CALIFORNIA
ENERGY
COMMISSION

PIER Lighting Research Program

Project 4.5 Integrated Classroom Lighting System

FINAL REPORT

Consultant Report

January 2005
PUBLICATION # HERE

Arnold Schwarzenegger,
Governor

CALIFORNIA ENERGY COMMISSION

Prepared By:
Finelite Inc.
Terry Clark
Marc McMillan
Doug Bourne
Union City, CA

Managed By:
Architectural Energy Corporation
Judie Porter
Program Director
Boulder, CO
CEC Contract # 500-01-041

Prepared For:
California Energy Commission
Eric Stubee
Contract Manager

Nancy Jenkins
PIER Buildings Program Manager

Table of Contents

Contact Information:

Subcontract Project Manager
Terry Clark
Finelite, Inc.
30300 Whipple Avenue
Union City, CA 94587
510-441-1100 – Voice
tclark@finelite.com

AEC Program Director
Judie Porter
Architectural Energy Corporation
2540 Frontier Avenue
Boulder, CO 80301
303-444-4149 - Voice
jporter@archenergy.com

ACKNOWLEDGEMENTS

The products and outcomes presented in this report are a result of funding provided by the California Energy Commission's Public Interest Energy Research (PIER) program on behalf of the citizens of California. Architectural Energy Corporation and Finelite Inc. would like to acknowledge the support and contributions of the individuals below:

Project Lead: Terry Clark, Finelite Inc.

Technical and Marketing Assistance: Marc McMillan, Doug Bourne, Jane White, Buen Guido, Finelite Inc.; Rick Miller, RNM Engineering Inc.; Nancy Clanton, Clanton and Associates; Jim Benya, Benya Lighting; Christine Magar and Gregg Ander, Southern California Edison; Jack Rollow, Los Angeles Unified School District (LAUSD); Doug Paton and Jerry Mix, The Watt Stopper; Don Aumann, California Lighting Technology Center (CLTC); George Loisos, Loisos + Ubbelohde; and countless others who assisted with the installation of the ICLS at the various California classrooms.

Element 4 Lead: John Kesselring

Element 4 Technical Advisory Group: Jerry Mills, Easy Lite; Jeremy Bloom, EPRI; David Shiller, EPA.

Program Advisory Committee: Ron Lewis, Department of Energy; Jerry Mills, Easy Lite; Gregg Ander, SCE; Bill Daiber, WFD Associates; James Bryan, Arden Realty; Neall Digert, Solatube; Jim Benya, Benya Lighting; Dennis Tiede, Sempra Utilities; Noah Horowitz, NRDC; Amy Cortese, Northwest Energy Efficiency Alliance; Pekka Hakkarainen, Lutron; Peter Turnbull, PG&E; Michael Waxer, Carmel Development Co; Kit Tuveson, Tuveson & Associates; David Kaneda, Integrated Design Associates, Inc; Connie Buchan, SMUD.

Program and Contract Management: Eric Stubee and Nancy Jenkins, California Energy Commission; Karl Johnson, CIEE; Judie Porter, Architectural Energy Corporation

PREFACE

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:
- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research.

What follows is the final report for the Integrated Classroom Lighting System (ICLS) Project, PIER Lighting Research Program Contract #500-01-041, conducted by Finelite Inc. and directed by Architectural Energy Corporation. This project contributes to the Building End-Use Energy Efficiency program.

For more information on the PIER Program, please visit the Commission's Web site at: www.energy.ca.gov/research/index.html or contact the Commission's Publications Unit at 916-654-5200.

ABSTRACT

With input from representatives with the Collaborative for High Performance Schools (CHPS), Finelite Inc. used a combination of best practices and new technologies to develop and test an integrated classroom lighting system (ICLS) for K-12 classrooms. The basic system includes indirect luminaires with energy efficient T-8 lamps and electronic ballast, 96% reflective material within the fixture, a teacher control center located at the front of the classroom, and plug-and-play components.

Working with six California schools, variations of the ICLS were installed in 19 classrooms. Researchers continuously monitored the ICLS and other baseline classrooms for one school year and analyzed the resulting data. The data shows a 30 to 50 percent reduction in energy use in the ICLS classrooms with improved lighting on the teaching walls and better flexibility for adjusting light levels during audio/visual presentations. The ICLS also provides approximately 40 to 50 footcandles of light on student's desks while maintaining less then one watt per square foot (0.9/ S.F.) in the classrooms. 2005 Title-24 codes require schools to have 1.2/ S.F. or less in new classrooms. Teachers were also surveyed and provided positive responses to the light levels and the quality of light in the classrooms. A derivative project that involved installing a hybrid ICLS in a daylit training classroom was also completed.

The ICLS provides quality lighting and is an economical alternative to typical classroom lighting designs and, to help minimize support and warranty costs, is bundled as a package system with one source of responsibility.

EXECUTIVE SUMMARY

Lighting typically represents 20% of the total energy use in a K-12 school. By reducing the connected lighting load and giving teachers more control of the lighting system, significant energy savings can be realized while providing a higher quality of light.

The Integrated Classroom Lighting System (ICLS), PIER LRP Project 4.5, was a two and a half-year research and development effort focused on developing a lighting system that was energy efficient, provided high quality lighting and control flexibility, yet was affordable and easy to install and maintain. The project had tremendous collaboration and followed a rigorous methodology.

With input from representatives with the Collaborative for High Performance Schools (CHPS), Finelite Inc. used a combination of best practices and new technologies to develop and test an integrated classroom lighting system (ICLS) for K-12 classrooms. The basic system includes indirect luminaires with energy efficient T-8 lamps and electronic ballast, 96% reflective material within the fixture, a teacher control center located at the front of the classroom, and plug-and-play components.

Working with six California schools, variations of the ICLS were installed in 19 classrooms. Figure 1 provides an example of the existing lighting system and the new ICLS. Researchers continuously monitored the ICLS and other baseline classrooms for one school year and analyzed the resulting data. The data shows a 30 to 50 percent reduction in energy use in the ICLS classrooms over typical lighting systems with improved lighting on the teaching walls and better flexibility for adjusting light levels during audio/visual presentations. The ICLS also provides approximately 40 to 70 footcandles (fc) of light on student's desks while maintaining less then one watt per square foot (0.9/ S.F.) in the classrooms. 2005 Title-24 codes require schools to have 1.2/ S.F. or less in new classrooms. Teachers were also surveyed and provided positive responses to the quality of light in the classrooms.

Figure 1: Existing Lighting System (1.8 Watts/ S.F.) and New ICLS System (.8 Watts/ S.F.)

Researchers then installed a hybrid ICLS in a Southern California Edison (SCE) training classroom, which is designed to take advantage of daylighting. Light level measurements were taken to verify the ICLS performance in daylit environments. The hybrid system was demonstrated to several lighting specifiers and customers, and feedback obtained.

Key results from the ICLS project include:

- Reduced energy usage by 30 to 50 percent
- Lower lighting power densities (LPDs) which are 20% less than new 2005 Title 24 levels (reference Figure 2)
- Improved flexibility for setting light levels for general teaching and audio-visual (A/V) presentations
- Perceived reduction in eye strain and glare and improved quality of light by teachers
- Documented ICLS component and installation costs
- Integration of ICLS with daylight in a harmonious and energy efficient manner

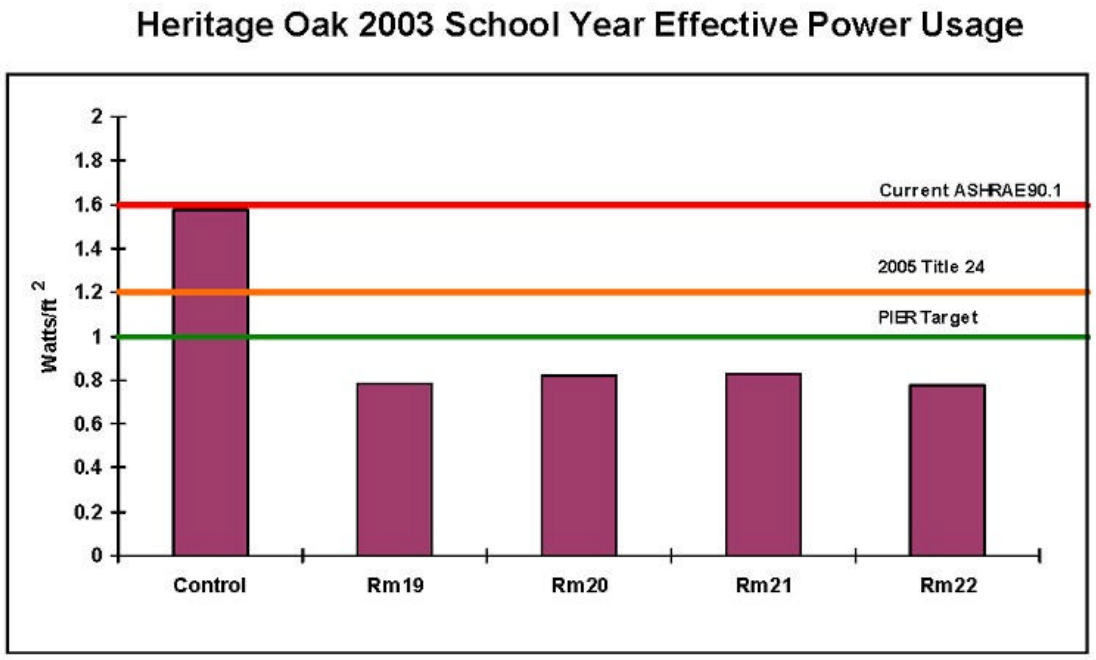


Figure 2: Lighting Power Density (LPD) for four of the ICLS test classrooms shows approximately .8 Watts/ S.F. as compared to ASHRAE 90.1 and 2005 Title 24 standards.

Key features of the ICLS include:

- High performance, pendant-hung indirect luminaires
- Easy-to-use teacher controls located at the front of the classroom
- Dual technology occupancy sensors with a teacher-controlled time delay
- Low-voltage, plug-and-play interconnection cables to tie the system together
- Optional photosensors for daylit environments
- Single-source “system” responsibility for layout, pricing, commissioning, and warranty to ensure that budgets are met and savings are obtained

Teachers, principals, school administrators, facility managers, energy managers, architects, engineers, lighting specifiers, project managers, and general and electrical contractors should benefit from the documented and quantified results of the PIER LRP Project 4.5 ICLS. The results, which demonstrated dramatic energy savings combined with strong teacher preference for the ICLS, may also help school districts, and local, state, and federal governments set more aggressive energy efficiency standards and policies.

Over the last two years, Finelite Inc. and other PIER LRP participants provided presentations highlighting the results of this project to numerous schools districts, lighting designers, utility representatives, and other interested audiences. However, work still needs to be done to build awareness in the teaching, design, and construction communities. These communities need to be aware that the benefits and energy efficiency of the ICLS are documented, the system is available for today's classrooms and is reasonably priced, and the quality of lighting is exemplary.

INTRODUCTION

Background

Developing and documenting more energy efficient and cost effective ways to light K-12 classrooms meets the PIER goal of improving the energy cost and value of California's electricity because of the following reasons.

- Lighting in classrooms may potentially impact the rate of learning for over 6 million students attending K-12 classes in California. Lighting whiteboards, teaching walls, students' and teachers' desks, and teachers' faces is fundamental to the learning process.
- California spends approximately $3 billion per year on school improvements. Building schools requires coordination between school administrators and teachers, and their architects, engineers, construction managers, and contractors. Making these parties aware that it is time to change from old, out-of-date lighting systems to new, more effective ones is a major challenge.
- Installing improved, up-to-date lighting systems is a cost-effective way to spend school construction dollars. Nevertheless, many decision-makers believe they cannot afford quality indirect lighting because they rely on inaccurate or out-of-date cost estimates or advice.
- New, energy-efficient indirect lighting systems can reduce lighting loads by almost 20% from the new 2005 Title 24 levels. Cutting energy waste in classroom lighting reduces operating expenses for the school.
- The current building boom in schools creates an opportunity to ensure that effective classroom lighting systems are installed. However, since classrooms do not go through regular updates or remodels, missing this window of opportunity means up to a 30- to 40-year wait for the next chance to improve a particular school's classroom lighting.

New methods of learning and other factors affect the way classrooms should be lighted. These changes mean that old, proven ways to light classrooms are obsolete. Some of the factors that have changed with respect to classroom lighting are:

- Classrooms are becoming computerized environments. Schools are installing cable and fiber networks in over 99% of all new classrooms. Classrooms need glare-free lighting systems with proper light levels for computer use. Indirect lighting, used in the ICLS, is recommended for lighting classrooms by both the Illuminating Engineering Society of North America (IESNA) in their publication RP-3 and by the Collaborative for High Performance Schools (CHPS) in their training materials.
- Classrooms are becoming A/V centers. New curriculums are beginning to include more web-based and DVD-based instruction materials. Use of overhead and computer-based projectors and televisions to display materials means teachers need to be able to change the lighting from General mode (light on the teaching walls and ceiling) to an A/V mode (limited lighting on the walls and ceiling) at the touch of a switch. Research indicates that teachers need to be able to do this in an easy manner, which does not disrupt the class, or they will not do it. Adding an A/V lighting mode option to a lighting system needs to be affordable and energy-efficient.

- More schools are incorporating daylighting into classrooms. This means that the classroom lighting system must be flexible and able to adjust to different daylight conditions. Adding automated dimming options to a lighting system also needs to be affordable and energy-efficient.
- New technology delivers better lighting at lower costs. Examples include:

    - Indirect luminaires with new 96% reflective materials can deliver more light onto the workplane and are up to 15% more efficient than older luminaires
    - 3100 lumen "Super" T8 lamps are 10% more efficient and provide better color rendering than standard T8 lamps
    - New T8 electronic ballasts with 1.2 ballast factors (BF) allow two lamps to perform the work of three without reducing lamp life or performance
    - New occupancy sensors and controls let teachers reduce annoying and disruptive false luminaire shut-offs during tests or other "Quiet Time" periods
    - New plug-and-play interconnection systems reduce installation costs to help meet today's tight budget requirements.

Project Goals and Objectives

The goals of the PIER LRP Project 4.5 were to use new technologies to build a high-performance, cost-effective integrated lighting system, to verify system performance and teacher acceptance in actual California classrooms, and educate school districts, the design and construction communities, and others about the results. Specific objectives for the ICLS were:

- Use high-efficiency indirect luminaires to light the teacher's face, the walls, and the desks while at the same time cutting glare in the classroom.
- Demonstrate that 2 rows of indirect luminaires can be used instead of the 3-row system originally recommended by CHPS. (It should be noted in this report that the term "indirect luminaire" is used to describe luminaires with a lighting distribution that ranges from 90% uplight and 10 % downlight to as much as 67% uplight and 33% downlight. Other reference materials may call some of these luminaires indirect/direct or even direct/indirect luminaires.)
- Provide effective lighting options for A/V presentations. With this option, there is less light on the walls and ceiling to produce veiling reflections. However, there is still adequate illuminance on the student's desk for note taking.
- Keep installed costs affordable to meet budget requirements. System options should be priced separately so design teams for each school can easily match benefits to cost.
- Operate at a maximum connected load of less than 1.0 Watts/ S.F. Savings due to time in A/V mode and automatic shut off of the lights by the occupancy sensor should lead to an additional 10-20% reduction from the maximum level. This means that the average energy usage should be around .8 Watts/S.F.
- Build a robust ICLS. Recognize the potential for student abuse and meet or exceed seismic requirements.
- Utilize plug-and-play interconnections between sensors and controls to help ensure correct, cost-effective installation and problem diagnostic and resolution.
- Provide ICLS layout, pricing, delivery, and field support from a single-source manufacturer.

Project Methodology

Finelite used the following research methodology to meet the project's goals and objectives. Throughout the project, Finelite staff communicated with representatives from CHPS, SCE, AEC, Clanton and Associates, BKi, LAUSD, and the California State Architect's office to understand best practices, design, installation, and maintenance issues, and codes and standard implications.

Step 1: Review best practices including new reflector materials, T8 and T5HO lamps, electronic ballasts with different ballast factors, sensors, and controls.

Step 2: Design a system using components that would become commercially available by early 2005.

Step 3: Build a 28 x 30-foot classroom with 10-foot-high ceilings. Furnish it with desks and chairs to provide a test area for the project. Install the initial ICLS system in the test classroom and verify its performance. Improve the system based on feedback from lighting professionals.

Step 4: Work with 6 schools to identify "test" classrooms to receive the ICLS. Install different versions of the ICLS in the test classrooms.

Step 5: Use an independent consultant (Rick Miller) to document performance (light levels, energy loads, and teacher preference). Record energy usage 24 hours a day, seven days a week for an entire teaching year. Develop, distribute, and collect questionnaires to get teacher feedback on the ICLS performance. Summarize findings to show savings and preferences.

Step 6: Make additional ICLS adjustments and enhancements to incorporate feedback from the teachers, facilities managers, school administrators, and lighting specifiers who visited the test ICLS classrooms.

Step 7: Install a hybrid ICLS system at the SCE daylit classroom that includes a dedicated, cost-effective whiteboard luminaire in a classroom and document its performance under different daylight and teaching conditions.

Step 8: Educate school districts, the design and construction communities, and others about the results.

Step 9: Produce a final report with findings and supporting documentation.

PROJECT OUTCOMES

Project 4.5 research and development activities led to a number of significant findings. This section summarizes the key outcomes.

96% Reflective Material Technical Data

The first key outcome was the development and testing of the 96 percent reflective material that is used in the ICLS luminaire. A summary of the test results is provided below.

Background

Every time light reflects off of a surface a portion is absorbed or "lost." Since light often bounces multiple times within a fixture before it is directed outward, the amount of light that is lost can become substantial very quickly. Table 1 shows how an increase in reflectivity from 86% to 97% generates 62% more light output after only four reflections.

Material type	Reflectivity	Formula for 4 reflections	Efficiency after 4 reflections	% Increase
White, pre-painted steel (standard quality)	86%	.86 x .86 x .86 x .86	55%	Base case
Desired white reflective material	97%	.97 x .97 x .97 x .97	89%	+ 62%

Table 1: Reflectivity and efficiency comparisons of white pre-painted steel versus new white reflective material.

Despite its relatively poor optical performance, white pre-painted steel is used for most luminaires because it is widely available from numerous sources and it is cheap. Currently available materials with high reflectance have limitations that make them difficult to use in an affordable classroom lighting fixtures. A summary of materials and issues associated with them are listed below in Table 2.

Material	Reflectivity	Issues:
Pre-painted white aluminum	90%	About twice as expensive as pre-painted steel.
Specular aluminum and metalized films	95%	About four times as expensive as pre-painted steel. Maybe vulnerable to scratches. Specular (mirror) finishes can cause glare.
Gortex	97%	Very expensive. Many times more expensive than pre-painted steel. Specialty material.

Material	Reflectivity	Issues:
AOT paint	97%	Good high-temperature characteristics, difficult to apply on large surfaces. Moderately expensive

Table 2: Summary of the potential luminaire material and issues.

