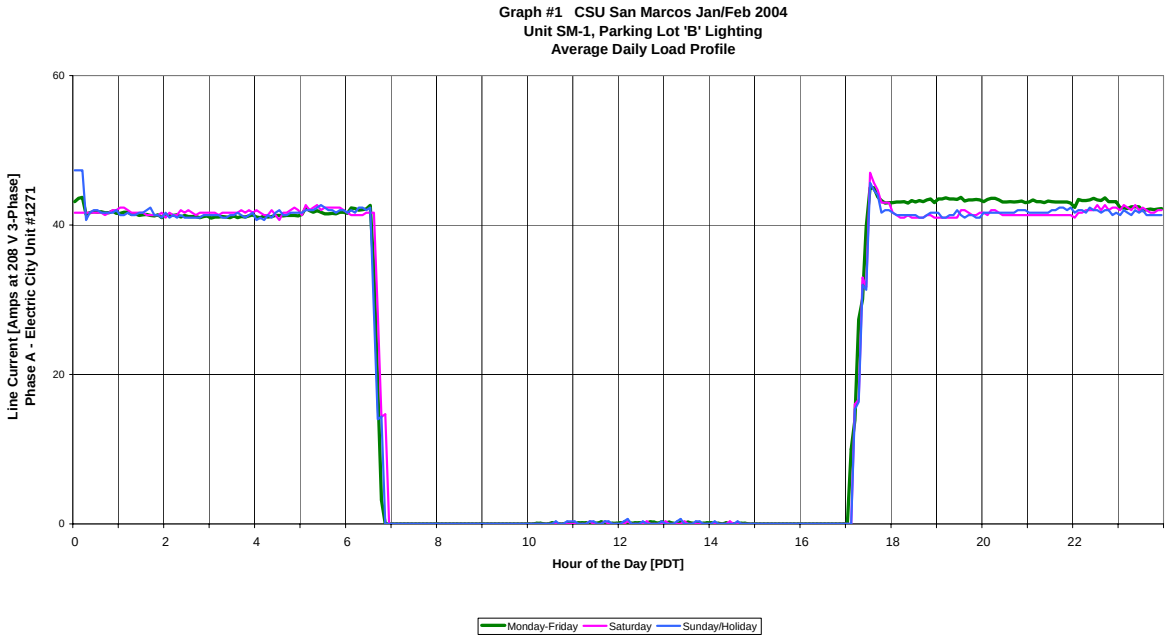
We measured actual output voltages averaging 111.0 volts. The input power was 12.92 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 14.55 kW, indicating that the power reduction was 1.63 kW, or 11.2% of the original load. The system operated at a 96% power factor in reduced-load mode and 97% power factor in full-load mode.

A datalogger was installed and recorded five-minute interval data from January 21 through February 10, 2004. The logger showed consistent operation of the lights during the night. The lights operated approximately 1.25 hours per day more than the time between sunrise and sunset. Adding this additional 456 hours per year to the 4380 hours gives an annual operating time of 4,836 hours.

The resultant energy savings achieved by this Energy Saver unit is 7,883 kWh per year (1.63 kW * 4836 h/yr). The connected load reduction is 1.63 kW, and the summer on-peak demand reduction is zero because the lights will not be operating during the summer on-peak period.

This value is only 16% of the 49,920 kWh/yr estimate on the CPUC spreadsheet. The operating hours measured were slightly greater than those assumed on the spreadsheet. However, the measured demand reduction is much lower than that assumed in the spreadsheet because the unit is not operating at rated capacity. This lowered demand reduction value is because (a) the unit is 120/208-volt, (b) it is not fully loaded, and (c) its voltage set-point is not as low as it could probably be.

The load profile of this Energy Saver is shown in the following graph.



## SM-2. Parking Lot N

This 277/480-volt 40-amp unit controls the lights in parking lot N. The Energy Saver unit is located on a concrete pad adjacent the switchgear. The Energy Saver unit was set to reduce the voltage to the lights to 227 volts line-to-neutral. No operational, installation, or equipment problems were noted.

We measured actual output voltages averaging 226.30 volts. The input power was 13.26 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 17.12 kW, indicating that the power reduction was 3.86 kW, or 22.6% of the original load. The system operated at a 72% power factor in reduced-load mode and 85% power factor in full-load mode.

A datalogger was installed but it malfunctioned. There is no reason to assume that these lights operate in any significantly different manner than those on Unit SM-1 described above. We therefore use an annual operating time of 4,836 hours for this unit as well.

The resultant energy savings achieved by this Energy Saver unit is 18,667 kWh per year (3.86 kW * 4836 h/yr). The connected load reduction is 3.86 kW, and the summer on-peak demand reduction is zero because the lights will not be operating during the summer on-peak period.

This value is 96% of the 19,413 kWh/yr estimate on the CPUC spreadsheet. The operating hours measured were slightly greater than those assumed on the spreadsheet, but the measured demand reduction is slightly lower than that assumed in the spreadsheet.

