

Higher Education Energy Efficiency Partnership Program

BEST PRACTICES AWARDS



UC / CSU Sustainability Conference, June 2005



*A program created by the
UC/CSU/IOU Partnership
under the auspices of the
California Public Utilities Commission*



HVAC Retrofit Pacific Hall and Stein Clinical Research Facility



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Manager, Utilities and Energy Services**

HVAC Retrofit: Best Practices Innovative Controls and Operations

- Basics: Install Variable Frequency Drives (VFD's) on supply and exhaust fans of an existing constant volume laboratory building and rebalance the building to current laboratory standards.
- Project of the Year Award from San Diego Excellence in Energy Awards (SANDEE).

Pacific Hall



Stein Research



Project Description / Background



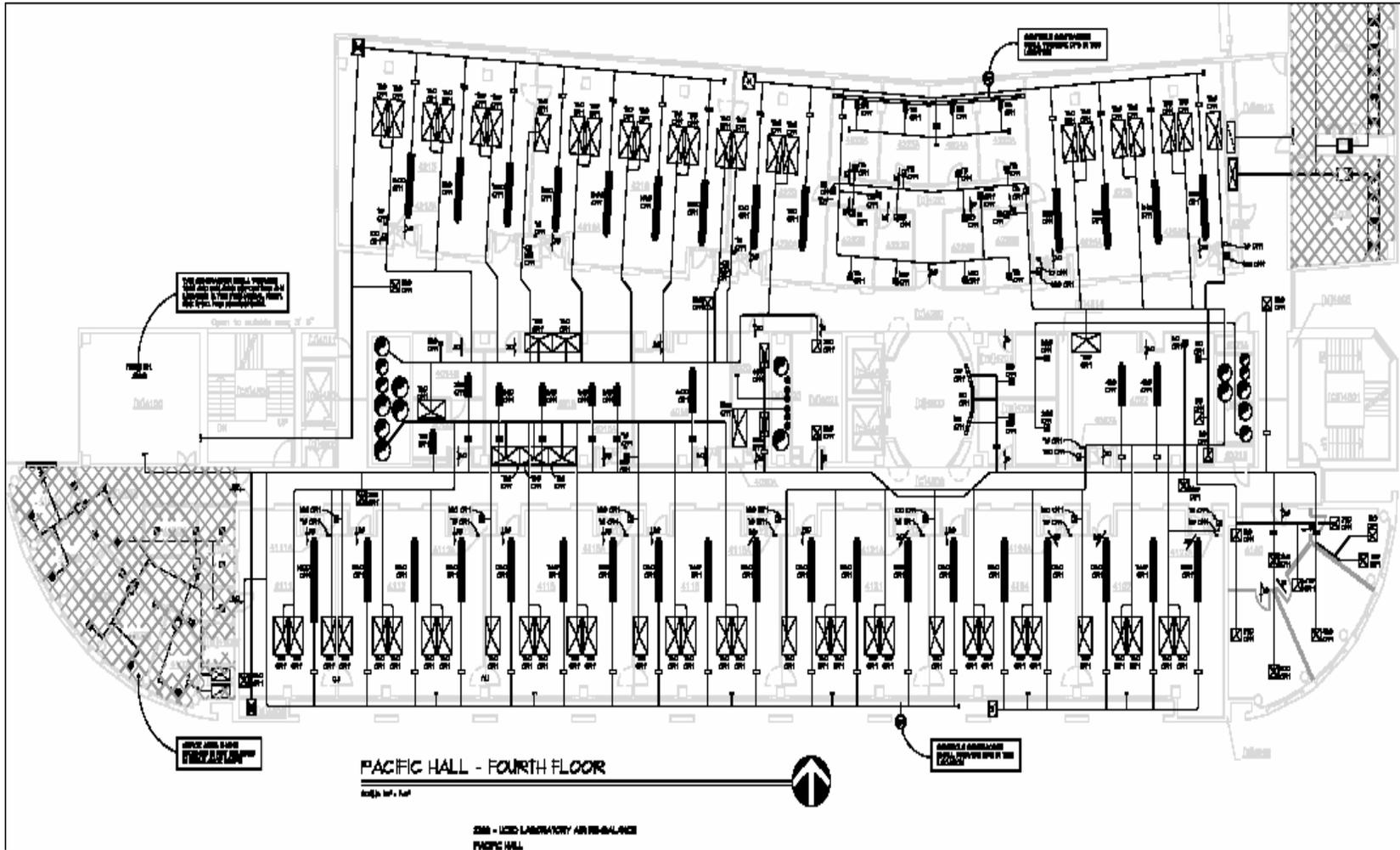
■ Pacific Hall

- ❑ Constructed in 1993
- ❑ 7 floors, 184,540 mgsf
- ❑ Biological Sciences and Chemistry and Biochemistry
- ❑ 96% Outside Air, 345,250 cfm osa supply/exhaust

■ Energy Benchmarks

- ❑ 580 kBtu/sf-yr
- ❑ 39 kw/sf-yr
- ❑ 4.8 w/sf
- ❑ \$7.9/sf-yr

Pacific Hall



Pacific Hall

Individual Air Handlers per Floor

2 - Plenum Exhaust systems (4 exhaust fans per plenum)