Several years ago, the Filled and Reinforced Plastics Division of FERRO Corporation's Specialty Plastics Group was approached to develop a high-reflectance material. (For the balance of the report, we will refer to this Division as "FERRO.") As a result of that request, FERRO undertook an extensive development program to formulate a 97% reflective plastic material that was suitable for injection molding. That development program was a success. The final result was a new, custom plastic that achieved over 97% reflectivity and that was easy to injection mold.

The focus of the first task under Project 4.5 was to evaluate how this material would perform as a component of a new classroom luminaire. Specifically, researchers wanted to work with FERRO to determine what modifications, if any, would be needed to the original material. Once the modifications were determined, Finelite wanted to explore the impact of those modifications on the reflectivity and the cost of the material.

Criteria for Performance Evaluation

Finelite began by developing the criteria that would be used to evaluate the characteristics of the new material. From a lighting manufacturer's perspective, seven areas were identified that needed to be examined. For each area, performance targets were set. These areas and performance targets are listed below:

1. **Reflective Performance**
   We set our target for the material to be 97% reflective. This target was established based on the results of a series of discussion between Finelite and FERRO. The primary issue was that the cost of the new material varied with targeted reflectivity. Finelite found that as reflectivity became higher, the cost of the material also increased. Accordingly, 97% was selected as a target that would be a suitable balance between our drive for low material cost versus high performance.

2. **Cost**
   Our target was to achieve superior performance while keeping the cost premium less than 20% compared to parts made from PVC plastic (about 84% reflective) or pre-painted steel (about 86% reflective.) We focused on the final part cost rather than material costs in order to allow for different manufacturing processes required for steel versus plastic parts.

3. **UV Stability**
   We set a goal of no visible yellowing after close exposure to fluorescent lamps for a period of 10 years. In scientific terms, this translated to a goal of a delta b* and delta E* shift of less than 3 units under accelerated UV testing.

4. **Flammability**
   We set the goal to meet or exceed the standard UL-94 V2 set by Underwriter Laboratories . By meeting this standard, we would ensure that any part made with this material would be "self extinguishing" within 250 seconds. (This is measured from the time the source of combustion is removed.) This ensures that the luminaire would not spread a fire from one part of the classroom to another.

5. **Temperature stability and mechanical strength**
   We set our temperature stability target at 140 degrees Fahrenheit (this is the temperature that a part might experience while being shipped or stored in a closed container in 105 degree weather.) The strength should be sufficient to meet all UL requirements and to stand up to potential classroom abuse.

6. **Molding and extrusion parameters**
   We approached this point by working with a vendor that currently provides injection molded plastic parts to Finelite. Our criteria was to run tests using actual material to ensure that all parameters of the new material would be suitable for his equipment and run on our normal dies.

7. **Availability**
   The final material developed must be able to be formulated on FERRO's existing lines. And, it needs to be relatively "risk free" in our ability to move from pilot production quantities to higher-volume production. Due to its custom formulation, we did not set the criteria to have more than one supplier for the material.

Performance Results

Below is a summary of the results for each area:

1. Reflectance – Achieved 97% reflectivity.
2. Cost – Appropriate for special parts at production quantities.
3. UV Stability – Verified this is very stable material.
4. Flammability – Passed UL 94 - V2 rating criteria.
5. Temperature stability and mechanical properties – Met most goals.
6. Molding parameters – Successfully made parts with existing dies.
7. Availability – Verified material is available.

The custom material that was evaluated is part number NPP00RT5678WH made by FERRO Corporation – Specialty Plastics Group, Filled and Reinforced Plastics Division. The description of this plastic is " HIGHLY REFLECTIVE, UV STABELIZED, FLAME RETARDANT POLYPROPYLENE WITH AN IN-HOUSE UL94 RATING OF V-2 @ 1/16"."

Conclusion

The 5678 WH material evaluated by Finelite looks like a very good candidate for use in a more efficient classroom luminaire. This new material offers the potential to develop more efficient

reflector systems that can still meet the cost constraints imposed by the educational market. By using more efficient reflectors, classroom lighting fixtures can be made to deliver the same level of desk-level illumination in the classroom with less electrical power. Accordingly, this new plastic material is an enabling technology that helps the State of California accomplish its goal of reducing energy usage.

Further, this material seems to have uses for making reflectors for emerging technologies such as LEDs. FERRO's willingness to work with manufacturers to optimize the formula for their unique needs will help further speed the development of luminaires that bring this new technology to market.

Generic Classroom Lighting Specification

Another key outcome of this project is the development of a classroom lighting specification based on the ICLS for use by school districts, lighting specifiers, and lighting contractors. The ICLS specification is provided in Appendix A and may be included as part of any Section 16500 Specifications for classroom lighting.

The ICLS combines a high performance, direct-indirect luminaire with three high-efficiency Super T8 lamps. General-purpose classroom illumination (~0.95 W/sf) is achieved using 2 of the 3 lamps in the direct-indirect lighting fixture producing approximately 75 percent up-light and 25 percent down-light. An appropriate light level (~40 to 70 fc) is maintained on the student's desk. An Audio/Video (A/V) or reading mode provides 3 percent up-light and 97 percent downlight using only a single down-light with optional dimming to 5 percent output. In the A/V mode, light levels on the ceiling and walls are reduced while an appropriate light level (~30 fc) is maintained on the student's desk.

Energy and Cost Savings

Energy Savings

One of the major outcomes of this project is the documented energy savings. Daily energy savings ranged from a minimum of 35% to a maximum of 75%, and averaged over 50% for the entire year for the ICLS installations. Most of the savings (~80%) were the result of the reduction in the connected lighting load from 1.8 to 1.0 W/sf. Additional savings (~20%) were the result of allowing teachers more control of the lighting system and providing occupancy sensors.

One of the test sites, Heritage Oaks School in Roseville, had the ICLS installed in four classrooms. The daily energy savings are clearly demonstrated in Figure 3 for all of the ICLS rooms. The base case at Heritage Oaks was 2X4 lay-in troffers with T-8 lamps. Four variations of the ICLS were installed: 2 rows of ICLS lighting; 2 rows of ICLS lighting with manual dimming on the teacher control center; 3 rows of ICLS lighting; 3 rows of ICLS lighting with manual dimming on the teacher control center.

Graphs representing the LPDs for all six schools, the energy data collection methodology, and an example of the resulting data are shown in Appendix B. Appendix C provides the light levels, LPDs, and installed system information for each of the test classrooms.

The actual monitored data from the test classrooms, which was taken in one minute intervals for the entire 2003/2004 school year and includes more than 10 million data points, is available for download and review at www.archenergy.com/lrp/products/classroom.htm. The file size of the data is extremely large approaching close to 100 MB.

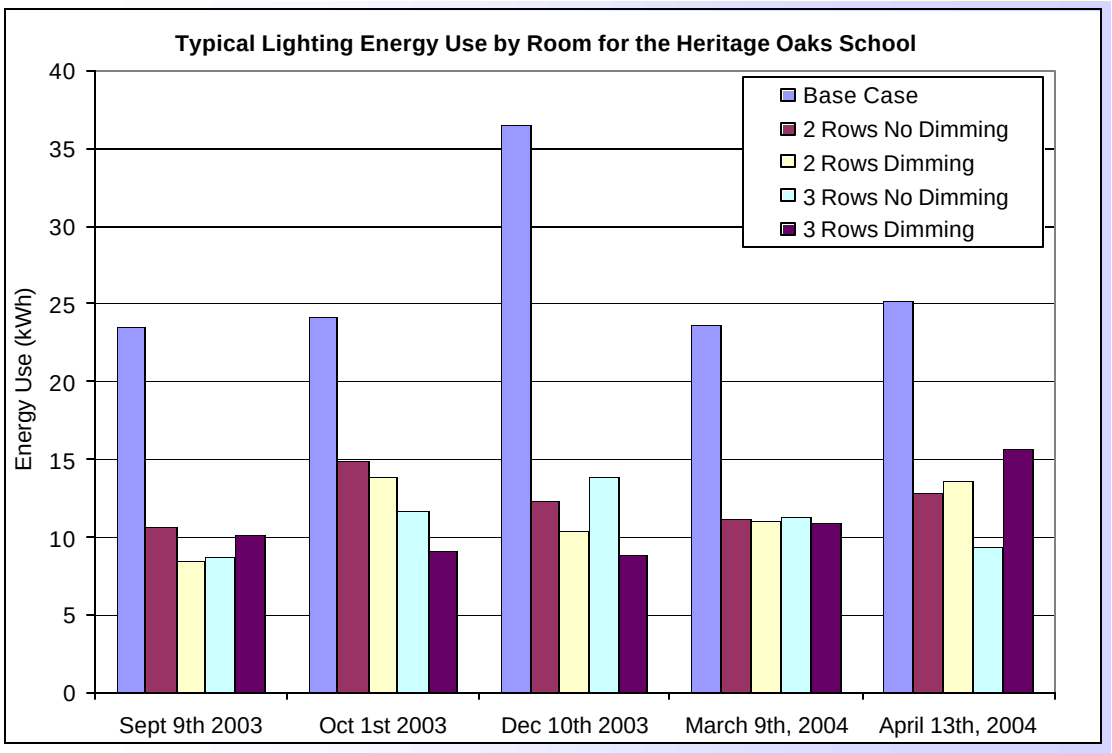


Figure 3: ICLS energy use compared to a lensed troffer lighting system. Energy savings vary seasonally. Greatest savings were realized during the winter.

Cost Savings

The cost of the classroom retrofits at Heritage Oaks was $2600 for the two-row without dimming and approximately $3100 with A/V dimming control. The third row of luminaires cost an additional $1100. The ICLS retrofit using occupancy sensors resulted in energy savings averaging more than 50%, which based on 7 months of data translate into nearly $500 savings annually per room ($0.14/kWh, 200 days per year). The resulting payback period was a minimum of 6.5 years for two rows of luminaires and a maximum of 9.6 years for three rows with A/V dimming control. The information is summarized in Table 3.

Heritage Oaks School Retrofit Payback Period						
	Average Daily Use (kWh)	Estimated Annual Use (kWh)	Estimated Annual Cost ($)	Estimated Annual Savings ($)	Initial Cost ($)	**Retrofit Payback (yrs)**
Base Case (26 Parabolics)	26.6	5318	$745	$0	$0	**--**
ICLS 2 Rows, No A/V Dim*	12.3	2469	$346	$399	$2,600	**6.5**
ICLS 2 Rows, with A/V Dim*	11.4	2284	$320	$425	$3,100	**7.3**
ICLS 3 Rows, No A/V Dim*	11.0	2191	$307	$438	$3,700	**8.4**
ICLS 3 Rows, with A/V Dim*	10.9	2185	$306	$439	$4,200	**9.6**

* Includes Occupancy Sensor

Table 3: Summary of the energy and cost savings for the various lighting configurations at the Heritage Oaks School, one of the schools that was retrofitted.

For new construction, the installed cost of the ICLS (~$2.71 / sq ft) is less than the cost of a typical layout using 15 parabolic troffers (~$2.86 / sq ft.). The maximum connected load for the ICLS is approximately 0.95 watts per square foot compared to 1.35 watts per square foot for more typical designs. The reduced lighting load combined with no additional first cost yields an instant payback. Installing the optional upgrade of A/V dimming still results in a payback of 2 years while a third row of luminaires has a longer payback (8.1 years), assuming $0.14/kWh and 200 days/yr.

New Construction Estimated Payback Period						
Alternative	LPD (W/sq ft)	Installed Cost ($/sq ft)	Installed Cost ($)	Cost Difference ($)	Cost Savings ($/yr)	Simple Payback (yrs)
15 Parabolics (typical)	1.35	$2.86	$2,745	$0	$0	--
ICLS 2 Rows, No A/V Dim*	**0.93**	**$2.71**	**$2,600**	**-$145**	**$106**	**Instant!**
ICLS 2 Rows, with A/V Dim*	0.73	$3.23	$3,100	$355	$176	2.0
ICLS 3 Rows, No A/V Dim*	0.95	$3.86	$3,700	$955	$118	8.1
ICLS 3 Rows, with A/V Dim*	0.75	$4.38	$4,200	$1,455	$168	8.6

* Includes Occupancy Sensor

Table 4: Summary of the LPD, cost, and savings for new construction using the four variations of the ICLS as compared to a typical classroom lighting system.

Teacher Acceptability and Feedback

Teachers at each of the 6 schools were surveyed and provided valuable feedback to the researchers and the manufacturers about the system. Overall, the teachers preferred the ICLS to typical classroom lighting systems. Some teachers expressed the comment that they did not realize the poor quality of light from the typical classroom lighting systems, which were 2X4 lay-in troffers with T-8 lamps and on/off switches located only at the room entryway, until the ICLS was installed. This comment indicates that teachers and school administrators need to be educated about the importance of the quality of light in the classroom. The teacher surveys provided other useful information about the acceptability of the ICLS and a summary report is provided in Appendix D.

One issue identified from the surveys was the need for a "Quiet" time switch, which allows the teachers to disable the occupancy sensor for one hour during test times or reading periods. This feature eliminates the lights turning off when students and teachers are in the room, but not active. The development of the "Quiet" time switch, see Figure 4, is a key outcome.

In addition, a high-performance, dedicated whiteboard luminaire was developed and will be introduced in 2005 to provide more light on the main teaching wall. Some teachers had expressed a concern about the light levels at the teacher's desk and on the teaching wall. The addition of the whiteboard luminaire alleviates this issue.

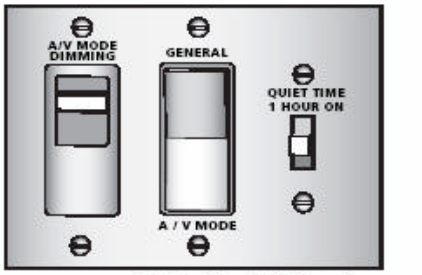
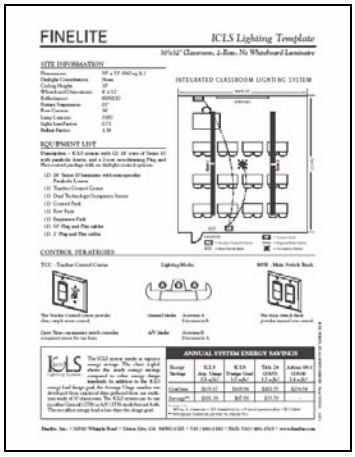


Figure 4: A "Quiet" time switch option was added to the Teacher Control Center as a result of teacher feedback to increase the acceptability of the ICLS.

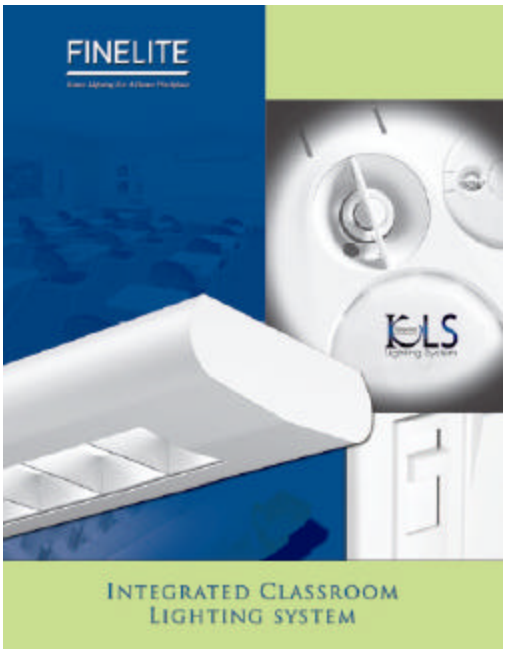
ICLS Templates and Manufacturer Literature Development

Templates based on the ICLS were developed, which provide visual and easy to read guides for lighting specifiers and school personnel. The following four scenarios were developed and are provided in Appendix E.

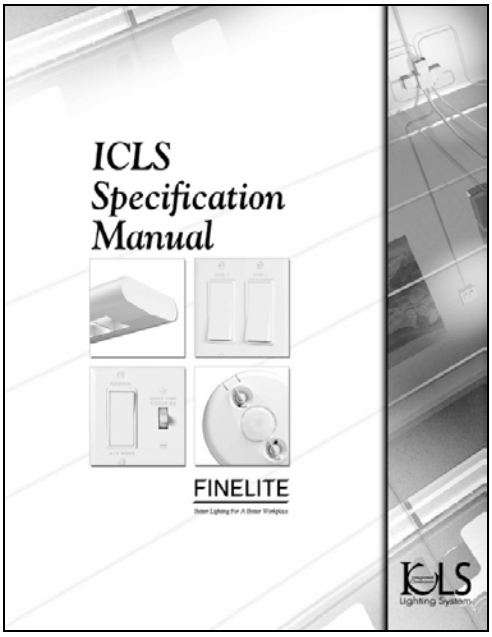


- 30 x32 Classroom, 2-Row, No Whiteboard Luminaire
- 30 x32 Classroom, 2-Row, With Whiteboard Luminaire
- 28 x28 Classroom, 2-Row, No Whiteboard Luminaire
- 28 x28 Classroom, 2-Row, With Whiteboard Luminaire

Literature was also developed by the manufacturer and includes the following: the ICLS brochure, a specification manual that describes the major components and features of the system, and a use and care manual.



ICLS Brochure



ICLS Specification Manual

ICLS Use and Care Manual

Copies of the literature are provided in Appendix F. A PIER Project 4.5 brochure and case study were also developed and are available at www.archenergy.com/lrp/products/classroom.htm.

TECHNICAL RECOMMENDATIONS

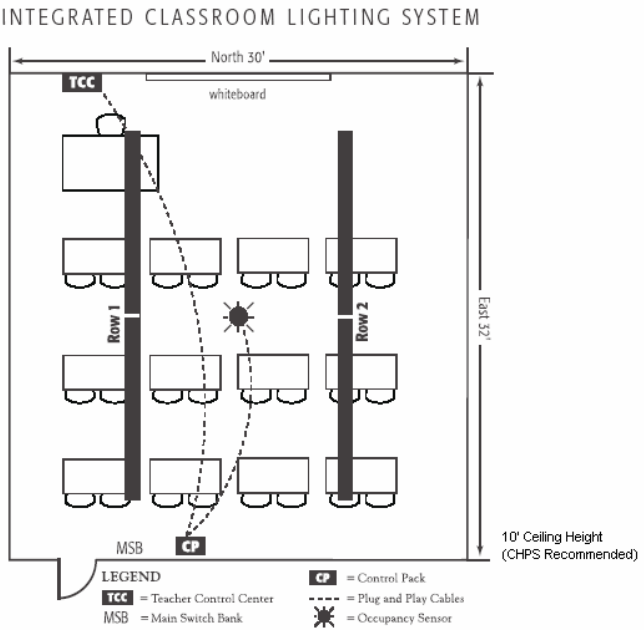
Based on the project results, several technical recommendations follow.

Use indirect luminaires to light the classroom. Prices for these luminaires have decreased over the last several years and their energy efficiency has increased. It is now possible to use these high quality, recommended luminaires in K-12 classrooms.