## SM-3a and 3b. Library

Unit SM-3a is a 277/480-volt 120-amp unit that controls the lights on the first, second, and third floors of the library. This Energy Saver unit is located in Room 1206 of the library and feeds Panel ES-1120-480. Unit SM-3b is a 277/480-volt 150-amp unit that controls the lights on the fourth and fifth floors. This unit is located in Room 4206 of the library and serves panel ES-1150-480. Unit 3a was set to reduce the voltage to the lights to 247 volts line-to-neutral, and Unit 3b was set to reduce the voltage to 237 volts. No operational, installation, or equipment problems were apparent on first observation.

We measured actual output voltages on Unit 3a averaging 244.7 volts. The input power was 60.0 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 59.6 kW, indicating that the unit took 0.4 kW more under reduced voltage.

On Unit 3b we measured output voltages averaging 234.7 volts. The input power was 59.6 kW when operating the lights on reduced voltage. In full-voltage bypass mode, the unit drew 59.4 kW, indicating that the unit took 0.2 kW more under reduced voltage.

Output currents on both units were observed to rise proportionally as voltage dropped. The systems operated at a near-unit power factor consistently.

The library has just been built. We discovered that the lights controlled by this unit contain "adaptable" or "universal voltage" electronic ballasts. These ballasts are interchangeable for 277V, 120V, and any other voltage operation from 108 to 305 volts. The electronic ballasts adjust current in accordance with voltage in a manner to provide proper output to the fluorescent tubes. These ballasts are relatively new on the market and are designed primarily to reduce inventory and installation errors.

The Energy Saver works by reducing supply voltage to the ballasts. For most ballasts, including both magnetic and "standard" electronic ballasts, this results in lower input power and lower light output. With the adaptable ballast, the ballast counteracts the effects of the Energy Saver, resulting in no demand change.

This is a serious installation problem, as the Energy Saver will be incapable of saving *any* energy in the library. We discussed this problem with the campus facilities personnel, and they are developing plans to relocate the Energy Savers to another building where they will be able to save energy.

We will estimate the energy that would have been saved by the Energy Saver had the new lights not had universal-voltage ballasts. This will give an estimate as to how much they will be able to save once they are moved. The campus and project totals will present the current situation, with zero energy savings for these units, but with reference to what the total will become once these units are moved.

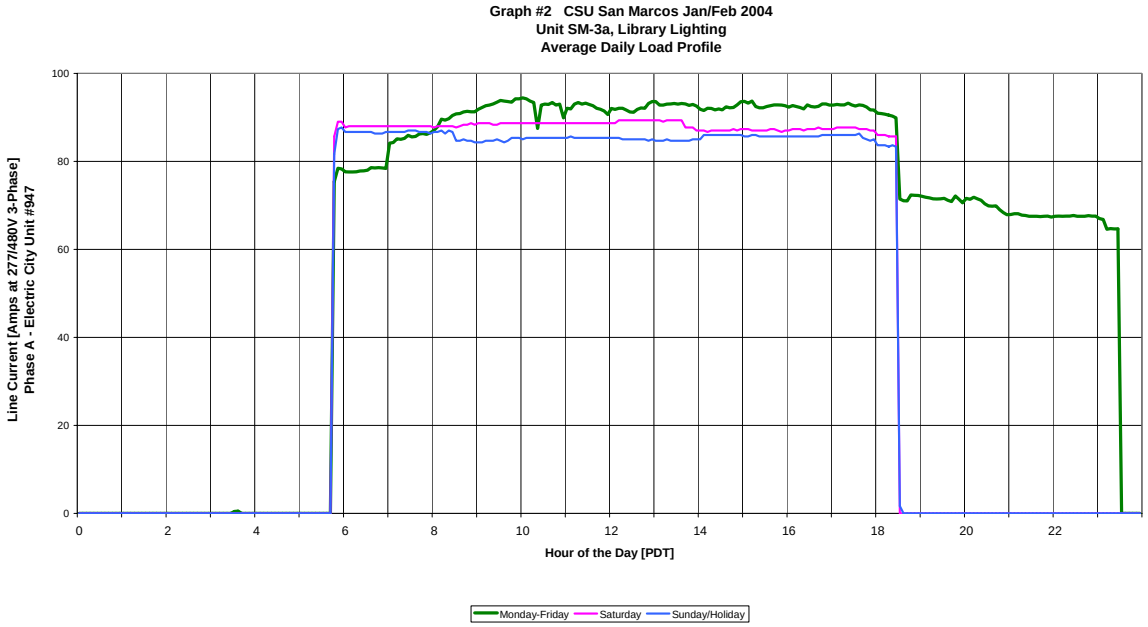
Dataloggers were installed and recorded five-minute interval data from January 21 through February 10, 2004. Both loggers showed well-controlled lighting patterns with lights operating from 5:45 a.m. until 11:30 p.m. (17.75 hours) Monday through Thursday and 5:45 a.m. until 6:30 p.m. (12.75 hours) Friday, Saturday, and Sunday. This amounts to 5,699 hours per year.

