



Lighting Research Program



Project 4.5 Integrated Classroom Lighting System

Funded by Finelite and California Energy Commission's
Public Interest Energy Research (PIER) Program

Project Objectives

1. Excellent general classroom lighting
2. Excellent lighting for A/V presentations
3. Affordable
4. Energy efficient
5. Robust (students and seismic)
6. Easy to install, use, and maintain
7. One-stop support.

General Classroom Lighting

- Light walls uniformly
- Light teacher's face
- Follow RP3 & CHPS fixture guidelines
- S10 Indirect / direct fixtures w/ 96% CCO option
- Super T8 lamps w/ 1.18 BF ballasts
- 0.95 watts / square foot
- 30 – 50 FC on student's desks



Lighting for A/V Presentations

- Screens and TVs look sharp (Veiling reflections reduced)
- Desks remain lighted
- Switch at front of classroom
- 0.45 watts / square foot
- Excellent lighting for reading



Teacher Controls Classroom Mode

Switch “Up” = general classroom mode

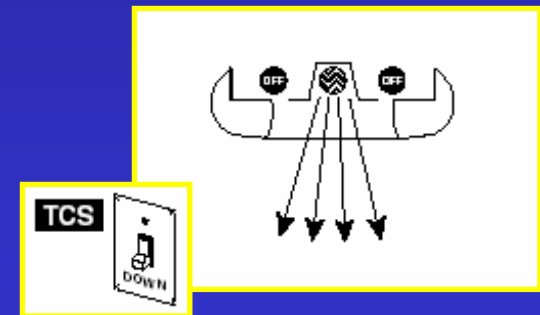
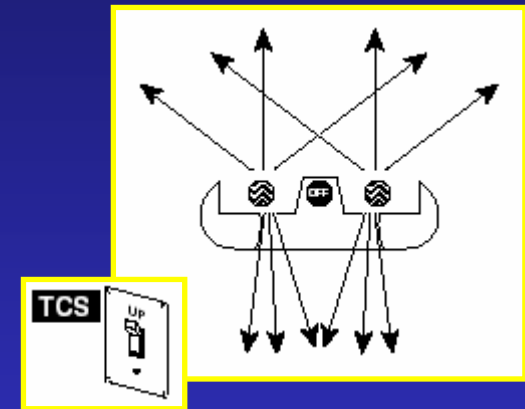
Switch “Down” = A/V or reading mode

Switch in the front of classroom

Easy to use

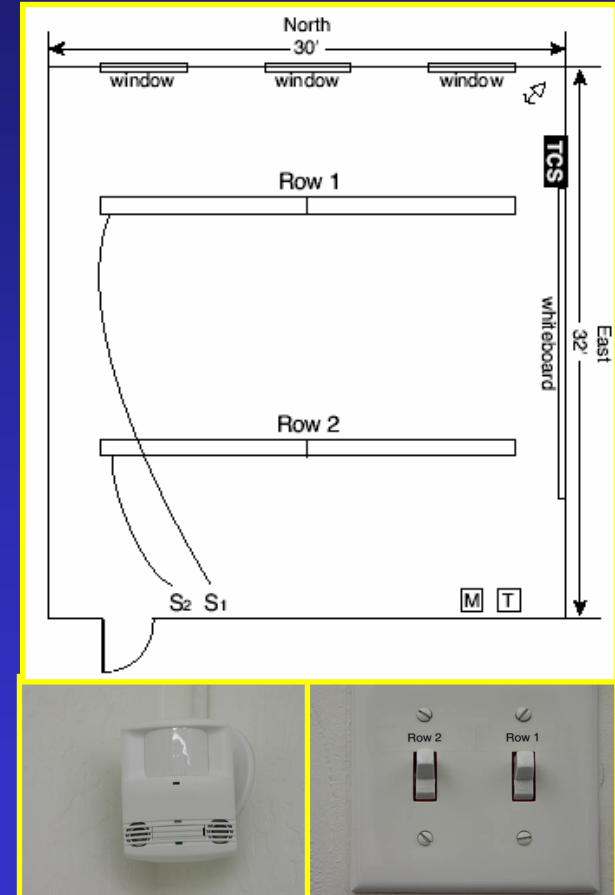
No class disruption

NOTE: All 3 lamps can not be on at the same time.