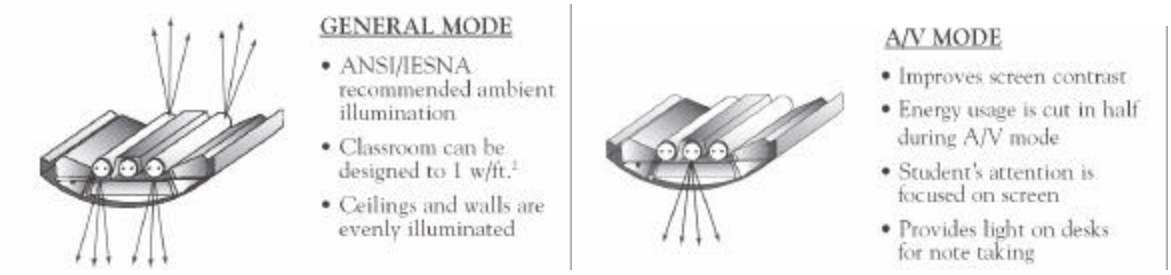
Indirect Luminaire

- ICLS uses indirect luminaires to deliver expert recommended lighting quality.
- Glare is eliminated for fewer classroom distractions
- Walls and ceilings are evenly illuminated
- High reflectance materials ensure optimum efficiency.

Light a 32 x 30-foot classroom with two 24-foot rows of indirect suspended luminaires. The indirect luminaire should use two 3100-lumen T8 lamps, in cross section, in an uplight mode to light the ceiling, walls, desks, and teacher's face uniformly and without glare. The maximum connected load of this system will be under 1-watt per square foot; this will occur when the luminaires are in the General Mode with all rows turned on. Use 1.2 ballast factor electronic T8 ballasts in this system to provide an average of over 60 fc with a 4 to 1 uniformity across the students' desks. For lower light levels or different sized rooms, use electronic T8 ballasts with .88 BF, .77 BF, or even .71 BF electronic T8 ballasts to keep the maximum connected load equal to or less than 1 watt per square foot.

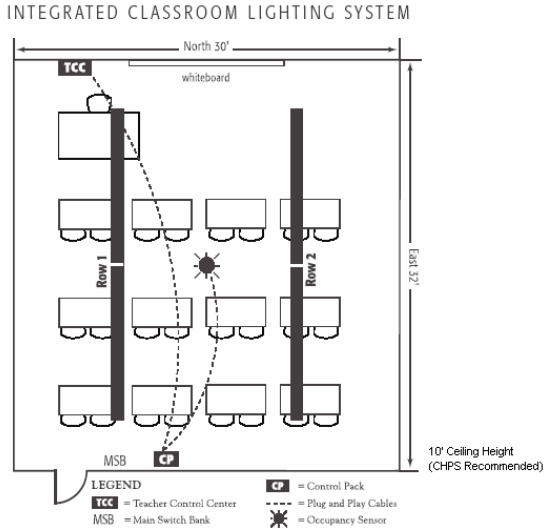


Use the indirect luminaire to create an A/V lighting mode in classrooms. While this is primarily used during A/V presentations, teachers also used this mode to calm students and to help them focus on tasks on their desks like silent reading or individual problem solving. Over 99% of new California classrooms are being wired for Internet access to accommodate more web-based learning tools. Manufacturers of textbooks are also planning on more DVD-based instruction materials. This means that during the useful life of the classroom, it may become a space where A/V presentations are used many times a day. The recommended, cost-effective way to provide an A/V mode of lighting is to use an indirect luminaire with a separate downlight compartment. The teacher uses a switch located at the front of the classroom to change from General to A/V mode. The switch has an interlock mechanism to ensure that all three lamps are not on at one time. This ensures that the maximum load never exceeds 1 watt per square foot.



Place a Teacher Control Center (TCC) at the front of the classroom. This is where the switch to control the mode of lighting (General or A/V) is located along with controls for other options and features. It is important for the teacher to control the system without losing eye contact with students. Teachers tend to not use control switches when they were located next to the door. In these cases, they turned on all the lights and left them on for the entire teaching day.

In contrast, when the TCC was located in the front of the classroom, the teacher used the TCC nearly every day and often used it several times a day to enhance the teaching environment.



Teacher Control Center

Provide ways to control the light levels based on the amount of daylight in the classroom. The system should use a separate switch for each row of luminaires. This provides manual on/off control of the row of lights parallel to the windows. Automatic on/off row switching or automatic dimming based on daylight should be explored and evaluated based on overall design objectives. Blinds should be used in classrooms with substantial daylight to ensure proper light levels are achieved during A/V presentations.

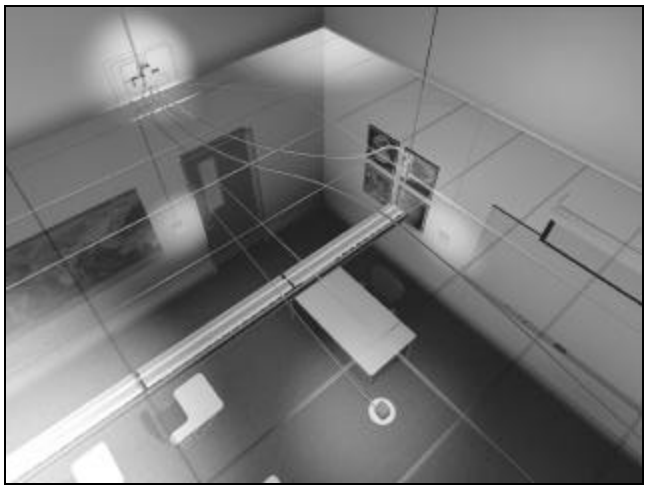
Row Control (Main Switch Bank)

Use occupancy sensors that combine dual sensor technologies and a teacher-controlled delay that keeps the lights on for a longer period of time during tests and other quiet periods. The nature of the classroom is unique. Generally, sensor delays should be kept short to maximize savings (reduce energy waste) during recesses, lunch periods, or whenever the teacher is away from the classroom, and other non-occupied periods. However, the delay needs to be sufficiently long to avoid false luminaire shut-offs during tests and other quiet periods. The results of Project 4.5 indicate that this is best done by a simple teacher control at the front of the classroom that allows the teacher to change the delay. A toggle switch located in the TCC is used to change the delay from its normal 10-minute setting to 1-hour. Each time the toggle is pushed, the delay is re-set to a full hour. This lets the teacher participate in cutting waste while, at the same time, ensure that the class is not disrupted during tests or other quiet periods.

Dual Technology Occupancy Sensor

Teacher Control Center w/ Quiet Time

Select a system that uses plug-and-play interconnection cables between the controls and sensors. This approach will help ensure that initial installation costs remain within existing construction budgets. Plug-and-play interconnections reduce system life-cycle costs due to simplified troubleshooting and maintenance procedures.



Low Voltage Plug together wiring

Specify a system that has a single manufacturer as the point of support for applications, pricing, and field support. The nature of the ICLS is sufficiently complex that it will benefit the school district to work with one manufacturer. This will help ensure that the system is priced properly and that training can be delivered to teachers through a well-constructed "Use and Care" manual. Additionally, the maintenance and facility groups in the school district will only have to make one call for support and technical training.

Select a system that has flexibility. For example, look for easy addition of a second occupancy sensor in a particular room or a whiteboard-specific luminaire.

Evaluate adding the ability to dim the T8 lamp in the A/V mode. This is a cost-effective way to let the teacher reduce the light in the classroom; it also increases the contrast of the material on the A/V screen. This works with simple overhead projectors and with sophisticated PC-based

projector systems. The controls should be at the front of the classroom and should be clearly labeled so substitute teachers can operate the system without the need to scroll though different scenes.

Keep the entire system simple and easy to use. Positive teacher preference resulted from three things: increased control, a user-friendly interface, and better-quality indirect lighting.

INTEGRATED CLASSROOM LIGHTING SYSTEM COMPONENTS

The following components make up the ICLS that was developed in Project 4.5.

- Luminaires:
    i. An indirect luminaire with an optical system utilizing new 96% reflective materials was selected to provide general lighting in the classroom. The actual luminaire installed in the test classrooms was Finelite's Series 10-PLV-3T8-DC-EP-CCO-277volts-FA-FE. Information on this luminaire, including its photometric performance, can be found at www.finelite.com.
    ii. A/V mode was accomplished by using a 3-lamp cross section where the center lamp is in a separate optical compartment. This allows for separate "General" and "A/V" mode operation. Two other systems for providing A/V modes have been explored:
        1. The first is dimming all the lamps in the luminaire. When all the lamps are on full output, the classroom is lighted in the General mode. When the lamps are dimmed, veiling reflections are reduced and the room is in an A/V mode. We did not make this our "standard" configuration for a number of reasons. First, this approach is significantly more expensive than the luminaire that uses a separate optical compartment for the A/V mode. Second, dimming ballasts carry a 10% to 20% energy penalty when compared to instant-start T8 ballasts. Third, while we understand that a number of manufacturers are testing a 1.2 BF T8 dimming ballast, none of these ballasts were commercially available during the test period. Using standard, readily available .9 BF T8 or 1.0 BF T5HO dimming ballasts, may not provide sufficient illuminance levels for some customers. Nevertheless, if dimming ballasts are needed for another reason, such as working with a closed-loop daylight dimming system, the dimming ballasts will provide a very adequate A/V mode.
        2. The second approach is to use a switching scheme that turns off lamps in the row of luminaires closest to the main teaching wall and leaves them on at the back of the classroom. (This approach is presented as Example 1 in Classroom Lighting Guidelines developed by Southern California Edison. These can be found at www.sce.com.) This system has the advantage that it uses a luminaire with 2-T8 lamps in cross section and may have a lower installed cost than even the recommended base system. However, the desk-level illuminance is not as uniform as with a dedicated A/V lamp in a separate compartment. Accordingly, for the relatively modest added cost for T8 ballasts and lamps, we felt that the more uniform lighting would provide a greater benefit over the years of use.
    iii. 3150 lumen 3500K T8 lamps were used in the ICLS. T8 lamps were selected over T5HO lamps in the base system for a number of reasons. These included:
        1. While in the A/V mode, a dedicated downward directed T5HO lamp provides too much illuminance in the classroom. (Desk-level

illuminance would be around 80 fc in A/V mode.) Using standard T5 lamps instead of T5HO would address this issue. However, the T5 system costs substantially more than a T8 system and does not provide substantial benefits. Since schools would prefer to avoid mixing lamp types in a luminaire, using a T8 lamp for A/V mode strongly suggests that T8 lamps should be used throughout the luminaire.

2. Information from the US Department of Energy shows that T8 lamps and ballasts actually have a higher end of life lumen maintenance level than a T5HO system. Therefore, using T8 lamps is the most energy efficient approach.
3. There are four different ballast factors for T8 lamps versus one for the T5HO system. This means that a design team can change ballast factors with a T8 system to address various room dimensions and still keep the total luminaire connected energy load under 1 watt per square foot.
4. The potential to make a slightly more efficient luminaire by using T5HO or T5 lamps instead of T8 does not offset the three disadvantages identified above.
5. The study selected 3500 K lamps based on a recommendation from consultants to the CHPS program. Some districts may prefer to use 4100 K lamps of even higher temperatures that bring into play Photopic and Scotopic considerations. An extensive study of how lamp temperature impacts students was outside the scope of this study.

iv. 1.18 BF instant-start electronic T8 ballasts were selected for the base system. Reasons that instant-start ballasts were selected included:

1. Currently, there is no 1.18 BF program-start ballast generally available. Accordingly, if the school wants to target an average of 50 to 60 maintained foot-candles and use a 2-row system, the only ballast that delivers this performance is a 1.18 BF instant-start T8. If a school has substantial daylight in the classrooms and is willing to accept maintained light levels of 35 to 40 fc, then this could be accomplished by using either .88 BF instant start or .88 BF program-start ballasts. However, based on the points below, instant-start ballasts would still seem to be a better choice.
2. Instant-start ballasts are generally less expensive and consume less energy than program-start ballasts. This means they save on initial installation costs and on-going energy costs.
3. Program-start ballasts have a 1- to 2-second delay after the switch is turned on until the lamps turn on. While this is not noticeable in many applications, it is noticeable when changing between General and A/V mode. Since user acceptance is a major point in developing ICLS, we wanted to go with the fastest change possible between modes.
4. Our data showed that the class was in A/V mode about one to two times a day. To project how this impacts lamp life, we needed to make several assumptions. One is that we felt, in relatively short order, use of the A/V mode would increase to 4 times a day. That means the

downlight-A/V lamps would switch on and off 4 times a day. At short switching cycles, T8 lamps will turn on and off approximately 4,000 times. (Source: OSRAM and GE.) This means that the A/V-mode lamps would last approximately 1,000 days (4,000 cycles divided by 4 cycles per day.) At 200 days per school year, this is a 5-year lamp life. This was judged acceptable to the specifiers and school facility managers we contacted.

5. However, T8 lamps will last close to their full rated life of 26,000 hours on a 3-hour switching cycle (source OSRAM.) when used with program-start ballasts and occupancy sensors. In schools where it is very expensive to replace a lamp, the advantage of a 20-year lamp life might offset the disadvantage of using more energy. (26,000 hours T8 lamp life, 6 hours a day in general mode, 200 days of school each year equals a 21.7 year projected lamp life for the lamps used in the general mode. The A/V lamp that operates for only a couple hours a day would last for nearly 60 years.) Each school district will need to review this tradeoff between increased energy usage and lower lamp replacement costs.

v. Parabolic louvers were selected to provide shielding for the downward lighting component. Parabolic louvers provide good shielding that reduces glare and have the advantage of being "open." This means that objects will fall right through the luminaire and there is less light depreciation due to dirt and contamination. On the other hand, different shields are available that may provide a better fit with needs such as a bright look in laboratories or a soft perforated look. However, when perforated luminaires are selected, the school should consider a dust cover to keep debris out of the luminaire. This adds cost and decreases luminaire efficiency by as much as 10%; however, it will keep the luminaires looking better for years.

vi. Aircraft cable pendant supports were used. Standard $1/16^{th}$ inch galvanized aircraft cables with a rated load of 450 pounds per support were used in the test classrooms. Aircraft cables capable of over 900 pounds per support are generally available for a modest added cost. We experienced no issues in the test classrooms; however, the maximum load requirement is best set on a school district level. We examined swivel stems that combine a steel stem with a ball at one end that is captured in a steel bracket. We rejected this support mechanism due to seismic concerns. On the surface, it would seem that steel supports would be superior. However, the swivel stems only rotate 45-degrees in any direction. Once they hit the stop, there is no specification as to the loads they can take before the ball dislocates from the socket. Investigations at actual earthquake sites found instances where the stem and ball did separate from the socket and the fixtures fell. Fixtures on aircraft cables do not have this problem. In fact, a number of years ago the City of Los Angeles maintained a testing laboratory that had an earthquake simulator capable of generating the shaking of a 9.0 magnitude earthquake. The $1/16^{th}$-inch aircraft cables were able to support the indirect luminaires during this test. Accordingly, this is the system we selected.

vii. Fixture supports were located "on-grid" with a CSA and UL-approved feed system selected to cut installation costs. The installed costs presented in the cost section of this document are based on indirect luminaires with mounting locations on 12-foot centers that are "on-grid." Care must be exercised in this area. There are indirect luminaires that do not have this style of mounting and may cost as much as $300.00 more per classroom to install. A more complete discussion of this point can be found on the Finelite web site, www.finelite.com, under the section entitled *Guide to Contractors*.

- Teacher Control Center (TCC) to allow the teacher to select general or A/V mode and control the occupancy sensor during tests or quiet periods.

  i. The TCC needs to be located at the front teaching wall. The research indicated that when the controls were located next to the classroom door, the teacher would not disrupt the class by walking to the controls and then walking back to the main teaching area. In fact, we did not see the levels change in the control classrooms during the entire teaching year despite the existence of several rooms with four or more switches by the door.
  ii. The TCC faceplate needs to have clear, easy-to-understand labels. Since substitute teachers need to become comfortable with the classroom in a few minutes, the control panel needs to be very simple to understand. Accordingly, clearly labeled faceplates were selected over switching systems that used multiple push buttons to control scenes.
  iii. The TCC should use low-voltage, plug-and-play interconnections. A number of control protocols, including DALI, were examined for use in the classroom. The selection of a low-voltage, plug-and-play system was based on the following findings:
    1. Many control systems had dramatically more features than were needed to let the teacher control all the pertinent features in the classroom. Because these extra features cost more to purchase and to program, the complex systems were not deemed cost-effective for a classroom.
    2. We selected the 0- to 10-volt dimming system for systems with optional A/V or daylight dimming because this was a standard protocol with ballasts and controls provided by multiple vendors.
    3. A low-voltage system has lower installed costs than a system that runs in conduit and is easier to modify if any changes are needed.

- A Power Control Center located above the ceiling tiles that contains:
  i. Control Pack that switches power based on occupancy and is tied into the TCC by means of low-voltage, plug-and-play cables. The Control Pack also includes a 24-volt supply to power the system and sensors. To assist in troubleshooting, the Control Pack should contain indicators that show that the main 24-volt power supply is operating and that the occupancy sensor is generating a proper signal.

ii. Row Pack with relays that control whether the luminaire is in General or A/V mode. The Row Pack has a second 24-volt power supply to provide backup in case of a failure to the primary supply and is connected via low-voltage plug-and-play cables.
iii. Extension Pack with relays to control the General and A/V mode of the second row of luminaires.
iv. A contractor-supplied J-box that is used to make the splices to the main power supply, the power to the master classroom switch(s), and the feeds to the 2-rows of luminaires.

- Occupancy Sensor with "Quiet Time" operating mode
  i. The sensor should use dual technology, passive infrared and ultrasonic, to detect occupancy. Several manufactures make this style sensor.
  ii. The sensor should be positioned in the center of the ceiling. We originally mounted the sensors in one of the corners of the room. However, teachers put up easels that obstructed its view and the diagonal distance from the corner to the door in a 30 x 32-foot classroom was at the end of the sensor range. Teachers complained that they had to walk too far into a dark classroom to activate the sensor. Placing the sensor in the center of the classroom addressed these issues.
  iii. It was less expensive to install a plug-and-play sensor in the ceiling than several feet down the wall. Given the savings and increased performance, the decision was reached that sensor placement should be in the center of a 30 x 32-foot classroom.
  iv. Coverage is up to 30 x 32 feet per sensor. Above that, add a second sensor. Some options are outlined later in this section.
  v. Sensor setting from the factory should be:
    1. Time delay equal to 10 minutes
    2. Turn on with both signals (ultrasound and passive infrared)
    3. Keep on with one signal (ultrasound or passive infrared)

- Plug-and-play interconnections
  i. A low-voltage plug-and-play system is necessary to lower installed costs.
  ii. A common form factor should be selected. RJ 45 jacks are preferred due to their ready availability, if anything happens during installation of the factory-supplied and tested cables.
  iii. Plug-and-play cables shall be Plenum rated and UL listed.

- A single manufacturer that provides layout assistance, pricing, training, commissioning, and warranty support is important.
  i. Manufacturer should be able to guarantee system pricing to ensure proper budgeting and life cycle costs.
  ii. The ballast manufacturer will pass through a 5-year warranty on ballasts and a2-year lamp warranty.
  iii. The sensor and controls will pass through a 5-year warranty on all sensors and controls.

iv. The system manufacturer will warranty all other parts and the plug-and-play interconnections for 5 years. This manufacturer will also serve as the main center for a one-call support with respect to all system support issues.
v. A Use and Care Manual for the teacher and school facilities department should be provided for each classroom.