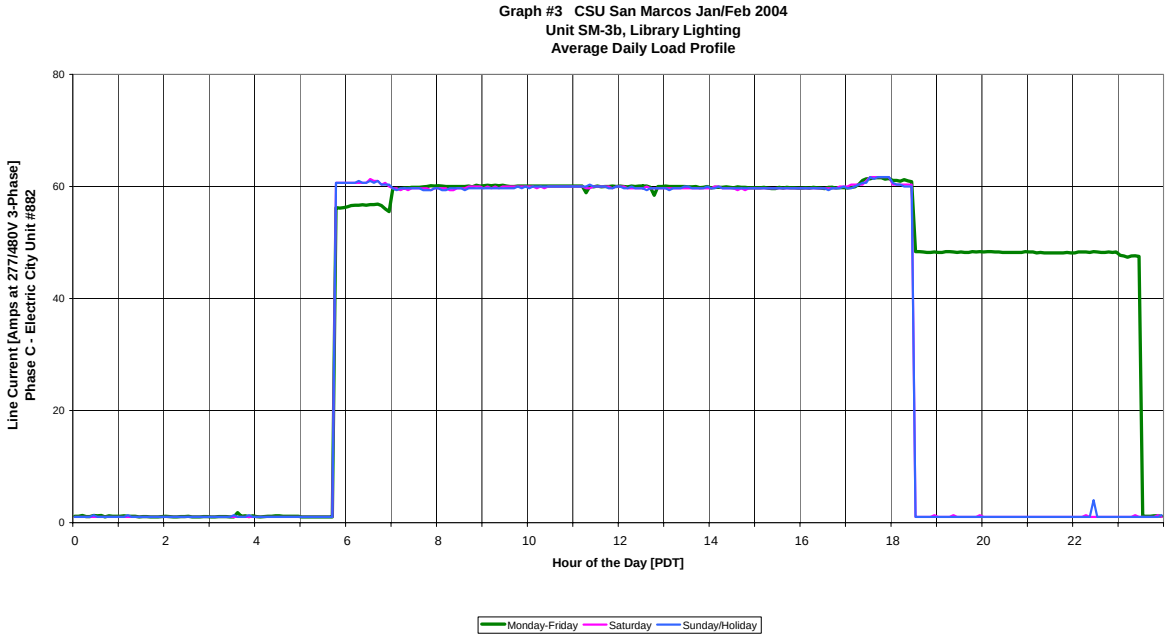
Energy savings for both of these units is zero because of the ballast problem.

However, the lighting load passing through each of the units is 60 kW. If the lights had had standard electronic ballasts, or if the Energy Saver units are reinstalled in a different but similar location, the would have reduced this demand by approximately 21.5%. (Compare units SB-1, SB-2, and SB-3 in the library at CSU San Bernardino.) This demand reduction would be 12.9 kW for each unit. This would result in an energy savings of 73,517 kWh/year for each unit, or 147,034 kWh/year for both combined.

The CPUC spreadsheet estimate is 52,240 kWh/year for the 120-amp unit and 74,880 kWh/year for the 150-amp unit, totaling 133,120 kWh/year. Thus if the ballast problem had not existed, the units would have saved 110% of the estimated amount.

The load profiles of these two Energy Savers are shown in the following graphs.




## Power Readings and Load Profiles

Following are tables of the power readings for each individual unit as well as full-page printouts of the load profiles.

## CSU Chancellor's Office

## *SM-1 CSU San Marcos*

| | | | |
|---|---|---|---|
| Location: | Parking Lot B concrete pad adjacent switchgears | Date Measured: | 1/21/2004 |
| Energy Saver Size: | **80-AMP** | Energy Saver Serial #: | **10-03-01-01-01271** |
| Panel Fed By Energy Saver: | | Datalogger #: | **M-10** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 120.6 | 43.09 | 4.96 | 5.20 | 1.56 | 0.95 |
| B | 120.8 | 40.20 | 4.60 | 4.90 | 1.40 | 0.96 |
| C | 121.0 | 28.63 | 3.36 | 3.45 | 0.82 | 0.97 |
| TOT/AVG | 120.80 | 37.31 | 12.92 | 13.55 | 3.78 | 0.96 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 111.7 | 46.60 | 4.96 | 5.21 | 1.60 | 0.95 |
| B | 110.5 | 43.40 | 4.60 | 4.80 | 1.40 | 0.96 |
| C | 110.7 | 30.95 | 3.32 | 3.42 | 0.82 | 0.97 |
| TOT/AVG | 110.97 | 40.32 | 12.88 | 13.43 | 3.82 | 0.96 |

| **Description of Lights Controlled:** |
|---|
| Set Point at 110V. |
| 14.6% Savings Potential |
| **Parking Lot lights** |