Approx 250 fume hoods

Air Change rate measured between 15 – 20 ACH



Project Description / Background



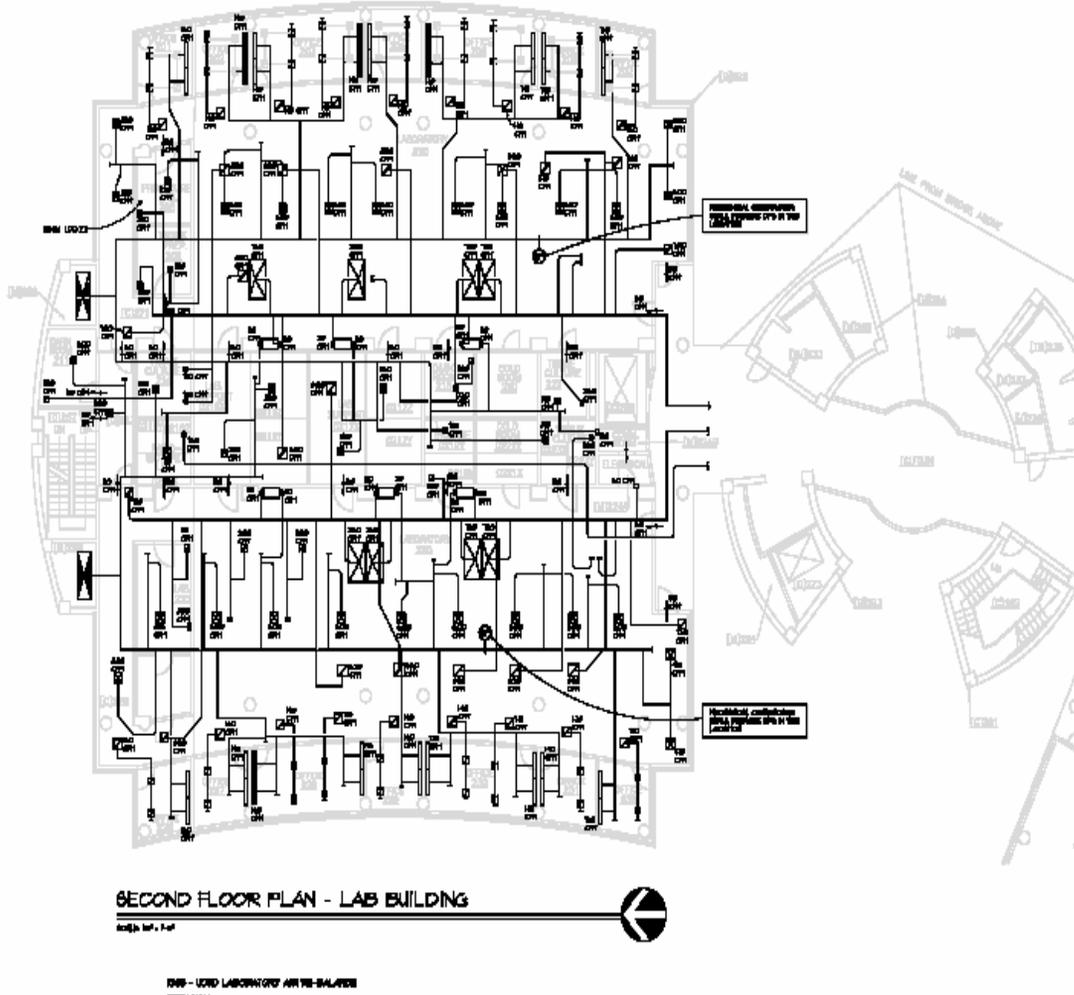
■ Stein Clinical

- ❑ Constructed in 1991
- ❑ 5 floors, 104,240 mgsf
- ❑ School of Medicine
- ❑ 87% Outside Air, 158,990 cfm osa supply/exhaust

■ Energy Benchmarks

- ❑ 550 kBtu/sf-yr
- ❑ 51 kw/sf-yr
- ❑ 5.8 w/sf
- ❑ \$8.3/sf-yr

Stein Clinical Research



Stein Clinical Research

2 - Air Handlers stacked and supply all floors

Individual Exhaust Fans per floor

Approx 250 fume hoods

Air Change rate measured between 15 – 20 ACH



Best Practices for Constant Volume Labs

- **Recognize the “power” of Fan Laws**
 - Horsepower varies as the cube of the fan speed.

- **Room Dilution rates set by EHS**
 - 10 – 12 ACH in open lab areas are sufficient while keeping 100 fps across constant volume fume hoods.
 - Older lab bldg often used higher exchange rates to assure safety and general exhaust is often flowing excess volumes.
 - Newer VAV buildings can turn down to 6 – 10 ach and occupancy sensing on fume hoods can allow 60 fps.

- **Variable Frequency Drives on the supply and exhaust fans have multiple benefits**
 - Retro-fit can occur with minimum (or zero) effect to occupants.
 - Allows static pressure to be controlled over time.
 - Allows energy (kw & kwh) monitoring of fan energy via EMS interface.
 - Allows incremental VAV upgrades during future lab renovations.
 - Corrects power factor.