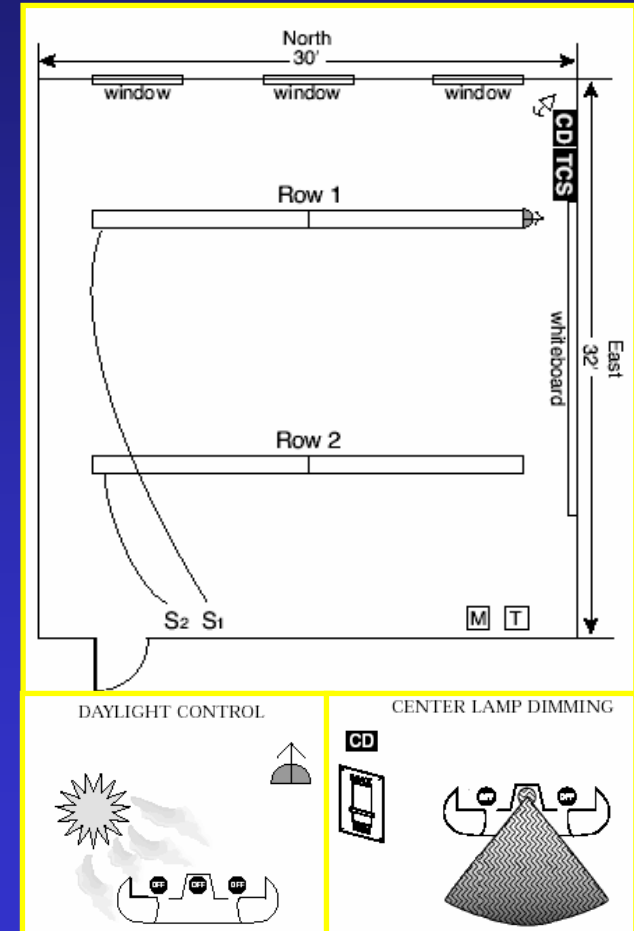
System Controls - Layout

- Occupancy sensor
- Independently switched rows
- Plug and play cables.



System Controls – Layout (continued)

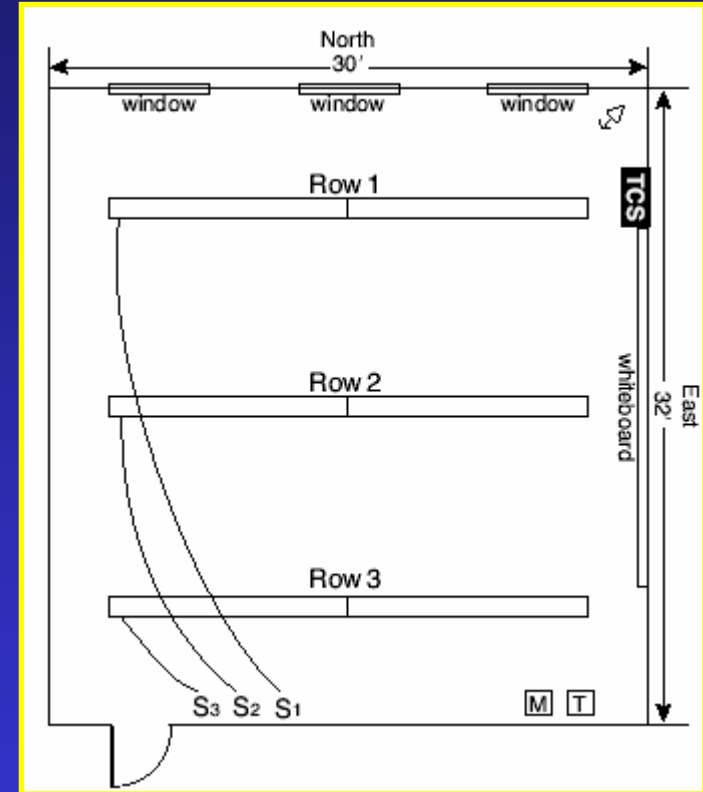
1. Dimming for A/V mode
 - Dimming one lamp lowers cost
 - Lower minimum light level
 - Easy to use
2. Automatic daylight control
 - Auto “on” in low light
 - Auto “off” when bright
 - Sensors factory calibrated



System Fixture Layout – 3rd row

Consider a third row when the classroom does not have daylight contribution.