## CSU Chancellor's Office

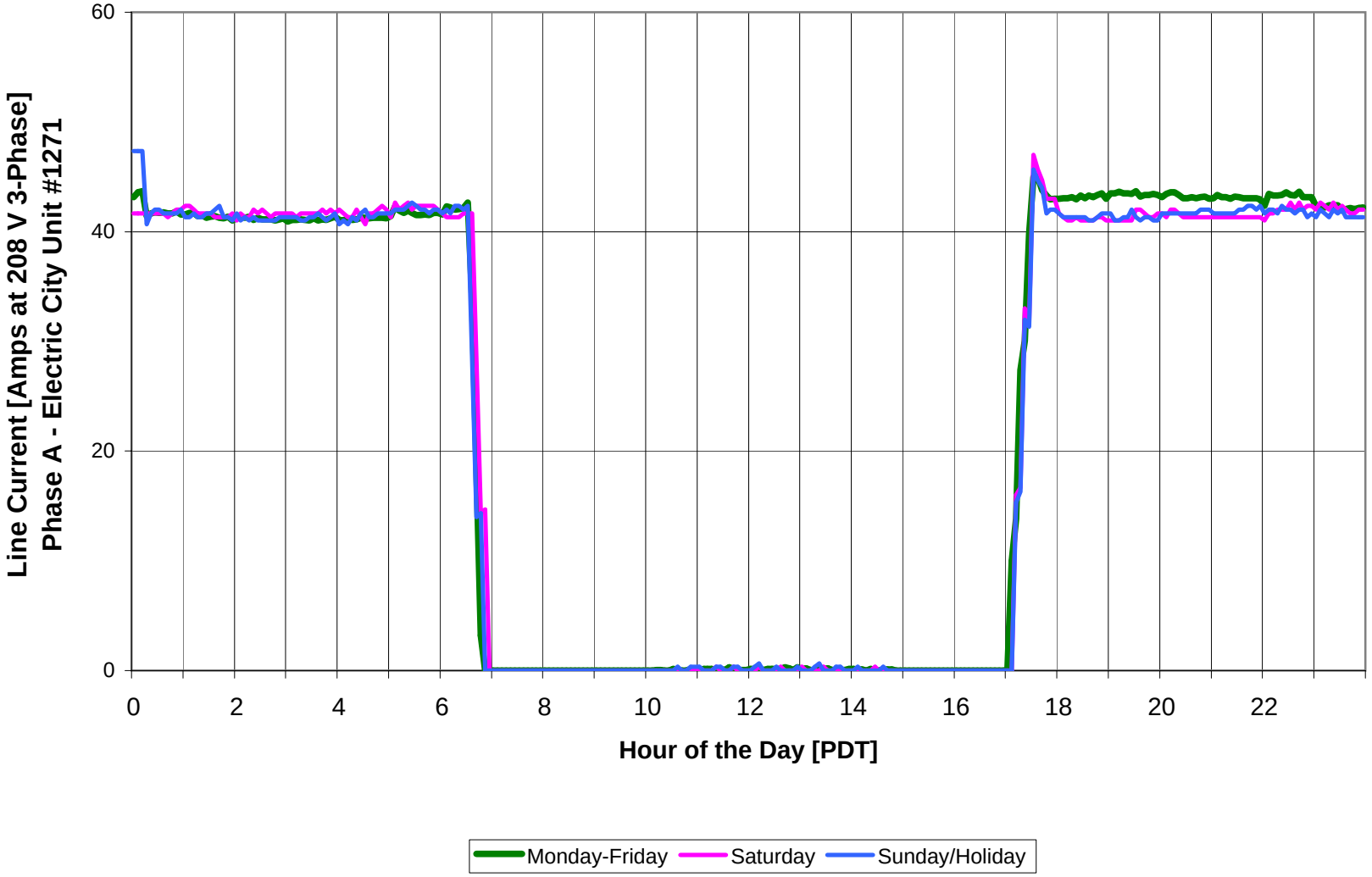
## *SM-1 CSU San Marcos*

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 120.2 | 50.10 | 5.70 | 5.90 | 1.70 | 0.98 |
| B | 120.1 | 45.70 | 5.10 | 5.40 | 1.60 | 0.96 |
| C | 120.4 | 32.64 | 3.75 | 3.86 | 0.92 | 0.97 |
| TOT/AVG | 120.23 | 42.81 | 14.55 | 15.16 | 4.22 | 0.97 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 121.3 | 48.60 | 5.70 | 5.90 | 1.70 | 0.98 |
| B | 118.7 | 45.10 | 5.10 | 5.40 | 1.60 | 0.96 |
| C | 119.2 | 32.40 | 3.75 | 3.86 | 0.92 | 0.97 |
| TOT/AVG | 119.73 | 42.03 | 14.55 | 15.16 | 4.22 | 0.97 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 120.8 | 37.31 | 12.92 | 13.55 | 3.78 | 0.96 |
| **Reduce Output** | 111.0 | 40.32 | 12.88 | 13.43 | 3.82 | 0.96 |
| **Full Input** | 120.2 | 42.81 | 14.55 | 15.16 | 4.22 | 0.97 |
| **Full Output** | 119.7 | 42.03 | 14.55 | 15.16 | 4.22 | 0.97 |
| **Power Savings** | | | **1.63** | | | |
| **Power % Savings** | | | **11.20%** | | | |