- **Combat simultaneous Heating and Cooling**
 - Tight T-stat control is only way
 - Zone averaging for Air Handler reset

- **Install whole building monitoring and sub metering of supply and exhaust fan energy**
 - Chilled and High Temperature water BTU metering (UCSD uses 4 channel ultrasonic) into EMS system.
 - Electrical metering of building main transformers networked into SCADA system (UCSD has existing PML-Ion system)
 - Sub metered supply and exhaust fans into EMS system
 - Integrated EMS and SCADA systems into single platform (UCSD used Ion EEM system)

Energy Savings

Microsoft Excel - Best Practices.xls

File Edit View Insert Format Tools Data Window Help

Type a question for help

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2004 - 2005 UC/CSU/IOU Partnership Program - Retrofit Project Information Sheet

Project Name: _____ Contact Name: John Dillliott
 Campus: UCSD Contact Phone: 858-822-2807 Email: jdillliott@ucsd.edu
 Building Name: _____ Building Type: _____ # Floors: _____ Age: _____ Sq. Ft. _____
 Utility: _____ Tariff: _____ Electric: _____ Gas: _____

Meas #	Location or ID	Measure Description	Effective Useful Life (yr)	Number of Units	Installed Cost per Unit (\$)	Subtotal Measure Cost (\$)
1	Stien	Install VFD on supply and exhaust fans, rebalance zones		99,636	2.61	\$228,899.00
2	Pacific Hall	Install VFD on supply and exhaust fans, rebalance zones		184,539	2.31	\$426,285.09
Total Measure Cost:						\$655,184.09