- Higher light levels on the walls
- Desk level uniformity improved
- .77 BF ballasts keep energy less than 1 watt / square foot



What is New About This System?

- System delivers 25% more light
- The Teacher Control Center with a Teacher Control Switch and slide dimmer
- Plug & play system
- Fast, no-hassle system installation
- Multiple choices
- Templates ensure performance
- Single call for support.

What is the Impact?

- Rate of student learning may increase
- Teachers have better control of lighting
- The teaching environment is improved
- Utility costs reduced
- Support costs cut
- Construction budgets stay the same
- More money is available for school programs

What is the Payback?

<u>Alternative</u>	<u>Installed cost</u>	<u>Difference</u>	<u>Energy</u> (watts / sq ft)	<u>Payback</u>
15 parabolics	\$2,745 (\$2.86 / sq ft)	0	1.35	None
“Base” System (inc. occupancy)	\$2,600 (\$2.71 / sq ft)	-\$145	.93	Infinite !
Daylight switching (each row)	\$175 (\$.18 / sq ft)	\$30	.47	3-6 months
Dimming (2 rows, 1-lamp)	\$500 (\$.52 / sq ft)	\$355	.20	2 - 3 years
3 rd row (3 rows / room)	\$1,100 (\$1.15 / sq ft)	\$955	.95	N.A.

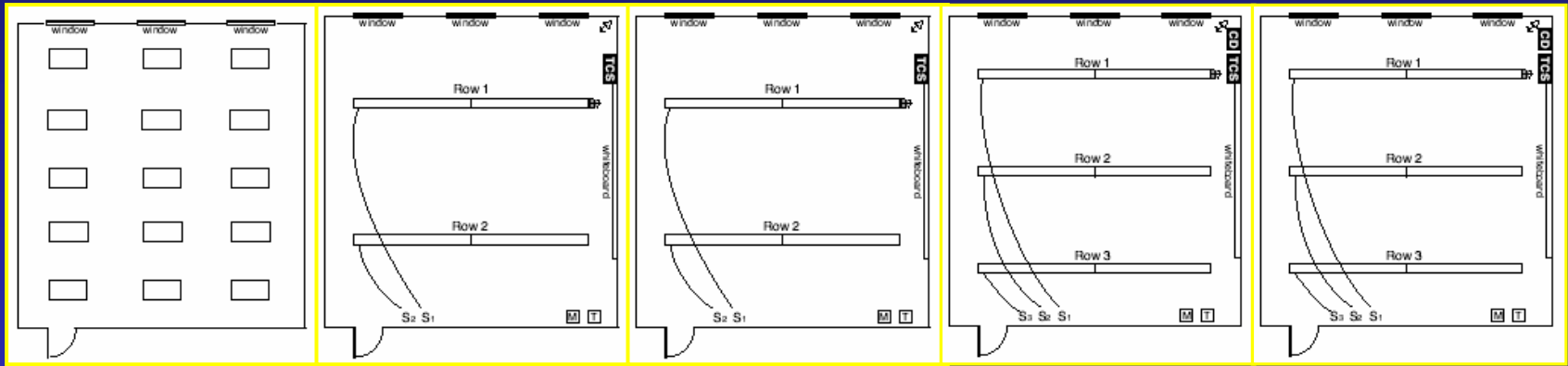
How to Prove the System Works?

- Build a test system & classroom - ***Done***
- Install systems in 19 classrooms - ***Done***
- Use independent experts to ensure objectivity
- Compare actual to expected performance
- Get teachers feedback
- Monitor energy use
- Record data for a full year

“Real World” Test Layout

Control

Test Classrooms



Control Classroom

2 Row Classroom
with Daylight

2 Row Classroom
with Daylight and
Dimming

3 Row Classroom
with Daylight

3 Row Classroom
with Daylight and
Dimming

Heritage Oak control classroom

(1.75 watts / sq foot)



Heritage Oak PIER system (.8 watts / square foot)



Dudley Elementary School

(1960's vintage fixtures, 1.7 watts / sq ft)