**Graph #1 CSU San Marcos Jan/Feb 2004**
**Unit SM-1, Parking Lot 'B' Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SM-2 CSU San Marcos*

| | | | |
|---|---|---|---|
| Location: | North Lot concrete pad adjacent switchgear | Date Measured: | 1/21/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 40 amp / #898 |
| Panel Fed By Energy Saver: | ES-1040-480 | Datalogger #: | **V-6** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 279.3 | 25.43 | 5.48 | 7.08 | 4.48 | 0.77 |
| B | 280.2 | 20.71 | 3.78 | 5.82 | 4.42 | 0.65 |
| C | 280.1 | 19.50 | 4.00 | 5.46 | 3.72 | 0.73 |
| TOT/AVG | 279.87 | 21.88 | 13.26 | 18.36 | 12.62 | 0.72 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 224.9 | 30.40 | 5.28 | 6.88 | 4.41 | 0.77 |
| B | 226.0 | 25.24 | 3.86 | 5.71 | 4.21 | 0.68 |
| C | 228.1 | 24.11 | 4.04 | 5.50 | 3.72 | 0.74 |
| TOT/AVG | 226.33 | 26.58 | 13.18 | 18.09 | 12.34 | 0.73 |

**Description of Lights Controlled:**

Set Point is 227V.

Parking lot lights.

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 278.6 | 29.22 | 6.99 | 8.03 | 3.95 | 0.87 |
| B | 279.7 | 22.50 | 5.06 | 6.26 | 3.68 | 0.81 |
| C | 279.0 | 20.66 | 5.07 | 5.77 | 2.74 | 0.88 |
| TOT/AVG | 279.10 | 24.13 | 17.12 | 20.06 | 10.37 | 0.85 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 274.5 | 26.80 | 6.57 | 7.38 | 3.36 | 0.89 |
| B | 273.7 | 21.95 | 4.94 | 6.00 | 3.41 | 0.82 |
| C | 272.8 | 20.88 | 4.97 | 5.70 | 2.97 | 0.87 |
| TOT/AVG | 273.67 | 23.21 | 16.48 | 19.08 | 9.74 | 0.86 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 279.9 | 21.88 | 13.26 | 18.36 | 12.62 | 0.72 |
| **Reduce Output** | 226.3 | 26.58 | 13.18 | 18.09 | 12.34 | 0.73 |
| **Full Input** | 279.1 | 24.13 | 17.12 | 20.06 | 10.37 | 0.85 |
| **Full Output** | 273.7 | 23.21 | 16.48 | 19.08 | 9.74 | 0.86 |
| **Power Savings** | | | **3.86** | | | |
| **Power % Savings** | | | **22.55%** | | | |

## CSU Chancellor's Office

## *SM-3a CSU San Marcos*

| | | | |
|---|---|---|---|
| Location: | Library - Room 1206 | Date Measured: | 2/10/2004 |
| Panel Serving Energy Saver: | | Energy Saver Size/Serial #: | 120 amp / #947 |
| Panel Fed By Energy Saver: | ES 1120-480 | Datalogger #: | **M-9** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 276.7 | 92.00 | 25.30 | 25.40 | 2.70 | 0.99 |
| B | 278.1 | 81.10 | 22.40 | 22.50 | 2.10 | 1.00 |
| C | 279.2 | 44.36 | 12.30 | 12.40 | 1.38 | 0.99 |
| TOT/AVG | 278.00 | 72.49 | 60.00 | 60.30 | 6.18 | 0.99 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 245.5 | 102.50 | 25.00 | 25.10 | 2.80 | 0.99 |
| B | 244.9 | 91.10 | 22.20 | 22.30 | 2.40 | 0.99 |
| C | 243.8 | 49.76 | 12.00 | 12.10 | 1.16 | 1.00 |
| TOT/AVG | 244.73 | 81.12 | 59.20 | 59.50 | 6.36 | 0.99 |