Options for the ICLS to deal with different classroom layouts, different levels of daylight in the room, and different use of A/V (current and anticipated) should include:

- Second occupancy sensor with plug-and-play cable should be available.

- Whiteboard luminaire with labeled faceplate and switches.

- A/V dimming. The only lamp that is dimmed is the T8 lamp in the downlight compartment. The two T8 lamps that provide the lighting for the General mode are on standard 1.18 BF instant-start ballasts. Following is an explanation as to why this unique approach was selected. During General mode, the teacher wants maximum light on the walls and the students' desks. (This is especially true when the maximum connected lighting load is less than 1 watt per square foot.) In the A/V mode, the teacher may want to control light levels to direct students' attention for specific time periods. We found teachers used this capability not only with sophisticated A/V systems but also with basic-level overhead projectors. For example, we observed a teacher using an overhead projector to display an algebra problem to the class. As the teacher did this, she dimmed the T8 lamp to the lowest level. As a result, the screen (with the problem on it) was the brightest object in the room and commanded the attention of the students. After the teacher made sure the students understood the problem, she used a slide dimmer to increase the light to the maximum A/V level (about 35 fc on the student desks.) The paper on students' desks became well lighted. This helped the students focus on solving the problem individually. At the same time, there was sufficient ambient lighting for the students to interact with the teacher. We watched the teacher repeat this exercise three times. Each time, the teacher focused the students on the problem and then re-directed them to individual problem solving. When the session was complete, the teacher returned to General mode and asked the students to put away the math books. In this way, the teacher used simple but effective ICLS controls to direct the students where to focus and for how long. We also observed simpler examples, where teachers used the dimming control to "quiet" the students after breaks or for group reading time in the lower grades. The final benefits of the A/V dimming mode that was selected is that it has about one-half the cost adder of a traditional full dimming system and actually provides a lower "low" level because there is only one lamp on the dimming ballast.

- Faceplates and switches for row control (2-row and 3-row with labeled faceplate should be available as well as having switches work with rooms with multiple entrances and switch locations.)

- Closed-loop continuous dimming for daylight and A/V control. The system should be capable of accepting a plug-and-play sensor that will control dimming ballasts on a closed-loop basis. While it is difficult using currently available technology to show a fast payback for dimming systems that control the light level in the classroom based on the level of daylight, schools may want to add this feature for reasons other than simply payback on energy savings. Accordingly, the ICLS should be able to support a full dimming system that allows the teacher to dim the light manually from the front of the classroom. At the same time, a closed-loop daylight sensor should be set to the maximum amount of electric light based on available daylight. The two controls work together with the lower of the two settings driving the light and the highest setting never exceeding the level indicated by the daylight sensor.

- Open-loop daylight control featuring stepped switching of T8 lamps. While switching lamps on or off based on the amount of daylight in the space creates more disruption to the teaching rhythm in the classroom than a closed-loop dimming system, it is much more affordable and generally easier to commission. The ICLS should be designed so that a school can add switching on or off entire rows, or lamps within a row, based on a sensor. Selection of a closed-loop system, open-loop system, or a manual system to control rows based on daylight in the classroom depends on factors, which include the nature of the daylight in the classroom, the cost of energy to the school, and the amount of daylight at the school's locations. A complete discussion of these factors is outside the scope of this study. The SCE Classroom Lighting Guideline has an excellent introduction to the issues in this area. The link is: www.sce.com.

- Additional rows of indirect luminaires with a new 96% reflective optical system that allows "general" and "A/V" mode operation, 3150 lumen T8 lamps, and 1.2 BF instant-start electronic ballasts (including luminaires and appropriate controls.) The system must be capable of working with three or more rows of luminaires to allow for different shaped classrooms or labs.

- Different ballast factors to keep power loads at approximately 1 W/S.F. for different classroom sizes.

Additional descriptions of ICLS components can be found in Appendix A that presents a performance specification that is generic (non-manufacturer specific), and in Manufacturer Literature (Appendix F) that contains information on one commercially available ICLS system.

DERIVATIVE ICLS PROJECT

Introduction

The initial scope of PIER Project 4.5 was expanded to study four additional questions. Finelite, The Watt Stopper, and AEC staff conducted a derivative study to address these issues. Southern California Edison (SCE) staff and their consultants played a central role by providing a well daylit training room to study different lighting plans and by developing the alternate plans to study. Los Angeles Unified School District (LAUSD) also played a key role in this phase of the study by providing input from a client's perspective. The four questions addressed were:

1. What was the impact of adding a dedicated, energy-efficient, and affordable whiteboard luminaire to the electric lighting plan? Particularly, the researchers wanted to see if increased vertical illuminations levels on the whiteboard (40 to 50 fc) would allow reduced illumination levels at the desk level (20 to 30 fc).

2. How would teachers react to a closed-loop dimming system that would continuously adjust the electric light based on the amount of daylight compared to an open loop system that switched lamps completely on or off based on daylight levels? And, could the researchers project a payback based on energy savings on the part of the system that controlled the electric light levels based on the daylight in the space?

3. What would be user response to providing the A/V mode of lighting by switching off lamps in the indirect luminaire that were closest to the white board or by dimming the lamps in the indirect luminaire? These layouts are shown in Appendix H as Examples 1 through 3 and were developed by SCE. The examples are also presented in their entirety in the SCE Classroom Lighting Guideline at www.sce.com.

4. What would be the life-cycle cost of these systems compared to the PIER ICLS developed in Project 4.5?

Approach

SCE provided a well daylit training room at their CTAC facility in Irwindale, California, to serve as a test laboratory for the different lighting layouts. The room was approximately 35 x 30 feet with an 11-foot 4-inch ceiling.

The room had been specifically built to demonstrate good daylighting practices. It had one wall with both view windows and top lighting windows. These had exterior light shelves to control direct sun light. Three skylights provided vertical illumination on the interior wall and the desks near the wall. The room had a 16-foot white board and a pull down A/V screen that would cover the whiteboard when lowered. The room was used for many different functions and used a desk system that was easy to reconfigure. Figure 5 provides the CTAC daylit classroom floor plan.

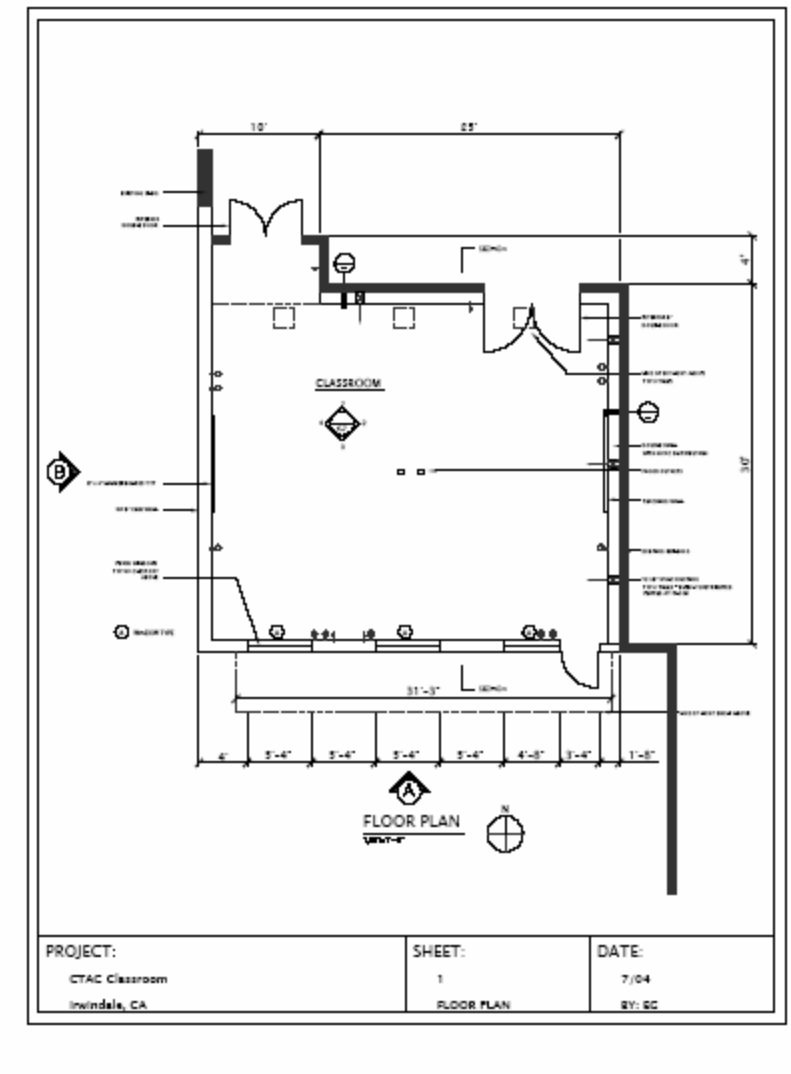


Figure 5: Floor plan of CTAC daylit classroom.

A newly developed, dedicated whiteboard luminaire was installed to light a 16-foot long whiteboard that was on a wall at right angles to the wall with the daylight and view windows. The 12-foot luminaire was mounted to the ceiling and approximately 3-feet back from the wall that contained the whiteboard. Controls for the whiteboard were at the front of the classroom.

A special purpose indirect luminaire and control system was built and installed in the training room. The indirect luminaire was built so it would operate as if it was a 2-T8 lamp driven by 1.2 BF electronic ballasts luminaire providing approximately 90% uplight and 10% downlight. The luminaire would also operate as a 1-T5HO indirect luminaire with the lamp on a dimming system. Switches in the control panel, mounted on a side-wall (see Figure 6), determined the mode of luminaire operation. The panel also contained additional switches that controlled which T8 lamps would be turned off based on the amount of daylight in the space. This let the researchers simulate the effect of turning an entire row off at one time or only one row of lamps at a time based on daylight.

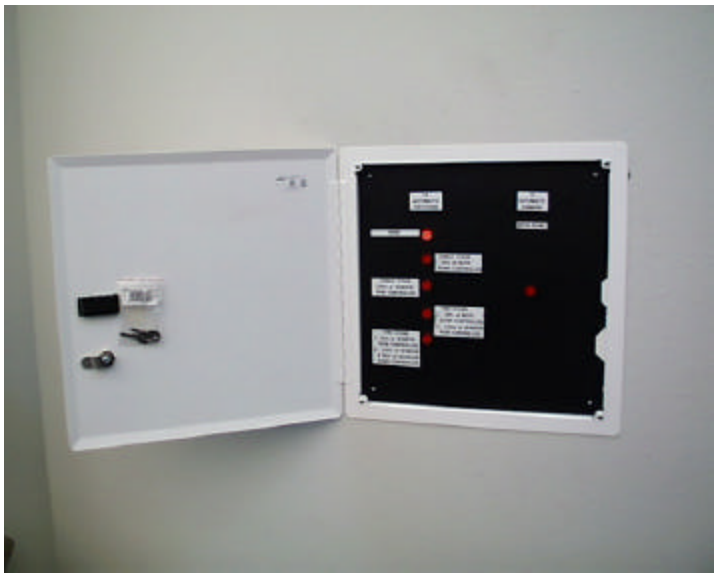


Figure 6: Control panel at CTAC classroom that provided switching from T-8 step switching lighting system to T-5HO automated dimming system.

Two separate Teacher Control Centers were provided. One Teacher Control Center was located to the left hand side of the whiteboard and controlled the system when the luminaire was in 2-T8-mode. The second Teacher Control Center was to the right of the whiteboard and controlled the system when the luminaire was in the 1-T5HO-mode.

A state-of-the-art light level sensor with a new commissioning system was installed to control the closed loop dimming system. This was the sensor that was developed in PIER LRP Project 3.3. The open loop control sensor was The Watt Stopper LS100. The commissioning of the sensor was performed by The Watt Stopper personnel and observed by researchers from the AEC, Finelite, and SCE staff.

Researchers took numerous light level readings under various daylight and electric light conditions. They converted these readings into graphical representations that are part of Appendix G. Researchers also conducted a number of discussions with presenters that used the room and were present during extended meeting and presentations in the room (Reference Figure 7).

The LAUSD provided useful input regarding all aspects of the derivative project. As a result, the school district is preparing their own lighting and lighting control specification based on some of the ICLS findings.

Figure 7: Pictures of lighting scenarios at the CTAC classroom. Starting at the top left is daylight only; Top right is T-5HO lighting system; Bottom left is T-8 lighting in A/V mode; Bottom right is T-8 lighting with whiteboard lighting on.

Findings

Researchers documented the following key findings.

- The addition of a dedicated whiteboard luminaire to the classroom layout had a positive impact. The results were:
    a. The luminaire installed was a 12-foot long whiteboard luminaire with 1T8 lamp in cross section and 0.88 BF electronic ballasts. It was mounted 11 feet 4 inches above finished floor and 36 inches from the wall that contained a 16-foot long whiteboard.
    b. With no daylight or other electric lights on, the illuminance on the whiteboard ranged from 15 fc in the lower corner to 33 fc in the top center (2.2 to 1 uniformity.)
    c. When the electric lights were turned on, the combined levels were:
        i. With the whiteboard luminaire and the 2-T8 with 1.2 BF system turned on, the illumination on the whiteboard was 42 fc in the corner, 62 at the top (1.5 to 1 uniformity.)

ii. With the whiteboard luminaire and the 1-T5HO system turned on, the illumination on the whiteboard was 34 fc in the corner, 53 at the top (1.6 to 1 uniformity.)
iii. Additional illumination could have been provided if the whiteboard luminaire was made longer. However, the researchers wanted to test the SCE layout that used 12-foot luminaires. If the luminaires were mounted as outlined in the guideline, additional vertical illumination would have been achieved. The guideline recommends mounting the luminaire approximately 18-inches form a 10-foot ceiling.
iv. The whiteboard luminaire was left as originally installed based on feedback that it provided excellent illumination as installed and moving it lower would have meant substantial changes would have been needed to the A/V projector and screen in the room.

d. The CTAC daylit classroom is one of the most requested rooms in this heavily used facility. The response of presenters and attendees in the room to the whiteboard luminaire was uniformly positive. The positive comments were made in both the T8 and T5HO modes. It is interesting to note that the T5HO light level of 33 fc on the desks is lower than generally found in classrooms or training rooms. The positive response to the room in this condition supports the idea that a well-lighted white board actually does let the illumination at desk-level decrease without creating dissatisfaction. However, due to the nature of the presentations made in this training room, we were not able to conduct the type of in-depth teacher surveys that were done for the base project. Nevertheless, attendees including architects, lighting specifiers, engineers, school personnel, and trainers have all complemented SCE on the room and its lighting.
e. Additional findings included:
i. The wall with the white board became the brightest surface in the room and helped focus attention of the students on the main teaching wall. Since reading cramped handwriting or low contrast material on chalkboards is often the most difficult task in a classroom or training room, the illuminance on this wall increased contrast and made this task easier as well.
ii. The switch for the whiteboard luminaire should be at the front of the classroom. The teacher will want to turn the luminaire off when going to the A/V mode. Properly locating the switch was important to the user satisfaction levels.
iii. While the white luminaire could have been automatically switched on or off when the presenter selected the A/V mode (whiteboard luminaire off) or General mode (whiteboard luminaire on), presenters appreciated having even more control. For example, when the whiteboard luminaire is switched on and the room lights are in A/V mode or dimmed, an interesting dynamic occurs. As a person enters the classroom, the material on the board is quite bright; however, the general light levels are sufficiently low to create a quiet or calming effect. This might be useful when the instructor wants the students to enter the classroom; open a textbook; and start an assignment right away.

iv. The installed cost of this 12-foot luminaire was estimated at $0.47 per square foot ($447.00.) This includes luminaire, lamp costs, and installation labor plus traditional contractor mark-ups. It does not include sales tax. However, the incremental cost may be somewhat less. This is due to the fact that the whiteboard was lighted so uniformly that it may be possible to reduce the row length to 20-feet from 24-feet. On the other hand, at least one client, has found that a combination of the dedicated whiteboard luminaire and two 24-foot runs with standard 0.88 BF ballasts provides exactly the light levels they need at less than 0.8 watts per square foot. Since new school construction costs often run $120 to $175 per square foot, the dedicated whiteboard luminaire brings such benefits for so little cost that many architects and specifiers may want to add it to their designs.

- User response to closed loop dimming system was positive. The response to the stepped T8 switching was more difficult to gage. Here are the findings:
    a. The slide dimmer switch was located at the front of the classroom and easy to use. The sensor that provided the maximum level of electric light based on the daylight in the room worked well. Even when the sensor was "limiting" the maximum electric light level due to the daylight in the space, the teacher could still dim the system to lower levels. The sensor selected was the state-of-the art Watt Stopper Model 301. The photo sensor is commissioned via a hand-help remote unit. One will be needed for each school or site. Extensive information on this sensor can be found by reviewing PIER LRP Project 3.3. The unit should become commercially available during 2006. Final pricing has not been set at the time of the report. The costs in the Life Cycle analysis section of this document are based on best estimates.
    b. The researchers found that commissioning went smoothly and the unit has the advantage of creating the documentation that the 2005 Title 24 code requires to indicate that the system was properly installed and set up. Since commission issues are often one of the biggest obstacles to overcome in closed-loop systems, the benefits provide by this new generation sensor should help architects and specifiers achieve their project goals for integrating daylight and electric light.
    c. Because the nature and amount of daylight varies so much from classroom design to classroom design, it was impossible to come up with a definitive payback review for the closed-loop system based on potential energy savings. Prior work indicates that savings of up to 50% have been achieved. However, when the base-level energy load is approaching 0.8 watts per square foot. A 50% savings may only equate to savings of $0.40 per day per classroom. As indicated earlier, the benefits of closed-loop dimming extend beyond energy-related payback and the incremental cost of this system need to be viewed based on overall design objectives.
    d. The stepped daylight switching system did not operate as expected when the luminaire was in T8 mode. The primary reason was that the level of daylight in the space was below the expected levels. The SCE-developed lighting guidelines for a typical school classroom showed between 120 and 200 fc of desk-level illumination near the windows. The SCE training room, however, was so well

designed with light shelves and other features that it had a maximum of only 50 to 60 fc of daylight illumination near the windows. Accordingly, the sensor never experienced the condition where the T8 lamps should be switched off. This led to several observations:

i. We were unable to get first hand feedback from the presenters about the disruption they felt when an entire row of lamps automatically shut off at one time. Further, since presenters are not in the classroom every day like teachers are, the researchers were unable to assess how distracting this would be after the teacher became familiar with it happening each day.
ii. The experience indicated that a closed-loop dimming system can be installed in rooms with much wider ranges of daylight levels and perform satisfactorily with high user acceptability. While there is a cost adder associated with closed loop dimming as compared to row switching, the cost of carefully designing a stepped switching system and the unknown factor of user acceptability may offset the apparent initial price difference.
iii. After the researchers found that the automatic stepped switching system did not perform as expected, the system was modified to let the lamps be controlled manually. This let the researchers determine the light levels under various stepped switching alternatives. These measurements indicate very satisfactory levels are achieved with stepped switching. Accordingly, the real issues surrounding stepped switching remains whether or not the luminaire can automatically switch without creating objectionable disruption and still deliver cost-effective energy savings based on daylight.