Dudley Elementary School

(Low Voltage Retrofit, .9 watts / sq ft)



Initial Feedback from Schools

- Energy Usage: .85 watts / sq foot or approximately one-half the energy of the control classroom (1.75 watts / sq foot).
- Desk-level lighting: ~35 fc in the far corners to ~ 75 fc under the fixtures. Vertical foot candles at 4' above the floor: 20 - 35 foot candles for the 2-row rooms and 26 - 36 foot candles for the 3-row rooms.
- Teachers said they liked the "calming feeling" of the indirect / direct lighting. All teachers used the down-light mode (~ one hour per day).
- Negative feedback revolved around whether there was sufficient light on the walls in the 2-row classrooms.

System Specifications - Fixture

- Fixture Specifications:
 - (2) rows direct-indirect fixtures on 14-foot centers
 - Finelite S10 with high-performance 96% reflective Center Control Optics (center lamp is 97% down)
 - Parabolic louvers for glare control
 - (3) T8 lamps in cross section – dual circuit control
 - Super T8 lamps (35K, 3050 lumens)
 - 1.18 BF T8 instant start electronic ballasts for 30 x 32-foot wide classrooms (templates assist with different sized classrooms. BF is reduced to maintain under 1 w / sq ft maximum connected load)
 - Aircraft cable suspension – adjustable 18 – 48-inches
 - 5 year warranty on electronics, 2 years on lamps

System Specification - Controls

- Teacher Control Center
 - Located on the teaching wall
 - Low voltage command center
 - Plug and play interconnection
 - Switches and faceplates with labels shipped with the fixtures in a “controls” box
- Row control switches
 - Located by entry door
 - Switches and faceplates shipped in the “controls” box
- 5-year warranty
- Single-source responsibility for performance templates, pricing, delivery, and support

System Option - Dimming

- Dimming for the down-light lamp
 - 5% electronic T8 dimming ballasts
 - Low voltage control (0 – 10 volts)
 - Slide dimmer located in the Teacher Control Center at the front of the classroom
 - Control Center Faceplate pre-labeled
 - Plug and play components
 - 5 year warranty on the system

System Option – Occupancy Control

- Automatic occupancy control
 - Dual technology sensor (IR and Ultrasound)
 - Universal voltage power control unit
 - Plug and play interconnection cables
 - Factory calibration (12 - 30 minute delay)
 - Installation instructions and templates
 - 5 year warranty

System Option – Daylight control

- Automatic daylight-based on – off control
 - Unit turns-off row of lights when an appropriate level of daylight is detected on the teaching wall
 - Factory installed and calibrated sensor and power-control unit
 - Teacher control of set points
 - 5-year warranty
 - No field installation step required
 - Not part of current PIER classroom test sites

System Option – 3rd row of fixtures

- 3rd row of fixtures
 - .77 Ballast factor for maximum load of .95 watts / square foot. (All three rows will have .77 BF.)
 - 12-foot row spacing
 - Fully adjustable aircraft cable mounting from 15 to 48-inches
 - Dual operating mode (General & A/V)
 - Consider using 3-rows when there is no daylighting in the classroom

System Option – Remodel kit

- Low voltage remodel kit
 - Low voltage command center at fixture feed
 - Exposed low voltage control cables
 - Teacher Control Center for wall-mounting
 - Uses existing wall switches and mounting locations
 - Excellent choice for areas with glue-on ceiling tiles, asbestos issues, and electrical circuits that are not readily accessible

Low Voltage Control Bus

(Fixture – fixture – occupancy sensor – Teacher Control Center)



Low Voltage Control Bus

(Teacher Control Center)



Low Voltage Control Bus

(Retained original power switches)



Actions for Educating Stakeholders

- *The Main Competitor is INERTIA!*
- We will be approaching School Districts and prominent School Architects to inform them about the Integrated Lighting System.
- If the CA State Architect pre-approves this system for new and re-modeled classrooms, it could speed its adoption.
- Simplified paperwork to qualify the integrated lighting system for energy saving incentives (Savings By Design, etc).
- Classes for estimators, project managers, electrical contractors and general contractors.
- We are compiling data for case studies to document the success of the system.