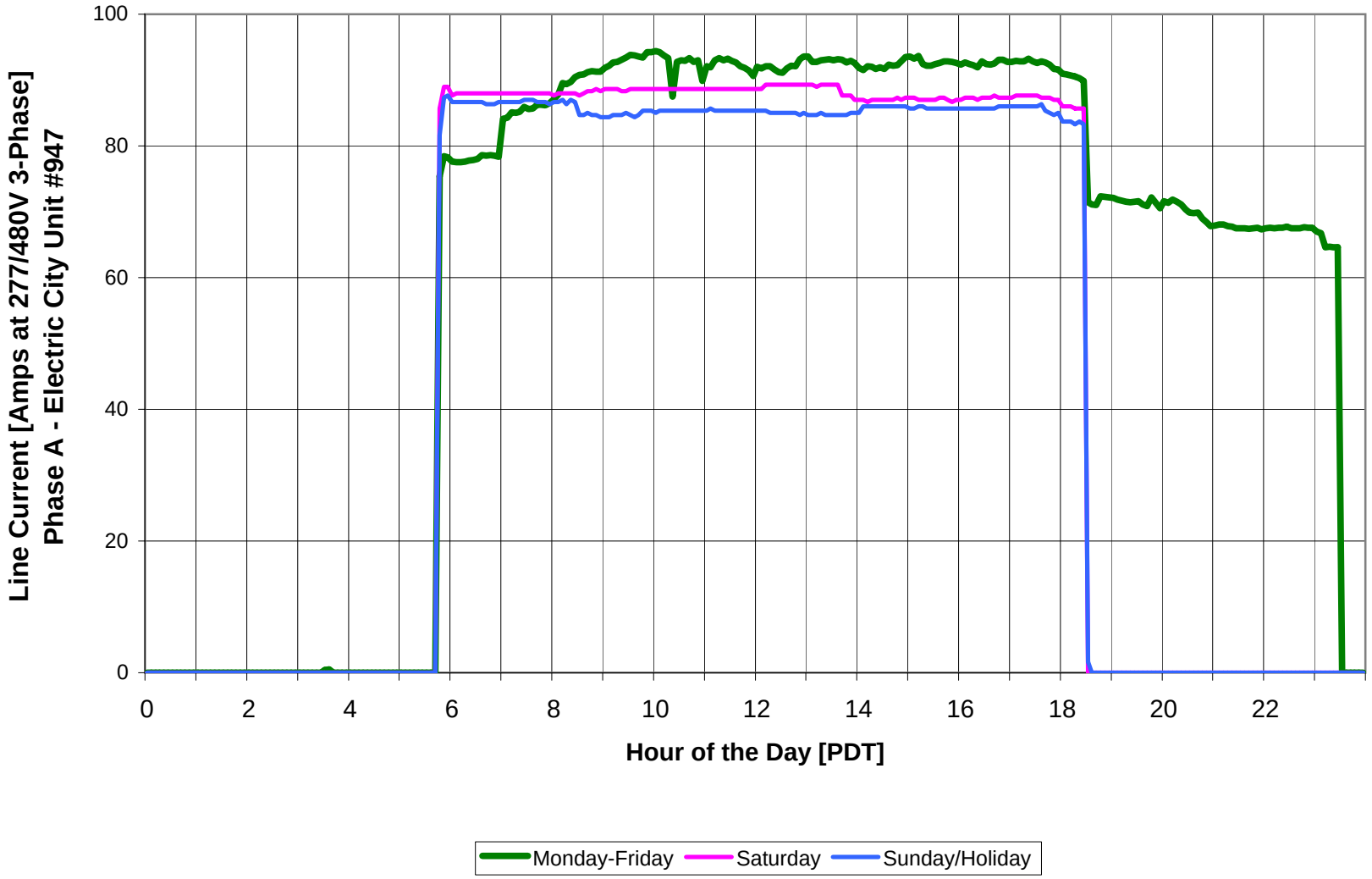
| **Description of Lights Controlled:** |
|---|
| Set Point 247V |
| Readout claims 6.6% Savings |
| Library Lights 1st, 2nd, 3rd Floor |

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 276.8 | 91.40 | 25.10 | 25.30 | 3.40 | 0.99 |
| B | 278.1 | 80.90 | 22.30 | 22.50 | 2.60 | 0.99 |
| C | 278.6 | 44.33 | 12.20 | 12.40 | 1.62 | 0.99 |
| TOT/AVG | 277.83 | 72.21 | 59.60 | 60.20 | 7.62 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 273.0 | 91.80 | 24.80 | 25.10 | 3.50 | 0.99 |
| B | 274.7 | 80.80 | 22.00 | 22.20 | 3.00 | 0.99 |
| C | 275.0 | 44.66 | 11.90 | 12.00 | 1.35 | 0.99 |
| TOT/AVG | 274.23 | 72.42 | 58.70 | 59.30 | 7.85 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 278.0 | 72.49 | 60.00 | 60.30 | 6.18 | 0.99 |
| **Reduce Output** | 244.7 | 81.12 | 59.20 | 59.50 | 6.36 | 0.99 |
| **Full Input** | 277.8 | 72.21 | 59.60 | 60.20 | 7.62 | 0.99 |
| **Full Output** | 274.2 | 72.42 | 58.70 | 59.30 | 7.85 | 0.99 |
| **Power Savings** | | | **-0.40** | | | |
| **Power % Savings** | | | **-0.67%** | | | |