- The findings of PIER 4.5 recommend that the classroom should have dedicated A/V mode. This extended study explored two additional ways to provide A/V lighting. The original study used a separate compartment with a dedicated lamp to provide downlight that did not create veiling reflections on the screen. (For classrooms with extensive A/V use, the downlight was dimmed for extra teacher control.) However, A/V mode can also be provided by lamps on a continuous dimming system or by switching off the uplights near the screen that create the most glare. The special luminaire let the instructors compare and contrast the A/V mode under the 1-T5HO dimming system and the 2-T8 indirect mode where lamps were switched off. The figures in Appendix G indicate the light levels that were obtained in each of these configurations. Computer simulations are also included that indicate light levels at specific locations in a typical 30 x 32-foot classroom with 10-foot ceilings. In addition to this data, researchers had the following observations:
    a. Daylight illumination in the test classroom varied from 5 fc at 8:00 AM to 40 fc at 2:00 PM and back down to 25 fc at 4:00 PM. These levels are shown on the figures in Appendix G. While the teacher had access to manual blinds that could reduce the amount of daylight, they did not generally use them. Therefore, during the A/V mode, there was always daylight in the room.
    b. Based on the daylight present, the researchers found that during both alternate A/V modes (T8 switching and T5HO dimming) there was sufficient light to take notes and see the teacher's face. And, both modes significantly reduced the vertical illuminance levels on the screen.

c. The computer simulations indicate that in the 2-T8 switched mode the light on the front screen drops to 4 fc. The desk-level illuminance from the electric light provides a low of 4 fc on the desks in the front row and 28 to 40 fc on the desks in the back row. When daylight levels of 20 to 40 fc are added to the electric light level, the combined lighting would be 24 to 44 at 4:00 PM or 44 to 80 at noon. In either case, the uniformity is excellent (better than 2 to 1.) Accordingly, if the classroom is well daylighted, then the switched mode to provide A/V mode should work well. (However, blinds are needed for most classrooms since some daylight levels of 120 to 200 fc near the windows will negatively impact projections on the screen.)
d. Similar to the findings above, the system with 1-T5HO lamps on a full dimming system provided excellent A/V lighting in the classroom. In a fully dimmed mode, the T5HO lights provide less than 1fc on the desks and less than 1fc vertical illuminance on the whiteboard. The slide dimmer made it easy to balance the light on the whiteboard with light on the desk. (As above, manually controlled blinds should be provided to ensure the daylight could be reduced to avoid veiling reflections during A/V presentations.)

Life cycle cost comparison

The following section compares the life cycle costs for three specific examples. Project 4.5 gratefully acknowledges the contribution of the examples by SCE with support from Clanton and Associates. More information about the examples can be found in Appendix H.

In Example 1, the ambient lighting system uses 2-20' of semi-indirect luminaires that are suspended in 2 rows of 5 each. Each luminaire employs (2) high lumen T8 lamps, all powered from high ballast factor electronic ballasts. The whiteboard task light is a linear wallwasher about 12 feet long that uses (3) Super T8 lamps.
Example 2 uses a (3) lamp Super T8 luminaire. The two outer lamps are used for a semi-indirect ambient lighting scene, and the third inner lamp is separately switched for use as a task light during projection and AV presentation. In this design, 2-20' PIER luminaires are suspended in 2 rows of 5 each.
In Example 3, the ambient lighting system uses 2 rows of 20' direct-indirect luminaires are suspended in 2 rows of 5 each. Each luminaire employs (1) high lumen T5HO lamp, powered from high ballast factor electronic dimming ballast. The whiteboard task light is a linear wall-washer about 12 feet long that uses (3) Super T8 lamps.

Please note that all costs are estimated prices that are negotiated between a school district and their suppliers and contractors. Several conclusions can be reached:

1. The base PIER system remains the lowest initial cost system. However, the projected energy savings from the stepped daylight switched system create sufficient energy savings that the life cycle costs of the base PIER system and the SCE Example 1 become the same over a 20-year period. The closed loop dimming system remains the most expensive. However, the incremental cost, on a life cycle-basis, for the complete dimming system is under $0.75 per square foot.

2. The initial incremental cost of adding the whiteboard luminaire is partially offset by cutting the length of the rows from 24-feet to 20-feet. In fact, in the SCE Example 1, the material cost is nearly the same as for the 2-24 run system with the dedicated chamber for the A/V lamp. This means the incremental initial cost is the labor to install the whiteboard.
3. The full dimming system with closed loop dimming provides the greatest level of control and user satisfaction. However, it also has the highest initial and lifecycle cost. Decision makers will need to determine whether or not these added benefits are consistent with the overall school design goals and budgets.
4. All costs are estimates based on the luminaires, sensors, controls, and plug-and-play interconnections used in the test classrooms. The cost of indirect luminaires and integrated controls can vary widely from one manufacturer to another. When specifiers are developing project budgets, they must exercise care to be specific about the performance they want and the sensors and controls that are selected. The performance specification presented in Appendix A is designed to help do this. They also must work with the client and their project managers to make sure the proper items are quoted. Otherwise, costs may be greater than expected and the benefits not achieved.

The cost information for the three examples is shown in Table 5 and categorized by component with material and labor costs. The information enables school representatives, lighting specifiers, and contractors to measure the cost against the benefit of the various system designs and components.

Component	**SCE Example 1**	**SCE Example 3**	**PIER 4.5 System**
First Costs:			
Indirect Suspended Luminaire			
Luminaire Type	S10- 2T8-EP-DC-CP	S10-1T5HO-Dimming-EP-PLV	S10-3T8-EP-DC-CCO-PLV
Luminaire row length	20.00	20.00	24.00
ballast type	T8 1.2 BF IS	T5HO dimming	T8 1.2 BF IS
# luminaire rows per classroom	2.00	2.00	2.00
lamp type	T8	T5HO	T8
# lamps in cross section	2.00	1.00	3.00
# lamps per row	10.00	5.00	18.00
Price per lamp	2.75	9.00	2.75
Whiteboard Luminaire			
Luminaire type	12-foot SX2-1T8	12-foot SX2-1T8	none
Luminaire length	12.00	12.00	n.a.
ballast type	T8 .88 BF	T8 .88 BF	
# luminaire rows per classroom	1.00	1.00	
lamp type	T8	T8	
# lamps in cross section	1.00	1.00	
# lamps per row	3.00	3.00	
Price per lamp	2.75	2.75	

Component	SCE Example 1	SCE Example 3	PIER 4.5 System
Total luminaire material costs	$1,867.75	$2,592.45	$1,866.88
Total luminaire installation costs at $75.00 / hour	$329.00	$329.00	$293.00
Control and Sensor Costs			
includes:			
Switches			
Teacher Control Center, and Control Packs			
Plug-and-play interconnections			
Occupancy Sensor			
Daylight Control			
Total sensor and control materials	$658.00	$848.00	$508.00
Total sensor and control labor	$590.00	$540.00	$390.00
Total System Cost			
(Material)	$2,525.75	$3,440.45	$2,374.88
(Labor)	$919.00	$869.00	$683.00
Contractor OH&P (15% material cost)	$378.86	$516.07	$356.23
Contractor Supervison (10% labor)	$91.90	$86.90	$68.30
General Conditions (7.5% material and labor)	$258.36	$323.21	$229.34
Total System Cost First Cost	**$4,173.87**	**$5,235.63**	**$3,711.75**
First cost per square foot	**$4.35**	**$5.45**	**$3.87**
Expected power density (watts per square foot)	*0.60*	*0.50*	*0.80*
Annual Costs:			
Lamp rated hours (derated to reflect IS ballast cycles)	15000.00	20000.00	20000.00
Annual hours of general operation (burning General lamps)	1750.00	1750.00	1500.00
Estimated years to replace general lamps	8.00	11.00	13.00
Annual hours of A/V mode operation (burning A/V lamps)			250.00
Estimated years to replace A/V lamps			13.00
Estimated annualized re-lamping costs	$4.69	$5.00	$4.58
Annual energy for General ($.13 / kwhr)	$131.04	$109.20	$149.76

Component	SCE Example 1	SCE Example 3	PIER 4.5 System
Annual energy for A/V mode ($.13 / kwr)			$12.48
Total Annual Energy Cost	$131.04	$109.20	$162.24
Estimated annualized cleaning cost	$13.75	$13.75	$13.75
Estimated annualized heavy maintenance	$13.75	$13.75	$13.75
Total Annual Costs	**$163.23**	**$141.70**	**$194.32**
Life Cycle Cost:			
First Cost	$4,173.87	$5,235.63	$3,711.75
Annual Cost	$163.23	$141.70	$194.32
Years of operation	20.00	20.00	20.00
Inflation rate for Annual Costs	0.04	0.04	0.04
Salvage value at end (20% of first cost)	-$834.77	-$1,047.13	-$742.35
Rebates and incentives:	0.00	0.00	0.00
Present Value of All Costs	**$5,794.09**	**$6,444.10**	**$5,795.01**
Present Value of All Costs per square foot	**$6.04**	**$6.71**	**$6.04**

Table 5: Cost information categorized by component with material and labor costs for three different classroom lighting systems evaluated under the derivative ICLS project.

CONCLUSIONS

With input from representatives with the Collaborative for High Performance Schools (CHPS), Finelite Inc. used a combination of best practices and new technologies to develop and test an integrated classroom lighting system (ICLS) for K-12 classrooms. The basic system includes indirect luminaires with energy efficient T-8 lamps and electronic ballast, 96% reflective material within the fixture, a teacher control center located at the front of the classroom, and plug-and-play components.

Working with six California schools, variations of the ICLS were installed in 19 classrooms. Researchers continuously monitored the ICLS and other baseline classrooms for one school year and analyzed the resulting data. The data shows a 30 to 50 percent reduction in energy use in the ICLS classrooms with improved lighting on the teaching walls and better flexibility for adjusting light levels during audio/visual presentations. The ICLS also provides approximately 40 to 70 footcandles of light on student's desks while maintaining less then one watt per square foot (0.9/ S.F.) in the classrooms. 2005 Title-24 codes require schools to have 1.2/ S.F. or less in new classrooms. Teachers were also surveyed and provided positive responses to the light levels and the quality of light in the classrooms. A derivative project that involved installing a hybrid ICLS in a daylit training classroom was also completed.

Based on the results of Project 4.5, the benefits of an Integrated Classroom Lighting System are well tested and documented. School districts and their architects and lighting designers should consider the following criteria for classrooms:

- Use indirect luminaires to provide general classroom illumination. Light a 30 x 32-foot classroom with 2 rows of a high-performance, indirect suspended luminaire with 3100 lumen T8 lamps and 1.2 BF T8 electronic ballasts. Use different T8 ballast factors for different size classrooms or for classrooms with extensive daylight.

- Provide an A/V-appropriate lighting mode in classrooms. During A/V mode, reduce light on the front teaching wall while keeping an appropriate level of light on the students' desks for note-taking and class interaction.

- Give the teacher control at the front of the classroom to change between General and A/V modes of operation and to control other functions and options.

- Provide ways to control the electric light to reflect the amount of daylight in the classroom. Depending upon the nature of the daylight in the classroom, use manual control, stepped switching, or automatic dimming based on daylight levels.

- Allow the teacher to keep the lights on during periods of quiet time for tests or periods of individual study or work. Position the occupancy sensors in the ceiling to minimize obstruction by objects in the room.

- Select a system with plug-and-play sensors and controls and that have a single manufacturer as the point of support for applications, pricing, and field support.

- Provide modularity and options to deal with different classroom layouts, teaching and A/V requirements, and daylighting conditions.

The ICLS provides quality lighting and is an economical alternative to typical classroom lighting designs and, to help minimize support and warranty costs, is bundled as a package system with one source of responsibility. Policy makers may want to use these findings to set overall guidelines that encourage ICLS use. In this way, they can help ensure that energy savings together with a better teaching environment are implemented in as timely a manner as possible in the State of California.

APPENDIX A: CLASSROOM LIGHTING PERFORMANCE SPECIFICATION

Appendix A
ICLS performance specification

SECTION 16512 - CLASSROOM LIGHTING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 OVERVIEW

A. This section specifies an integrated classroom lighting and control system that provides:

1. Single source responsibility by the manufacturer for the specified lighting fixtures, sensors, and lighting control devices in the classroom. The manufacture shall provide the following:

Lighting fixtures, lamps, motion sensors, photo-sensors, dimmer controls, power packs and relays, switches and wall cover plates, with labels, as described herein and as noted on the drawings.

Confirmation of lighting and power calculations based on the indicated design.

Wiring diagrams.

Control cables with pre-installed plug connectors.

Control Devices as indicated with receptacles for Control cables.

Installation and Owners Manuals.

Factory training for installation of products.

Single-source post-installation support for owner and their designated representatives.

Pass through warranties apply for lamps, ballast, sensors and controls from the appropriate manufacturers.

B. This Section includes the following:

1. Interior lighting fixtures with lamps, ballasts and controls designed specifically for multi-functional classroom lighting.
2. Accessories: As noted on the plans, provide Teacher Control Center, Single Pole Switches, Low Voltage Switches, dimmer controls (optional), occupancy sensors, and/or light level photo-sensors (optional).

C. Related Sections include the following:
1. Division 16 Section "Raceways and Boxes".
2. Division 16 Section "Conductors and Cables".

1.3 DEFINITIONS

A. BF: Ballast Factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.

B. CRI: Color Rendering Index.

C. CU: Coefficient of Utilization.

D. LER: Luminaire Efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

E. RCR: Room Cavity Ratio.

1.4 PERFORMANCE REQUIREMENTS

A. The Classroom Lighting System shall consist of: pendant luminaires with specified ballast factor, lamps with specified lumen output and CRI, Teacher Control Center, Dimmer Control (if specified herein), faceplates with specified labels, motion control sensors, photo sensors (if specified herein), Relay Control Interface with Modular receptacles, Plenum-rated Low-Voltage Control cables with modular connectors, and control components.

B. The pendant luminaires shall contain two rows of 48-inch fluorescent lamps whose primary luminous distribution is upward and one center row of 48-inch fluorescent lamps whose primary luminous distribution is downward. These rows shall be dual switched per information to follow.

C. The control system shall consist of:

1. A Teacher Control Center (TCC) located near the teacher's primary teaching position. Teacher will select uplight on or downlight on, but uplight and downlight cannot be on at the same time. The cover plate for the Teacher Control Switch will be labeled "GENERAL" and "A/V MODE". Wiring from the TCC shall be through factory wired receptacle and factory supplied low-voltage cable with pre-installed connectors as described.

2. "Quiet Time Switch". The instructor can use a toggle switch on the TCC to send a signal to the motion sensor. When the switched is toggled, the lighting in the classroom will stay on even in the absence of motion, for one hour. After one hour, the motion sensor will automatically restore to its previous state. The instructor can toggle the switch at any time to re-set "Quiet-Time" to a full 60 minute on period. While in "Quiet Time" mode the instructor will have full control of the classroom lighting. The label on the TCC will read "QUIET TIME 1 HOUR ON".

3. Motion Sensor shall be ceiling-mounted and connect to the lighting system through low-voltage wiring using factory-installed receptacles and factory supplied cable with pre-installed connectors as described. The sensor shall turn lights on when both PIR and ultrasonic sensors detect occupancy. Once on, detection by either sensor will keep the lights on. A field adjustable time-delay shall be factory preset to recommended NEMA standards. Sensitivity settings shall adjust automatically through integrated sensor technology.

4. (Optional) The downlight of each luminaire shall be dimmed to 5% of the initial light level. The TCC contains the dimmer control unit, which is labeled "A/V MODE DIMMING."

5. (Optional) Daylight Control sensor shall be ceiling-mounted facing the primary window wall and located approximately one-half way between the first row of luminaries and the wall. It shall provide for user-adjustable light level setting between 10 and 1000 footcandles. It shall provide for an adjustable dead band setting to prevent lighting system cycling. The Daylight Control sensor shall be connected to a set of relays by plug together low voltage cables. The relays will be used to turn off one-half of the uplights in each row when the sensor indicates that sufficient daylight is present. Sensor will be factory calibrated to reduce the field commissioning time to calibrate the units.

D. Performance of uplight portion of the luminaries:
   1. 'Uplights' shall provide a maintained average horizontal illuminance of not less than 50 footcandles measured at 30 inches above the floor with a uniformity of better than 4 to 1. Lighting power density shall be equal to or less than (1.0) watt per square foot.
   2. Performance results will be calculated as follows: Horizontal light reading averages shall be taken from an area 3-feet in from each wall with readings every foot. Standard reflectances used should be 80/50/20.

E. Performance of downlight portion of the luminaries:
   1. 'Downlights' shall provide an average horizontal illuminance of not less than 25 footcandles 30 inches above the floor with a uniformity of better than 4 to 1. Lighting power density shall be equal to or less than (.5) watts per square foot.
   2. Performance results will be calculated as follows: Horizontal light reading averages shall be taken from an area 3-feet in from each wall with readings every foot. Standard reflectances used should be 80/50/20.

F. The Classroom Lighting System shall be shipped from the luminaire manufacturer complete with luminare, ballasts, lamps, fixture supports, applicable control components, control cables, and device coverplates. The installer shall supply standard electrical components such as, but not limited to, electrical boxes, conduit, building wire, etc.

1.5 SUBMITTALS

A. Product Data: For specified lighting fixture. Include data on features, accessories, finishes, and the following:

   1. Physical description of luminaire, including dimensions and verification of indicated parameters.
   2. Certified Photometric Test Report prepared by an independent testing laboratory.
   3. Fluorescent ballasts.
   4. Lamps.
   5. Control components: Switches, dimmers, occupancy sensors, light level sensors, relays.

B. Shop Drawings: Show details of luminaires. Indicate dimensions, weights, and method of field assembly, components, features, accessories, and location and size of each field connection.

C. Wiring Diagrams: Power, and control wiring.

   1. Operation and Maintenance Data: For lighting equipment and fixtures to include: in- operation, and maintenance manuals.

D. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer shall have not less that ten years experience of manufacturing pendent fluorescent luminaires.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Mockups: If required for this project, provide luminaires and accessories for room or module mockups. Install luminaires for mockups with power and control connections.

1. Obtain Architect's approval of luminaires for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved luminaires in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Source Limitations: Obtain Classroom Lighting System through one source from a single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

1.8 PROJECT CONDITIONS: Existing Facilities

A. Interruption of Existing Classrooms: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than four days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

B. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
2. Parabolic Diffusers: 1 for every 500 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 1 for every 500 of each type and rating installed. Furnish at least one of each type.
4. Occupancy Sensors: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
5. Light Level Sensors: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
6. Dimmer Controllers: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
7. Power Pack Relays: 1 for every 200 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Classroom Lighting System:

Finelite or approved equal. Submit documents for approval 10 days prior to bid.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

A. Fluorescent Fixtures: Comply with UL [**1570**] [**1598**]. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 96 percent.
2. Specular Surfaces: 95 percent.
3. Diffusing Specular Surfaces: 85 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
b. UV stabilized.