Energy/On-Peak Demand Savings Summary

Meas #	Electric						Gas			
	Existing Measure Usage (kWh/yr)	Installed Measure Usage (kWh/yr)	Energy Savings (kWh/yr)	Existing On-Peak Demand (kW)	Installed On-Peak Demand (kW)	On-Peak Demand Reduction (kW)	Existing Measure Usage (therm/yr)	Installed Measure Usage (therm/yr)	Energy Savings (therm/yr)	
1	3,163,475	2,122,787	1,040,688	330	212	118	379,190	321,300	57,890	
3	3,032,021	2,332,973	699,048	420	340	80	823,410	767,180	56,230	
Total:			1,739,736	Total:			198	Total:		114,120

Project Summary

Energy Savings Total (kWh/yr): 1,739,736
 Energy Savings Total (therm/yr): 114,120
 On-Peak Demand Reduction Total: 198
 Total Measure Cost: \$655,184.09
 Estimated Project Completion Date: _____

Project Assistance

developing bid packages, etc?

Yes No

Retrofit Project Form / Instruction / Effective Useful Life /

Ready

NUM

Start Inboxes - Micros... Untitled Mess... UC-CSU Best ... UC-CSU UCSD... Book1 Book2 Best Practic... Metasys pics... 3 Internet E... 11:41 AM

Real Time Thermal Metering

The screenshot displays a software interface for real-time thermal metering. On the left is a 'NETWORK MAP-UCSD' window showing a tree view of building categories. On the right are two data windows: 'BTU' and 'PHBTUS', each showing a table of energy and temperature data.

NETWORK MAP-UCSD

- UCSD\CP CENTRAL UTILITIES PLANT
- UCSD\CMG CENT. MOLEC. GENETICS
- UCSD\CMM CELL. MOLEC. MED. WEST
- UCSD\CMRR CENT MAGNETIC REC RSCH
- UCSD\CAB CHEMISTRY RESEARCH BLDG
- UCSD\CLASSRMT1 CLASSROOM BUILDING 1
- UCSD\CLINSCI CLINICAL SCIENCE BLDG.
- UCSD\CSB COGNITIVE SCIENCE BLDG
- UCSD\CSG CAMPUS SERVICES COMPLEX
- UCSD\DANCE DANCE STUDIO
- UCSD\EMF ENVIRO. MGMT. FACILITY
- UCSD\EBU-1 ENGINEERING BLDG. UNIT 1
- UCSD\EBU-2 ENGINEERING BLDG. UNIT 2
- UCSD\EBU-3 ENGINEERING BLDG. UNIT 3
- UCSD\ERC ELEANOR ROOSEVELT COL
- UCSD\FORUMTHR FORUM THEATER
- UCSD\GALBHALL GALBRAITH HALL
- UCSD\GYM MAIN GYM BLDG
- UCSD\HUBBS HUBBS HALL
- UCSD\HUMAN HUMANITIES & SOC SCIENCE
- UCSD\IGPP INST. OF GEOPHYSICS
- UCSD\IOA INSTITUTE OF AMERICAS
- UCSD\INSTRSCH INSTRUCTION & RESEARCH
- UCSD\IRPS INTRNATL RELATS PAC STD
- UCSD\KECK KECK CENTER
- UCSD\LIBRARY CENTRAL LIBRARY
- UCSD\LIPLAYHS LA JOLLA PLAYHOUSE
- UCSD\LEICHTAG LEICHTAG MEDIC.RESEARCH
- UCSD\MANDVCTR MANDEVILLE CENTER
- UCSD\MAYER MAYER HALL
- UCSD\MDT MOLECULAR DIAGNOSTIC
- UCSD\MEDIACTR MEDIA CENTER
- UCSD\MTF MED. TEACHING FACILITY
- UCSD\MBRF CELL. MOLEC. MED. EAST
- UCSD\MUIRPUMP MUIR PUMP STATION
- UCSD\BIOLOGY MUIR BIOLOGY
- UCSD\PACHALL PACIFIC HALL
- UCSD\McGILL PSYCHOLOGY & LINGUISTICS
- UCSD\NSB NATURAL SCIENCES BLDG
- UCSD\NTV Nierenberg/Vaughn Hall
- UCSD\RIMAC REC/INT ATHLETIC COMPLEX
- UCSD\RHBLD-A BUTLER HALL BLDG A