**Graph #2 CSU San Marcos Jan/Feb 2004**
**Unit SM-3a, Library Lighting**
**Average Daily Load Profile**



## CSU Chancellor's Office

## *SM-3b CSU San Marcos*

| | | | |
|---|---|---|---|
| Location: | Library Room 4206, 4th Floor | Date Measured: | 2/10/2004 |
| Panel Serving Energy Saver: | L4-A | Energy Saver Size/Serial #: | 150 amp / #882 |
| Panel Fed By Energy Saver: | ES 1150-480 | Datalogger #: | **M-31** |

**Reduced Voltage Operation -- INPUT Power (Line IN to Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 277.6 | 68.30 | 18.90 | 19.00 | 1.60 | 1.00 |
| B | 278.2 | 90.70 | 25.10 | 25.20 | 2.20 | 1.00 |
| C | 279.4 | 56.00 | 15.60 | 15.60 | 1.60 | 1.00 |
| TOT/AVG | 278.40 | 71.67 | 59.60 | 59.80 | 5.40 | 1.00 |

**Reduced Voltage Operation -- OUTPUT Power (Output From Energy Saver)**

| Phase | Voltage | Current | Real P [kW] | S [kVA] | Q [kVAR] | Pwr Fctr |
|---|---|---|---|---|---|---|
| A | 236.4 | 79.50 | 18.70 | 18.80 | 1.70 | 1.00 |
| B | 232.9 | 107.30 | 24.90 | 25.00 | 2.50 | 1.00 |
| C | 234.8 | 66.60 | 15.60 | 15.60 | 1.60 | 1.00 |
| TOT/AVG | 234.70 | 84.47 | 59.20 | 59.40 | 5.80 | 1.00 |