2.3 LUMINAIRES

A. Fixture:

1. Fixture - Optical Operation:

    a. Pendent mounted luminaire with an indirect/direct distribution using a semi-specular parabolic louver and a 96% or greater reflective center optical section to control the A/V mode of operation.

    b. In the uplight mode, the fixture shall be at least 83% efficient with 2T8 lamps operating in the uplight mode. 64% of the light distribution shall be upward and 36% down in this mode. Candela power from 55 degree to 90 degrees shall be 300 or less at all angles.

    c. In the downlight mode, the fixture shall be at least 64% efficient with 1 T8 lamp operating in the downlight mode. 100% of the light from this lamp will be in the downward direction. Brightness of the baffle shall be less than 360 candelas across all angles from 55 degrees to 90 degrees.

    d. To achieve the requirement of 1 watt per square foot or less, the fixtures must be designed to accept T8 electronic ballasts with BF ranging from .71 to 1.18. Generally, 2-row per classroom systems will use 1.18 BF ballasts for 960 square feet and 3-row per classroom systems will use .77 BF ballasts for 960 square feet.

2. Voltage: [**120**] [**277**] Volts AC.
3. Mounting: Adjustable aircraft cable system to allow up to 48-inch suspension.
4. Nominal Dimensions: 10 inches wide x 2 1/2 inches high in multiples of 48 inches long.
5. Lamps: Three per cross section**.** Sylvania 32 watt T8, Cat# FO32/835/XPS/ECO with a lumen rating of 3100 Lumens or equal.
6. High Ballast Factor Ballasts: 1.18 BF 3-T8 electronic ballasts. Sylvania # QT3X32 PLUS or equal.
7. Low Ballast Factor Ballasts: .77 BF 3-T8 electronic ballasts, Sylvania # QT3X32 ISL-SC or equal.
8. Dimming Ballasts: 5% - 100% 3-T8 electronic dimming ballasts with 0 to 10-volt dc control. Sylvania # QTP3X32 DIM5-Q or equal.

2.4 FLUORESCENT LAMP BALLASTS

A. Description: Include the following features, unless otherwise indicated:

1. Designed for type and quantity of lamps indicated at full light output.

B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:

1. Comply with NEMA C82.11.
2. Ballast Type: Instant Start, unless otherwise indicated.
3. Dimming Ballasts: Will be rapid start or programmed start units.
4. Sound Rating: A.

5. Total harmonic distortion rating of less than 20 percent according to NEMA C82.11.
6. Transient Voltage Protection: IEEE C62.41, Category A.
7. Operating Frequency: 20 kHz or higher.
8. Lamp Current Crest Factor: Less than 1.7.
9. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

C. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:

1. Dimming Range: 100 to 5% percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 25 percent of normal (93 watts reduced to 23 watts.)
3. Compatibility: Certified by manufacturer for use with specific dimming system indicated.

2.5 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, 3100 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

2.6 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 16 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, [**12 gage**].

C. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

D. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.7 FINISHES

A. Fixtures: Manufacturers' standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

2.8 LIGHTING CONTROL DEVICES

A. Teacher Control Switch: SPDT switch rated for its operating voltage and current. Specification grade decorator style.

B. Row Control Switches: 2PST switches rated for its operating voltage and current. Specification grade decorator style.

C. Dimming Ballast Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over a dimming range or 100% to 5%.

D. Coverplates: Nylon, quantity of opens to match quantity of decorator style devices.

E. Occupancy Sensors: Adjustable sensitivity and off delay time range of 5 to 30 minutes.

1. Device Color: White

2. Mounting: Ceiling-mounted.

3. Occupancy detection indicator.
4. Combination Sensors: Ultrasonic and infrared sensors combined.
   a. Ultrasonic Sensor: Crystal controlled with circuitry that causes no detection interference between adjacent sensors.
   b. Infrared Sensor: With daylight filter and lens to afford coverage applicable to space to be controlled

.

F. Light Level Sensor: Detect changes in ambient lighting level and provide supply for on/off control.
1. The detection range will be between 10 and 200 foot candles
2. The deadband will be adjustable with a 1 to 3 ratio
3. The delay will be adjustable from 3 seconds to 5 minutes
4. The sensor will operate via a 24-volt DC power supply and have a current draw of 22 milliamps.

2.9 Retain below to allow photometric tests by manufacturer's laboratory.

PART 3 - Execution

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install a minimum of one ceiling support system rod or wire for each pendent support cable.

2. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Continuous Rows: Suspend from cable, brace to limit swinging as required by seismic conditions.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

D. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

3.4 ADJUSTING

A. Set field-adjustable components on Occupancy Sensors, Light Level Sensors, and Dimmer Control.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.5 CLEANING AND PROTECTION

A. Remove and dispose of clear plastic protection from around luminaires.

B. Clean luminaire optical surfaces.

C. After completing installation of exposed, factory-finished luminaires, inspect exposed finishes and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain Classroom Lighting System. Refer to Division 1.

END OF SECTION 16512

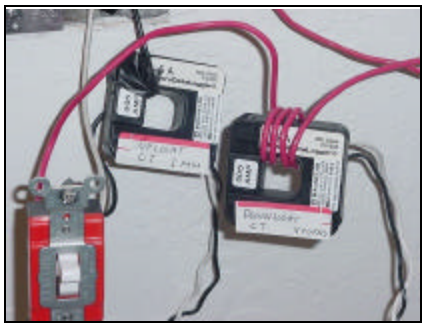
APPENDIX B: ENERGY METHODOLOGY

Appendix B

Data and analysis on energy usage included:

- Taking readings on energy each minute
- 14 classrooms successfully monitored
  - Special software developed
  - Data was translated into an Excel format
  - Daily records can be extracted
  - Savings were identified
- Yearly levels were calculated for the school
- Approximately 15 million data points exist
- Examples of data & analysis follow

1 – Data Loggers **2 – Sensors** **3 – Fax Modem**



Sensors were used in each classroom to detect when current was sent to the luminaire corresponding to the General Mode and A/V Mode and when the occupancy sensor was activated

The data from the sensors was captured by the data logger, which was then transmitted via fax modem to Finelite

Data is captured for every minute of every day for each classroom. The data for each

Time	Room 19			Room 20			Room 21			Room 22			Control
	General	AV	Occupancy Signal	General	AV	Occupancy Signal	General	AV	Occupancy Signal	General	AV	Occupancy Signal	Total
prior data	...	...	...	...	...	...	...	...	...	...	...	...	...
10/1/03 8:50 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00	3.37	0.00	100.00	6.05
10/1/03 8:51 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00	3.37	0.00	100.00	6.05
10/1/03 8:52 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00	3.37	0.00	100.00	6.05
10/1/03 8:53 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00				
10/1/03 8:54 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00				
10/1/03 8:55 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00				
10/1/03 8:56 AM	3.22	0.00	100.00	0.01	1.35	100.00	3.32	0.00	100.00				
10/1/03 8:5				0.01	1.35	100.00	3.32	0.00	100.00	3.37	0.00	100.00	6.05
10/1/03 8:5				0.01	1.35	100.00	3.33	0.00	100.00	3.38	0.00	100.00	6.05
10/1/03 8:5				0.01	1.35	100.00	3.32	0.00	100.00	0.01	1.76	100.00	6.05
10/1/03 9:0 AM	3.22	0.00	100.00	0.01	1.35	100.00				0.01	1.76	100.00	6.05
10/1/03 9:01 AM	3.22	0.00	100.00	3.08	0.00	100.00				0.01	1.76	100.00	6.05
10/1/03 9:02 AM	3.22	0.00	100.00	3.20	0.00	100.00				0.01	1.76	100.00	6.05
10/1/03 9:03 AM	3.23	0.00	100.00	3.24	0.00	100.00				0.01	1.76	100.00	6.05
10/1/03 9:04 AM	3.23	0.00	100.00	3.26	0.00	100.00	3.32	0.00	100.00	0.01	1.76	100.00	6.04
10/1/03 9:05 AM	3.23	0.00	100.00	3.27	0.00	100.00	3.32	0.00	100.00	0.01	1.76	100.00	6.04
10/1/03 9:06 AM	3.23	0.00	100.00	3.28	0.00	100.00	3.33	0.00	100.00	0.01	1.76	100.00	6.05
10/1/03 9:07 AM	3.23	0.00	100.00	3.28	0.					0.01	0.58	100.00	6.04
10/1/03 9:08 AM	3.23	0.00	100.00	3.28	0.					0.01	0.59	100.00	6.04
10/1/03 9:09 AM	3.23	0.00	100.00	3.28	0.					0.01	0.59	100.00	6.04
10/1/03 9:10 AM	3.23	0.00	100.00	3.28	0.					0.01	0.59	100.00	6.04
additional data	...	...	...	...	...	...	...	...	...	...	...	...	...

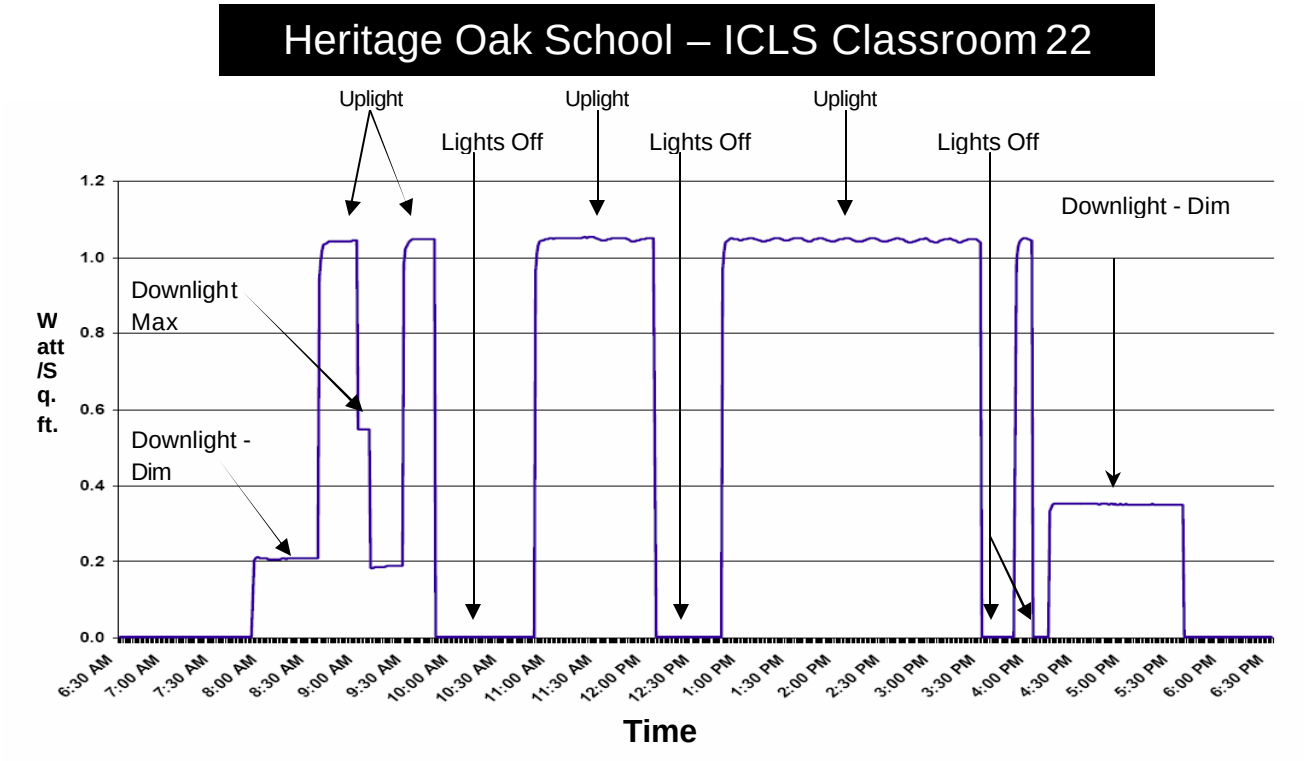
The Control Room uses 82% more energy than Room 22 in General Mode.

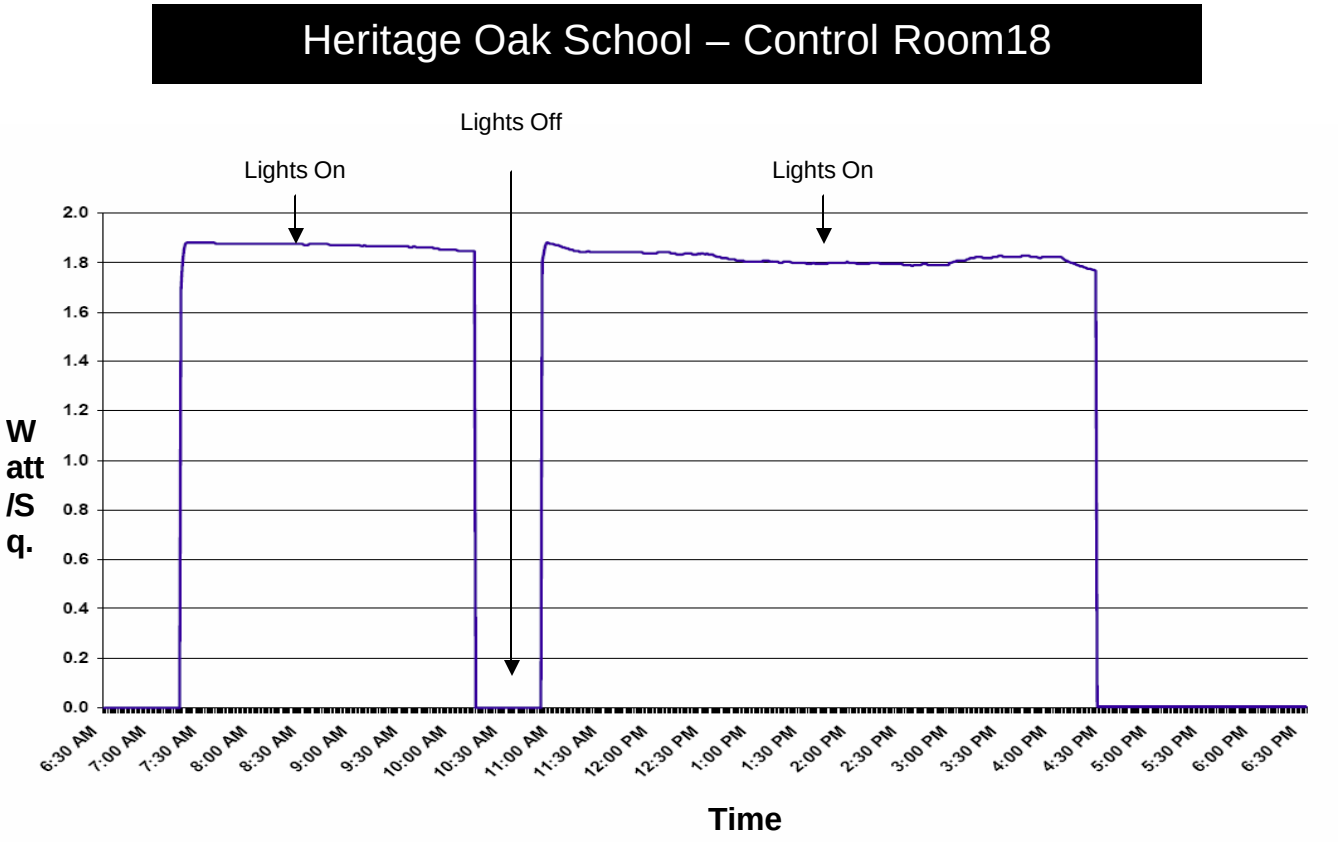
Room 20 Changes from A/V to General

Room 22 Changes from General to A/V

Room 22 Lights were dimmed in A/V Mode

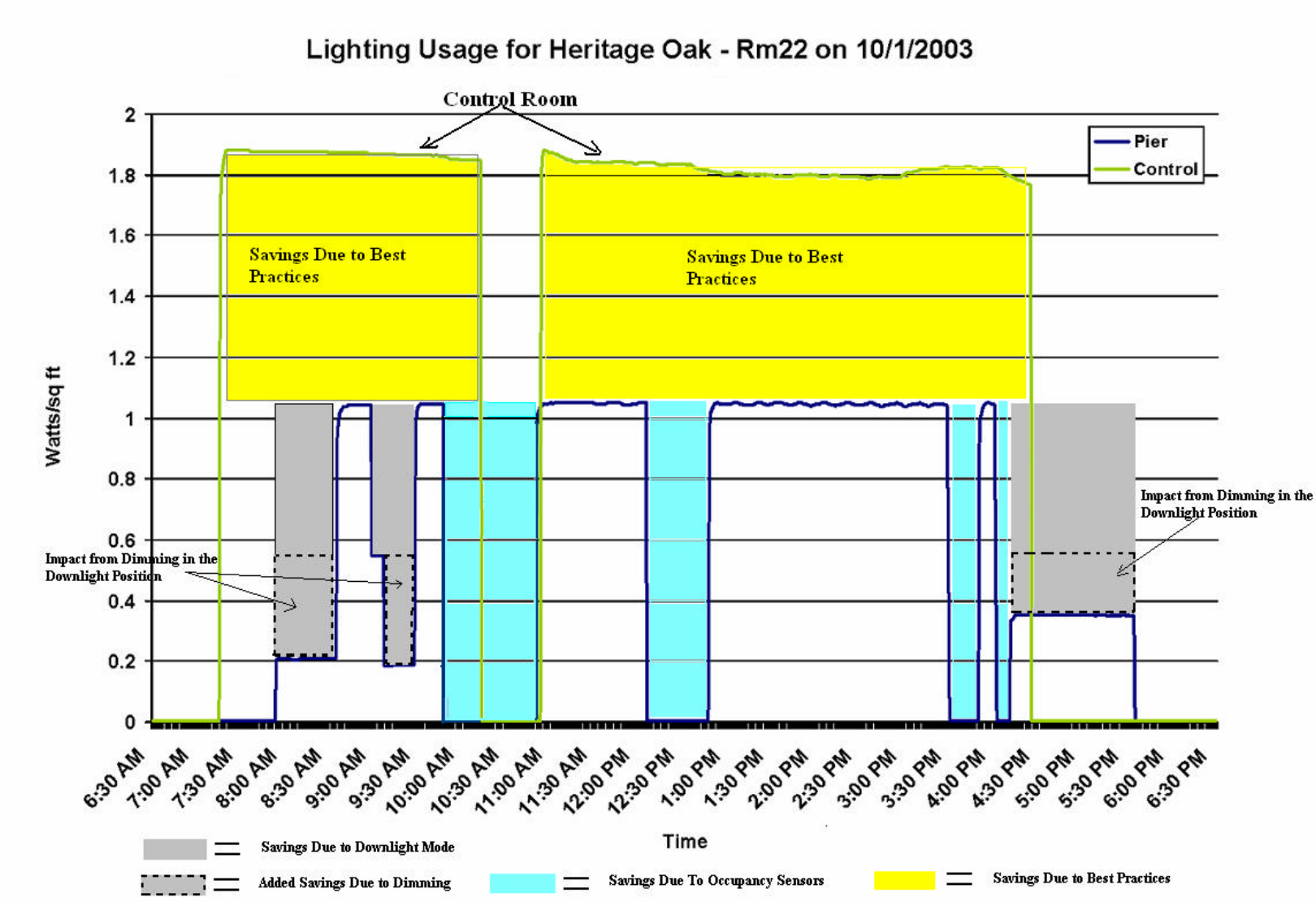
Proprietary software organizes data and presents it graphically for easy interpretation. The graphs below compare an ICLS classroom to the Control room.