BTU

UCSD CAMPUS WIDE NETWORK
 CLINSCI CLINICAL SCIENCE BLDG.
 PLANT CLINICAL SCI PLANT EQUIP
 BTU PLANT EQUIPMENT

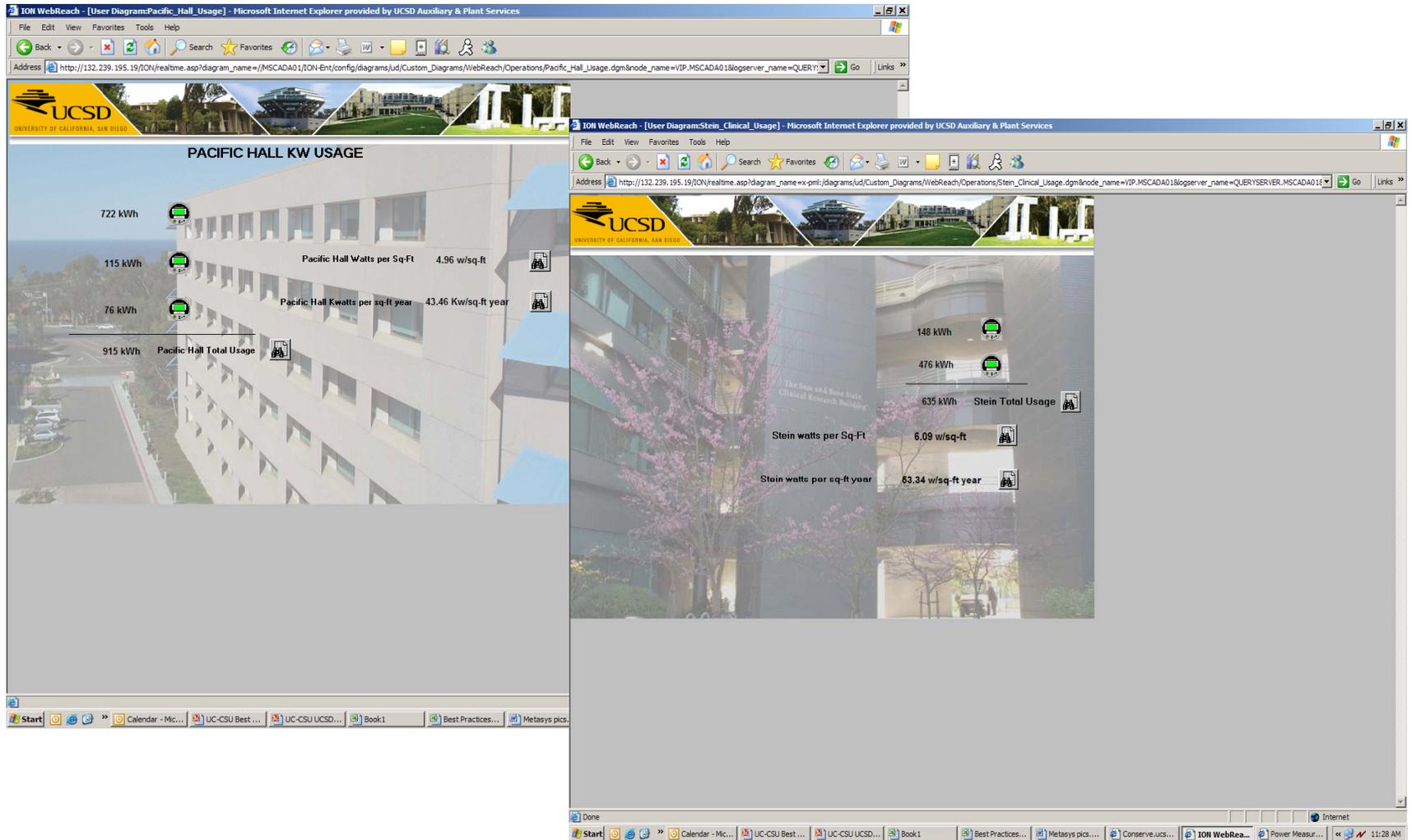
Status	Item	Description	Value	Units
	CHW-BTUS	CHW MBTU/HR	2.9	MBTU/H
	CHBTUTOT	CHW ENERGY TOTALIZER	3364.9	MBTU
	CHW-FLOW	CHILL WATER FLOW	0.472	KGPM
	CHWS-T	CHW SUPPLY TEMP	43.2	DEG
	CHWR-T	CHW RETURN TEMP	55.3	DEG
	HTW-BTUS	HTW MBTU/HR	2.0	MBTU/H
	HTBTUTOT	HTW ENERGY TOTALIZER	2484.7	MBTU
	HTW-FLOW	HTW FLOW	0.1	KGPM
	HTWS-T	HTW SUPPLY TEMP	317.0	DEG
	HTWR-T	HTW RETURN TEMP	286.1	DEG