**Description of Lights Controlled:**

Set point at 237V

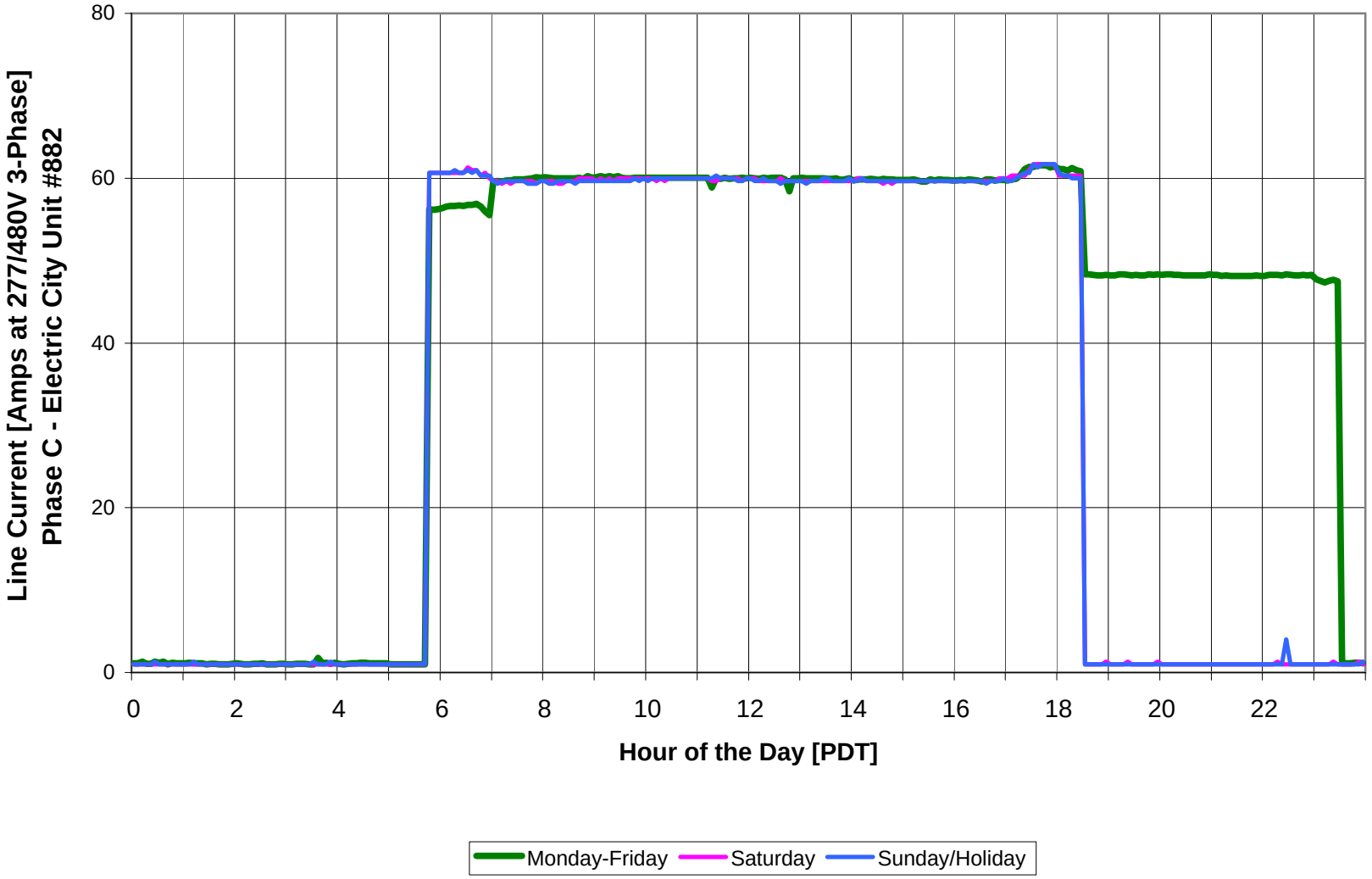
Library Lights 4th and 5th floor

| FULL Voltage Operation -- INPUT Power (Line IN To Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 277.7 | 68.90 | 19.00 | 19.10 | 2.10 | 0.99 |
| B | 278.6 | 90.10 | 24.90 | 25.10 | 2.90 | 0.99 |
| C | 279.3 | 56.00 | 15.50 | 15.60 | 2.10 | 0.99 |
| TOT/AVG | 278.53 | 71.67 | 59.40 | 59.80 | 7.10 | 0.99 |

| FULL Voltage Operation -- OUTPUT Power (Output From Energy Saver) | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| A | 275.7 | 67.90 | 18.60 | 18.70 | 2.10 | 0.99 |
| B | 269.6 | 92.60 | 24.80 | 25.00 | 3.10 | 0.99 |
| C | 268.2 | 57.60 | 15.30 | 15.50 | 2.00 | 0.99 |
| TOT/AVG | 271.17 | 72.70 | 58.70 | 59.20 | 7.20 | 0.99 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| **Phase** | **Voltage** | **Current** | **Real P [kW]** | **S [kVA]** | **Q [kVAR]** | **Pwr Fctr** |
| **Reduce Input** | 278.4 | 71.67 | 59.60 | 59.80 | 5.40 | 1.00 |
| **Reduce Output** | 234.7 | 84.47 | 59.20 | 59.40 | 5.80 | 1.00 |
| **Full Input** | 278.5 | 71.67 | 59.40 | 59.80 | 7.10 | 0.99 |
| **Full Output** | 271.2 | 72.70 | 58.70 | 59.20 | 7.20 | 0.99 |
| **Power Savings** | | | **-0.20** | | | |
| **Power % Savings** | | | **-0.34%** | | | |

**Graph #3 CSU San Marcos Jan/Feb 2004**
**Unit SM-3b, Library Lighting**
**Average Daily Load Profile**

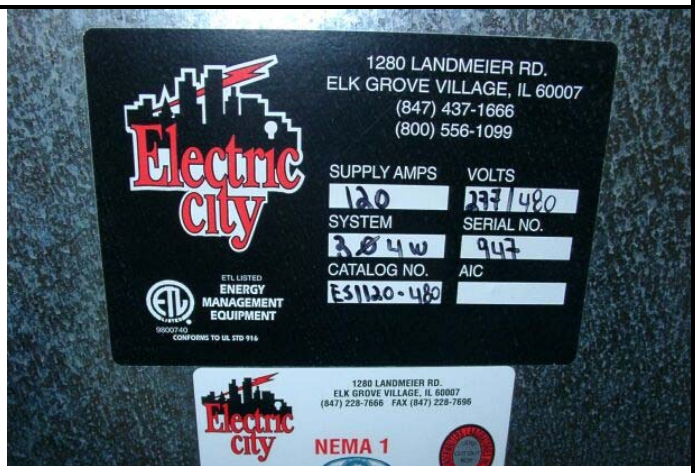


# *CSU San Marcos*
# *Energy Saver Units*

Lot N Unit 898

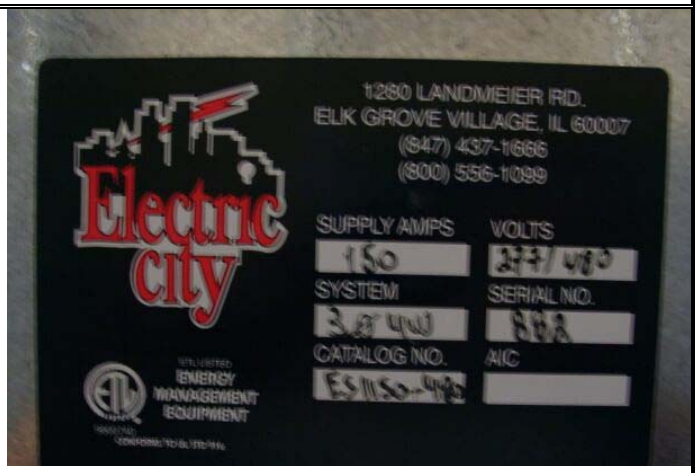

Nameplate Unit 898


Library 1st Floor Unit 947




Nameplate Unit 947

Library 4th Floor Unit 882




Nameplate Unit 882

# *CSU San Marcos*
# *Energy Saver Units*


Unit 882 in Bypass


Meter Unit 882