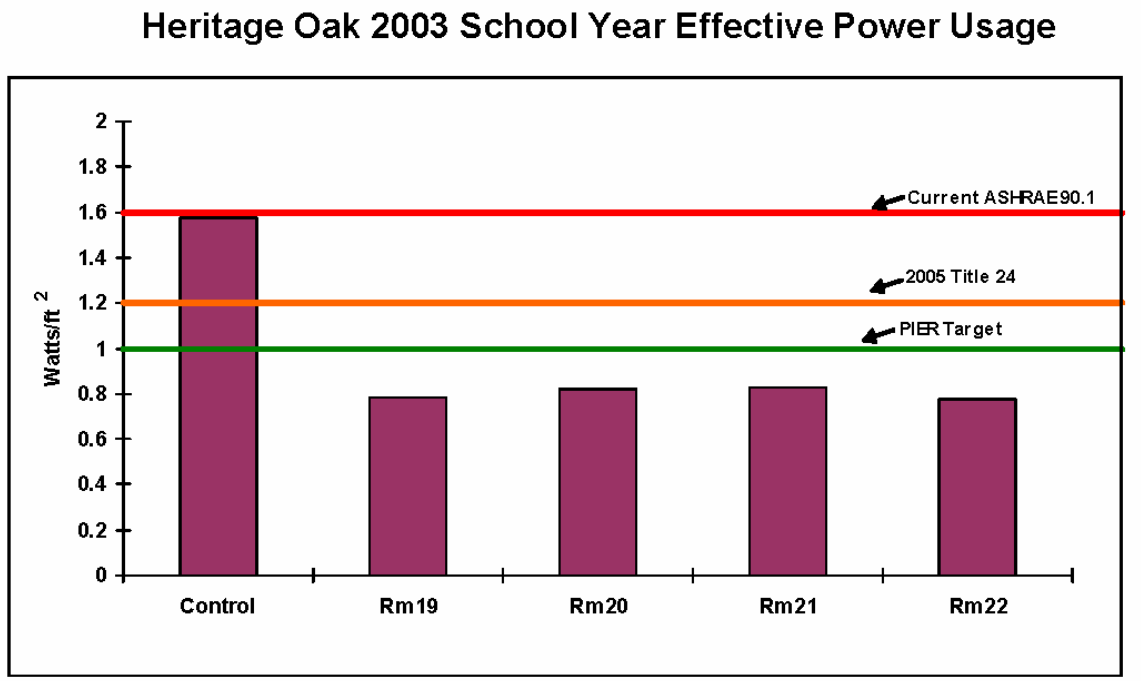


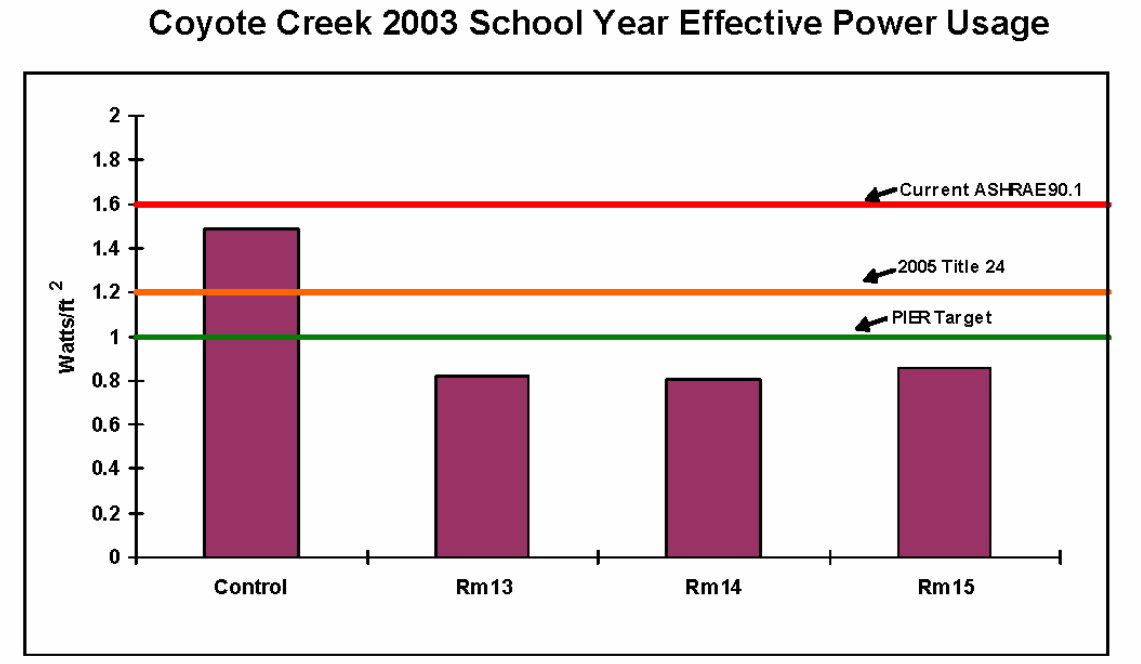
The Chart below shows the impact using Best Practices and the features of the ICLS System, including Downlight Mode, Downlight Dimming, and Occupancy Sensors.

Heritage Oak School – Room 22 Impact of ICLS

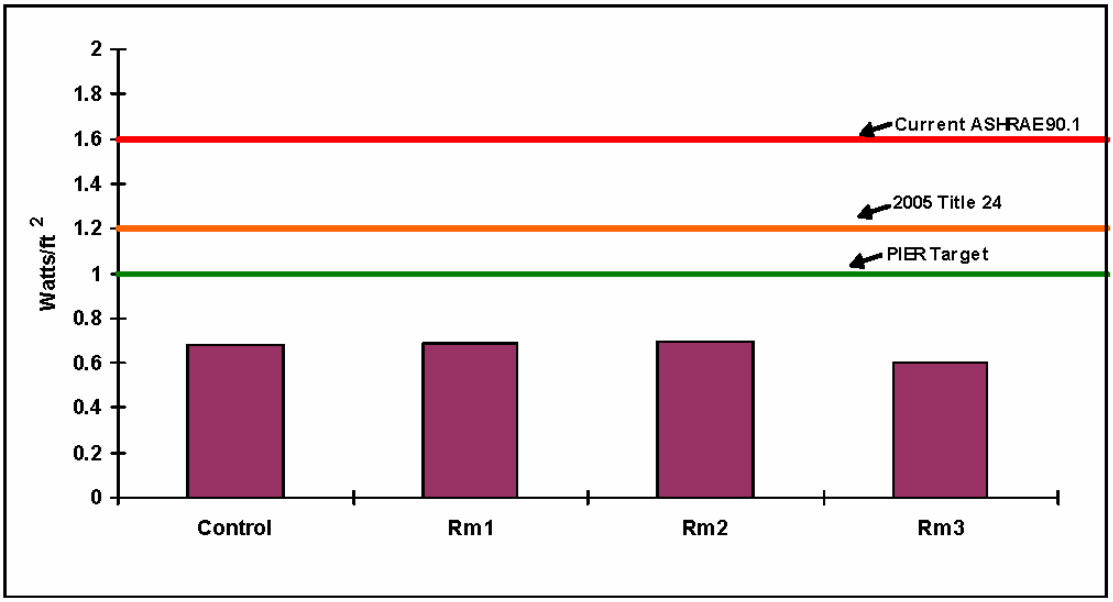


The charts below summarize the actual energy usage at the schools we monitored. The usage is compared to the PIER target, Title 24, and Ashrae 90.1.

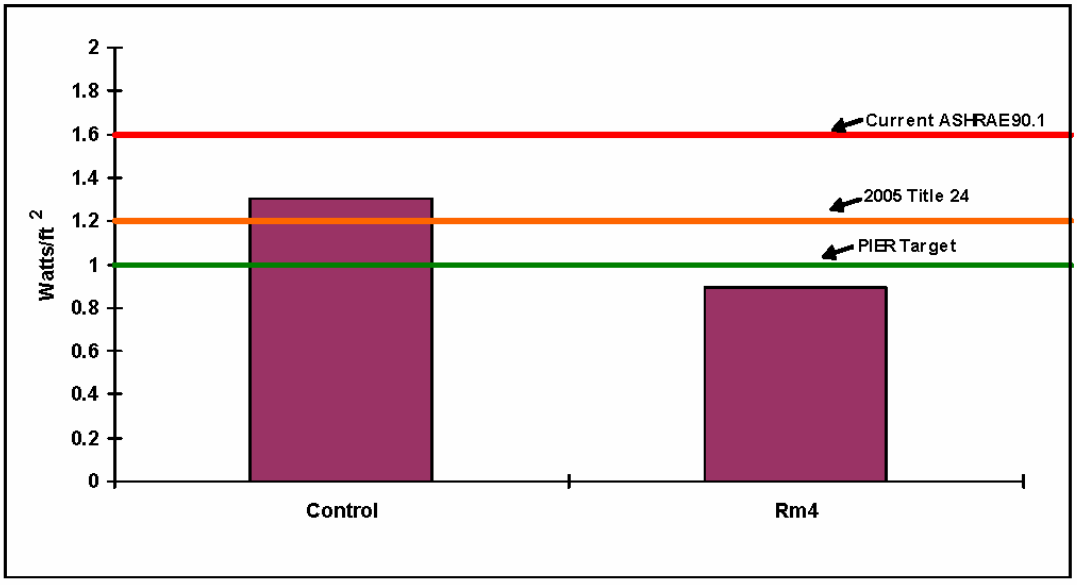




Country Club 2003 School Year Effective Power Usage



Carlmont 2003 School Year Effective Power Usage



APPENDIX C: TEST DATA FOR ALL CLASSROOMS

Heritage Oak Control Room - Room 18

Heritage Oak Room 22

Heritage Elementary School Room 18

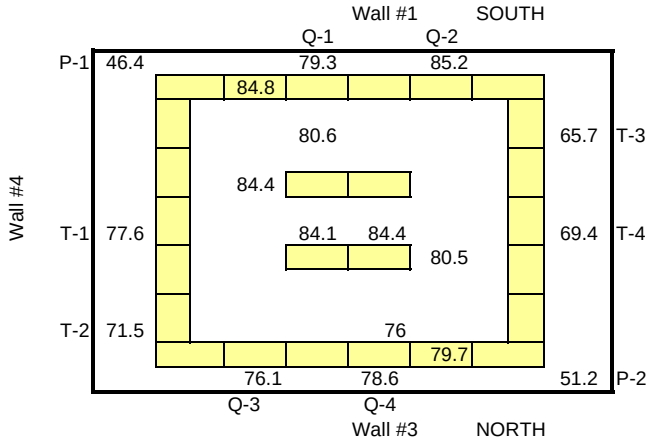
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 31.5 L (parallel to luminaires) 29.7 W 9.5 H 936 SF **Ceiling:** 2x4 lay-in acoustical tile
Ceiling Reflectance: 84%
Lumianire Layout: 26 Fixtures - see below
Tile Floor Reflectance: 44%
Luminaire Description: Columbia 2X4 prismatic, 2 lamp **Luminaire Mounting:** recessed lay-in
Carpet Reflectance: 7%
Lamp Description: Philips - F32T8/TL741 52 Up 0 Down
Desktop Reflectance: 35%
Ballast Description: Advance - VEL-3P32-HR-TP 277V 2 Lamp 0.88 BF 0.34 Amps 26 Quan
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

Electrical Data: 277 Volts 5.9 Amps Uplight 0.0 Downlight Amps 1634 Watts Uplight **1.75 W/SF**

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires

N = Number of luminaires per Row

		Average				
M	N	P	Q	R	T	**Horizontal Average**
6	7	48.8	79.8	81.8	71.1	**79**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2					Aver	Wall #3					Aver	Wall #4				Aver
9 ft	15.0	31.0	24.0	23.3	18.0		18.5		14.6	17.0	15.4		24.8	27.8	16.8	21.2	12.9	22.7	22.3	14.8	18.2
6 ft	27.7	59.2	59.0	48.6	39.5	40.6	39.9	38.6	21.4	36.0	23.8	52.8	54.8	52.3	35.0	43.7	26.4	40.3	38.6	22.3	31.9
3 ft	28.5	55.2	58.1	47.3	39.7	41.9	40.3	36.7	28.2	37.4	31.1	42.1	46.3	44.7	28.2	38.5	29.3	38.7	37.7	28.0	33.4
				39.7						**30.1**						**34.5**					**27.8**

4 Wall Average
33.0

Heritage Elementary School Room 19

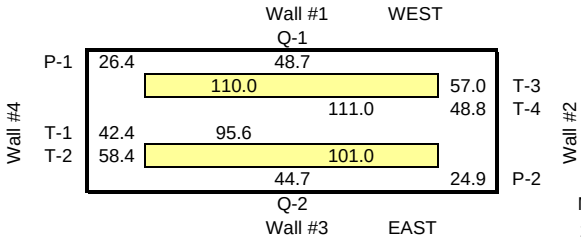
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 29.1 L (parallel to luminaires) 31.1 W 9.5 H 905 SF **Ceiling:** 2x4 lay-in acoustical tile
Lumianire Layout: 2 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 18" Pendant, 8'-0" AFF
Lamp Description: Sylvania - FO32T8/835 24 Up 12 Down
Ballast Descp (Uplight): Sylvania - QT3x32T8/277PLUS 3 Lamp 1.20 BF 0.42 Amps 8 Quan
Ballast Descp (Dwnlight): Sylvania - QT3x32T8/277PLUS 3 Lamp 1.20 BF 0.42 Amps 4 Quan
Electrical Data: 277 Volts 3.2 Amps Uplight 1.1 Downlight Amps 894.7 Watts Uplight **0.99 W/SF**

Ceiling Reflectance: 84%
Tile Floor Reflectance: 44%
Carpet Reflectance: 7%
Desktop Reflectance: 35%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= lighting layout
The primary teaching wall is # 4
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
2	6	25.7	46.7	104.4	51.7	**Horizontal Average 70**

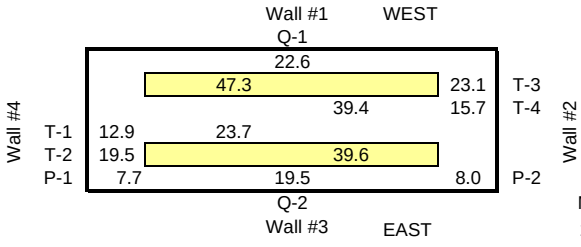
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2				Aver	Wall #3				Aver	Wall #4					Aver
9 ft	12.8	19.2	17.6	16.5	11.5	20.8	33.1	15.9	20.3	14.6	16.9	17.5	12.9	15.5	11.1	52.8	21.7	50.3	14.5	30.1
6 ft	18.0	26.2	22.3	22.2	12.5	30.5	32.7	22.1	24.5	20.8	25.6	25.1	17.5	22.3	15.2	40.4	28.7	38.8	18.5	28.3
3 ft	25.3	36.8	27.5	29.9	18.8	39.3	44.8	22.3	31.3	22.0	30.4	28.7	24.3	26.4	16.4	38.5	31.1	37.6	20.8	28.9
				22.9					**25.4**					**21.4**						**29.1**

4-Wall Average 24.7

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.
= lighting layout

M	N	P	Q	R	T	Average
2	6	7.9	21.1	37.5	17.8	**Horizontal Average 27**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2				Aver	Wall #3				Aver	Wall #4					Aver
9 ft	12.8	14.2	17.6	14.9	11.5	20.8	33.1	15.9	20.3	14.6	16.9	17.5	12.9	15.5	11.1	52.8	21.7	50.3	14.5	30.1
6 ft	18.0	26.2	22.3	22.2	12.5	30.5	32.7	22.1	24.5	20.8	25.6	25.1	12.5	21.0	15.2	40.4	28.7	38.8	18.5	28.3
3 ft	25.3	36.8	27.5	29.9	18.8	39.3	44.8	22.3	31.3	22.0	30.4	28.7	24.3	26.4	16.4	38.5	31.1	37.6	20.8	28.9
				22.3					**25.4**					**20.9**						**29.1**

4 Wall Average 24.4

Heritage Elementary School Room 20

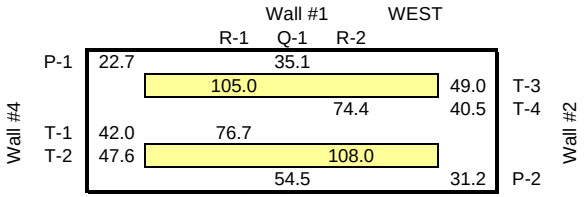
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 29.3 L (parallel to luminaires) 31.1 W 9.5 H 912 SF **Ceiling:** 2x4 lay-in acoustical tile
Lumianire Layout: 2 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 18" Pendant, 8'-0" AFF
Lamp Description: Sylvania - FO32T8/835 24 Up 12 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/277PLUS 3 Lamp 1.20 BF 0.42 Amps 8 Quan
Ballast Description (Downlight): Sylvania - QTP3x32T8/277DIM5QNL 3 Lamp 0.88 BF 0.34 Amps 4 Quan
Electrical Data: 277 Volts 3.3 Amps Uplight 1.3 Downlight Amps 900.3 Watts Uplight **0.99 W/SF**

Ceiling Reflectance: 85%
Tile Floor Reflectance: 44%
Carpet Reflectance: 7%
Desktop Reflectance: 35%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
2	6	27.0	44.8	91.0	44.8	**Horizontal Average 63**

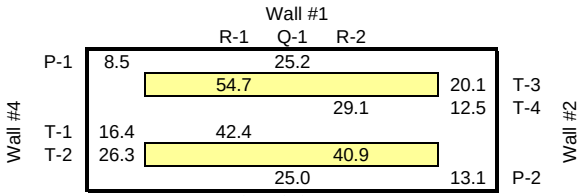
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1				Aver	Wall #2					Aver	Wall #3					Aver	Wall #4					Aver
9 ft	11.5	16.7	15.4	10.7	13.6	9.9	44.9	21.5	42.3	23.4	28.4	11.8	17.8	19.6	18.1	16.1	16.7	20.9	36.0	22.7	24.6	11.1	23.1
6 ft	15.2	24.3	20.8	16.2	19.1	16.6	32.9	27.1	33.5	23.6	26.7	12.8	21.5	24.5	23.9	20.1	20.6	24.6	31.0	29.2	21.1	13.3	23.8
3 ft	19.6	29.4	29.7	19.2	24.5	14.5	32.8	29.7	34.6	17.3	25.8	15.8	26.9	31.3	31.2	29.3	26.9	26.9	44.3	38.5	23.0	17.5	30.0
					19.1						**27.0**						**21.4**						**25.6**

4 Wall Average 23.3

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.