PHBTUS

UCSD CAMPUS WIDE NETWORK
 PACHALL PACIFIC HALL
 PLANT PACHALL PLANT EQUIPMENT
 PHBTUS PLANT EQUIPMENT

Status	Item	Description	Value	Units
	CHW-BTUS	CHW MBTU/HR	-3.5	MBTU/H
	CHBTUTOT	CHW ENERGY TOTALIZER	3831.2	MBTU
	CHW-FLOW	CHW FLOW	0.742	KGPM
	CHWS-T	CHW SUPPLY TEMP	62.6	DEG
	CHWR-T	CHW RETURN TEMP	53.3	DEG
	HTW-BTUS	HTW MBTU/HR	3.1	MBTU/H
	HBTUTOT	HTW ENERGY TOTALIZER	5727.6	MBTU
	HTW-FLOW	HTW FLOW	0.316	KGPM
	HTWS-T	HTW SUPPLY TEMP	265.5	DEG F
	HTWR-T	HTW RETURN TEMP	244.8	DEG F

Real Time Electrical Metering



Project Process

- Engineering Study (UCSD funded Kuhn & Kuhn)
- Statewide Partnership funding approval.
- Engineering (Plans and Specs)
- Bid VFD purchase and install to electrical contractor
- Bid rebalance to Air Balance Company
- UCSD purchased and installed metering and monitoring equipment

Summary of Lessons Learned

- Must work together
 - FD&C, -Facilities Management and Bldg Occupants.
- Not as Fast and Easy as it Seems
 - Space, enclosures, motor/drive compatibility issues.
- Costs
 - Balancing
 - Metering

Acknowledgements of Team

UCSD Energy Efficiency Team

(10) Business Affairs and Resource Management and Planning

Facilities Management

(10) Electric Shop (Motors, Controls and Metering)

(6) Zone Maintenance (HVAC Technicians)

(1) Energy Management System Specialist

Facilities Design & Construction

Gerry White, Engineering Director

Craig Johnson, Mechanical Engineer

Nicole Kirk, Electrical Engineer

EHS

Jon Schmidt, Risk Manager

Brenda Wong, Safety Specialist

Acknowledgements of Team

Initial Engineering Study
Kuhn & Kuhn

Detailed Engineering
DEC Engineers (mechanical)
The Engineering Partners (electrical)

Statewide Partnership
UCOP - Maric Munn, Matt St.Clair and Karl Brown and
SDG&E/SoCal Gas - Guy Hanson and Randall Higa

Equipment Suppliers:
Johnson Controls Inc
Toshiba Variable Frequency Drives
Controlotron Ultrasonic BTU Meters
Power Measurement Ltd Electrical meters and EEM software

Contact Information

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