= lighting layout

M	N	P	Q	R	T	Average
2	6	10.8	25.1	41.8	18.8	**Horizontal Average 31**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1				Aver	Wall #2					Aver	Wall #3					Aver	Wall #4					Aver
9 ft	2.2	3.4	2.9	2.1	2.7	2.1	3.8	2.9	3.2	2.1	2.8	1.5	2.6	3.2	3.4	3.3	2.8	3.3	4.4	3.7	2.7	2.1	3.2
6 ft	2.3	3.7	3.3	2.2	2.9	2.4	12.5	3.7	8.3	2.3	5.8	1.6	3.1	3.6	3.5	3.1	3.0	3.9	8.5	4.3	3.3	2.2	4.4
3 ft	2.8	8.3	8.7	5.0	6.2	2.6	8.8	8.8	13.2	5.3	7.7	1.9	4.2	5.7	5.4	6.1	4.7	9.4	15.9	11.3	12.5	3.5	10.5
					3.9						**5.5**						**3.5**						**6.1**

4 Wall Average 4.7

Heritage Elementary School Room 21

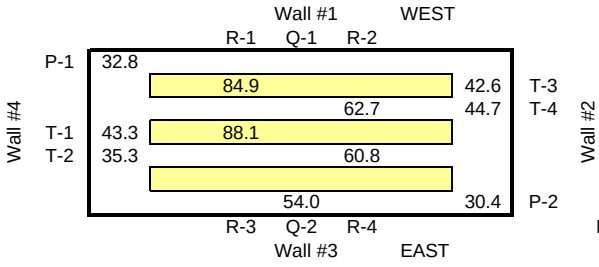
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 29.3 L (parallel to luminaires) 31.1 W 9.5 H 912 SF **Ceiling:** 2x4 lay-in acoustical tile
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 18" Pendant, 8'-0" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/277ISL-A 3 Lamp 0.77 BF 0.27 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QT3x32T8/277ISL-A 3 Lamp 0.77 BF 0.27 Amps 6 Quan
Electrical Data: 277 Volts 3.3 Amps Uplight 1.6 Downlight Amps 914.1 Watts Uplight **1.00 W/SF**

Ceiling Reflectance: 85%
Tile Floor Reflectance: 44%
Carpet Reflectance: 7%
Desktop Reflectance: 35%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= lighting layout
The primary teaching wall is # 4
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Horizontal Average
3	6	31.6	54.0	74.1	41.5	**63**

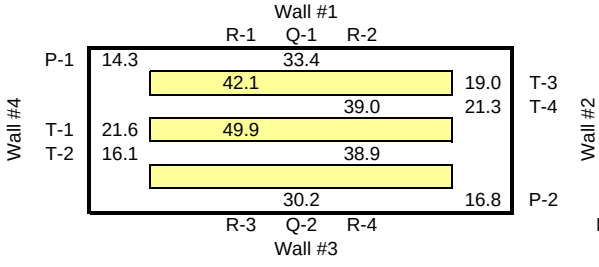
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2						Aver	Wall #3				Aver	Wall #4						Aver
9 ft	24.4	39.9	22.4	28.9	19.6	26.4	30.2	46.2	23.9	28.2	29.1	29.8	37.2	29.2	32.1	24.4	36.4	23.5	34.6	36.3	31.0
6 ft	26.7	39.9	25.5	30.7	22.6	24.6	33.8	37.9	28.9	28.3	29.4	29.9	38.7	31.6	33.4	21.0	30.4	27.6	32.1	29.7	28.2
3 ft	26.0	34.6	23.4	28.0	24.1	33.9	33.9	41.7	34.5	29.2	32.9	28.9	36.4	30.6	32.0	21.9	30.1	27.9	33.3	29.6	28.6
				29.2							**30.4**				**32.5**						**29.3**

4 Wall Average 30.3

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.
= lighting layout

M	N	P	Q	R	T	Horizontal Average
3	6	15.6	31.8	42.5	19.5	**36**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2						Aver	Wall #3			Aver	Wall #4					Aver
9 ft	3.4	4.8	3.8	4.0	3.5	3.8	5.1	5.4	4.8	4.8	4.6	4.7	4.8	4.0	4.5	3.1	3.9	3.7	4.1	2.8	3.5
6 ft	4.4	5.9	4.9	5.1	4.1	4.9	6.0	13.5	5.4	6.2	6.7	5.7	7.0	5.5	6.1	4.2	4.4	9.5	9.6	3.3	6.2
3 ft	14.7	21.4	11.7	15.9	12.1	14.7	16.0	19.6	15.9	12.5	15.1	15.1	19.9	17.7	17.6	10.1	10.6	13.5	12.3	8.6	11.0
				8.3							**8.8**				**9.4**						**6.9**

4 Wall Average 8.4

Heritage Elementary School Room 22

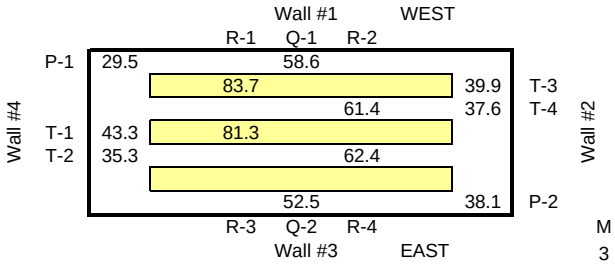
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 29.1 L (parallel to luminaires) 31.1 W 9.5 H 905 SF **Ceiling:** 2x4 lay-in acoustical tile
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 18" Pendant, 8'-0" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/277ISL-A 3 Lamp 0.77 BF 0.27 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QT3x32T8/277DIM5QNL 3 Lamp 0.88 BF 0.34 Amps 6 Quan
Electrical Data: 277 Volts 3.4 Amps Uplight 1.3 Downlight Amps 928 Watts Uplight **1.03 W/SF**

Ceiling Reflectance: 85%
Tile Floor Reflectance: 44%
Carpet Reflectance: 7%
Desktop Reflectance: 35%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= lighting layout
The primary teaching wall is # 2
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Horizontal Average
3	6	33.8	55.6	72.2	39.0	**62**

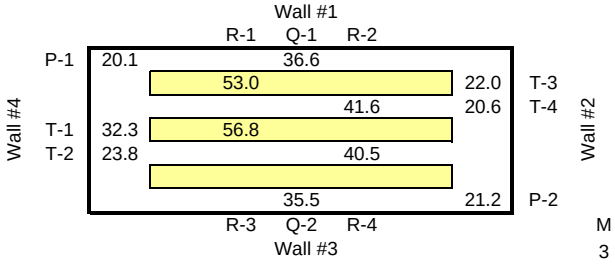
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2						Aver	Wall #3			Aver	Wall #4						Aver
9 ft	24.2	39.2	25.3	29.6	24.4	40.1	24.0	38.1	26.0	41.2	32.3	31.6	36.2	31.9	33.2	28.7	24.1	45.2	29.9	27.1	21.0	29.3
6 ft	25.5	39.8	25.5	30.3	25.6	31.6	30.2	36.4	30.2	3.8	26.3	36.9	37.4	32.8	35.7	28.4	29.2	38.6	32.9	27.0	21.7	29.6
3 ft	22.9	34.6	25.9	27.8	23.0	34.0	29.1	35.0	28.5	31.8	30.2	35.1	33.2	31.4	33.2	31.8	34.0	42.0	33.0	32.0	21.0	32.3
				29.2							**29.6**				**34.1**							**30.4**

4 Wall Average 30.8

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.
= lighting layout

M	N	P	Q	R	T	Horizontal Average
3	6	20.7	36.1	48.0	24.7	**41**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2						Aver	Wall #3			Aver	Wall #4						Aver
9 ft	4.9	5.6	4.0	4.8	4.0	4.9	4.9	5.0	5.5	5.2	4.9	5.0	5.8	5.7	5.5	5.8	6.2	6.9	6.2	5.1	4.5	5.8
6 ft	5.8	7.4	4.8	6.0	5.3	10.7	5.9	15.9	6.3	12.9	9.5	6.9	7.5	7.2	7.2	7.3	6.7	16.0	6.9	8.3	4.5	8.3
3 ft	12.7	25.9	17.0	18.5	11.9	15.0	13.6	16.8	12.7	15.5	14.3	21.3	22.1	18.9	20.8	14.1	17.7	21.8	18.2	16.5	12.9	16.9
				9.8							**9.6**				**11.2**							**10.3**

4 Wall Average 10.2

Coyote Creek School Room 16

Date Data Collected: October 9, 2003

Room Dimensions: 29.3 L (parallel to luminaires) 30.8 W 11.5 H 902.4 SF **Ceiling:** Vault (10' - 12'10" peak)

Lumianire Layout: (15) 2 x 4 recessed fixtures on 8' x 8' spacing

Luminaire Description: Prismatic 3-Lamp **Luminaire Mounting:** Recessed

Lamp Description: Syl F032/735 0 Up 45 Down

Ballast Description (Uplight): n/a 0 Lamp 0.00 BF 0 Amps 0 Quan

Ballast Description (Downlight): Syl - QT2x32/277+PLUSS tandem wired 2 Lamp 0.89 BF 0.29 Amps 23 Quan

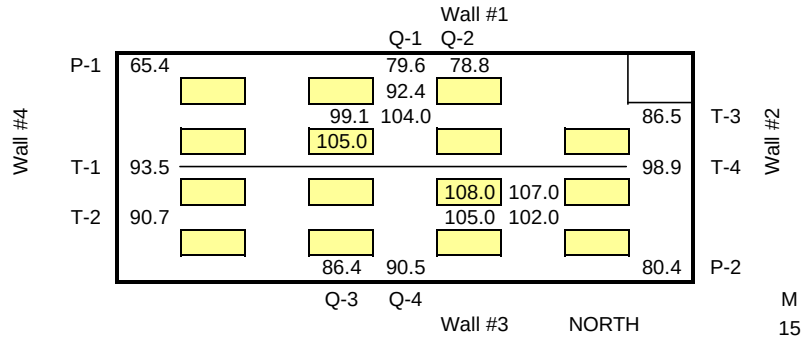
Electrical Data: 277 Volts 0.0 Amps Uplight 5.2 Downlight Amps 1440 Watts Uplight **1.60 W/SF**

Ceiling Reflectance:	85%
Tile Floor Reflectance:	59%
Carpet Reflectance:	14%
Desktop Reflectance:	12%
Wall Reflectance:	62%
Chalkboard Reflectance:	75%

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.

According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2

The secondary teaching wall is # 3

M = Number of rows of luminaires

N = Number of luminaires per Row

Average

M	N	P	Q	R	T	Horizontal Average
15	1	72.9	83.8	102.8	92.4	**96**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1					Wall #2							Wall #3				Wall #4						
AFF				Aver	AFF						Aver	AFF			Aver	AFF						Aver
9ft	49.3	33.8	28.1	37.1	10ft	30.8	122.0	87.2	117.0	74.0	86.2	9ft	42.9	48.7	43.1	44.9	10ft	68.1	67.5	79.8	47.6	85.0	69.6
6 ft	54.5	43.6	35.7	44.6	6 ft	38.9	52.7	59.9	58.9	65.1	55.1	6 ft	52.0	55.1	52.1	53.1	6 ft	67.5	60.3	62.5	60.9	77.1	65.7
3 ft	33.8	42.1	33.5	36.5	3 ft	35.8	45.7	50.1	47.0	479.0	131.5	3 ft	44.4	48.3	46.1	46.3	3 ft	42.6	43.6	49.6	50.1	46.6	46.5
				39.4							**90.9**				**48.1**							**60.6**

4 Wall Average
59.7

Coyote Creek School Room 13

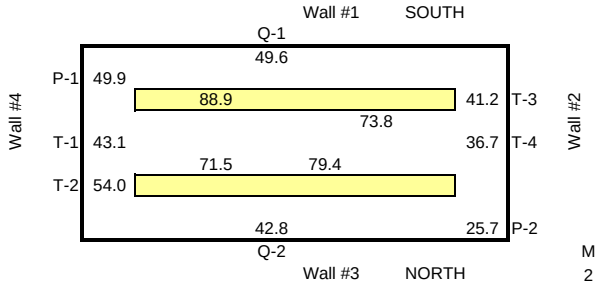
Date Data Collected: October 9, 2003

Room Dimensions: 29.3 L (parallel to luminaires) 30.8 W 11.5 H 902.4 SF **Ceiling:** Vault (10' - 12'10" peak)
Lumianire Layout: 2 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:**
Lamp Description: Sylvania - FO32T8/835 24 Up 12 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/277PLUS 3 Lamp 1.20 BF 0.42 Amps 8 Quan
Ballast Description (Downlight): Sylvania - QTP3x32T8/277DIM5QNL 3 Lamp 0.88 BF 0.34 Amps 4 Quan
Electrical Data: 277 Volts 3.2 Amps Uplight 1.4 Downlight Amps 886.4 Watts Uplight **0.98 W/SF**

Ceiling Reflectance: 85%
Tile Floor Reflectance: 59%
Carpet Reflectance: 14%
Desktop Reflectance: 12%
Wall Reflectance: 62%
Chalkboard Reflectance: 75%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 4
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

							Average	
M	N	P	Q	**R**	T		**Horizontal Average**
2	6	37.8	46.2	**78.4**	43.8		**59**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

	Wall #1			
AFF				Aver
9ft	29.5	21.3	18.0	22.9
6 ft	41.1	28.9	25.5	31.8
3 ft	31.6	33.1	27.2	30.6
				28.5

	Wall #2					
AFF						Aver
10ft	18.4	34.7	29.7	34.3	13.6	26.1
6 ft	27.2	34.6	31.5	34.4	18.7	29.3
3 ft	25.4	34.3	28.7	31.1	14.7	26.8
						27.4

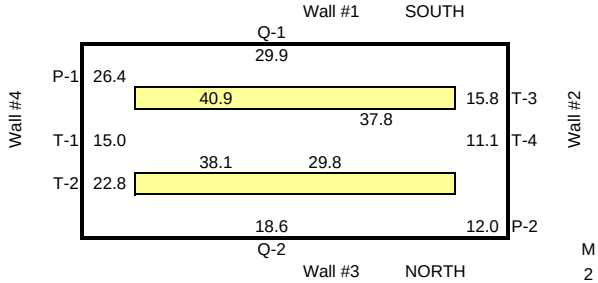
	Wall #3			
AFF				Aver
9ft	18.8	18.6	25.5	21.0
6 ft	24.1	26.1	32.7	27.6
3 ft	26.1	32.6	29.9	29.5
				26.0

	Wall #4				
AFF					Aver
10ft	21.9	76.8	34.0	79.6	53.1
6 ft	28.7	47.3	34.8	44.9	38.9
3 ft	22.2	35.8	31.6	30.7	30.1
					40.7

4 Wall Average
30.7

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

							Average	
M	N	P	Q	**R**	T		**Horizontal Average**
2	6	19.2	24.3	**36.7**	16.2		**29**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

	Wall #1			
AFF				Aver
9ft	15.2	4.7	4.4	8.1
6 ft	14.5	5.4	4.9	8.3
3 ft	14.3	12.1	10.1	12.2
				9.5

	Wall #2					
AFF						Aver
10ft	4.0	4.4	4.2	4.3	3.3	4.0
6 ft	5.3	10.9	4.8	10.9	3.7	7.1
3 ft	8.5	11.9	8.0	11.1	6.8	9.3
						6.8

	Wall #3			
AFF				Aver
9ft	3.7	3.8	4.3	3.9
6 ft	4.5	5.0	8.5	6.0
3 ft	10.8	11.3	15.0	12.4
				7.4

	Wall #4				
AFF					Aver
10ft	3.5	5.1	4.2	5.1	4.5
6 ft	6.2	20.0	4.6	18.7	12.4
3 ft	7.9	13.9	9.6	12.5	11.0
					9.3

4 Wall Average
8.3

Coyote Creek School Room 14

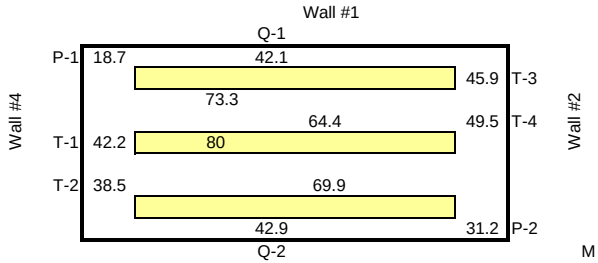
Date Data Collected: October 9, 2003

Room Dimensions: 29.3 L (parallel to luminaires) 30.8 W 11.5 H 902.4 SF **Ceiling:** Vault (10' - 12'10" peak)
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:**
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/277PLUS 3 Lamp 0.74 BF 0.26 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QT3x32T8/277PLUS 3 Lamp 0.74 BF 0.26 Amps 6 Quan
Electrical Data: 277 Volts 3.3 Amps Uplight 1.3 Downlight Amps 903 Watts Uplight **1.00 W/SF**

Ceiling Reflectance: 85%
Tile Floor Reflectance: 59%
Carpet Reflectance: 14%
Desktop Reflectance: 12%
Wall Reflectance: 62%
Chalkboard Reflectance: 75%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Horizontal Average
3	6	25.0	42.5	**71.9**	44.0	**59**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver
9ft	14.9	19.9	18.0	17.6
6 ft	17.8	25.6	22.7	22.0
3 ft	15.6	26.0	26.9	22.8
				20.8

AFF	Wall #2					Aver
10ft	44.4	66.6	42.0	61.2	18.3	46.5
6 ft	34.3	43.0	34.4	37.8	22.6	34.4
3 ft	29.2	35.5	30.6	30.7	21.1	29.4
						36.8

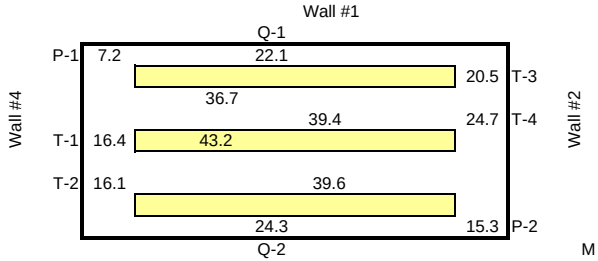
AFF	Wall #3			Aver
9ft	30.7	19.3	17.9	22.6
6 ft	32.9	26.0	22.0	27.0
3 ft	30.4	28.3	24.0	27.6
				25.7

AFF	Wall #4							Aver
10ft	14.4	26.0	31.3	34.0	31.0	25.5	17.0	25.6
6 ft	18.4	26.5	29.5	30.4	28.4	25.8	18.7	25.4
3 ft	17.7	26.4	27.9	26.9	26.6	23.9	17.7	23.9
								25.0

4 Wall Average
27.1

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

M	N	P	Q	R	T	Horizontal Average
3	6	11.3	23.2	**39.7**	19.4	**32**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver
9ft	3.2	4.3	3.9	3.8
6 ft	3.5	5.2	4.9	4.5
3 ft	5.9	11.8	13.9	10.5
				6.3

AFF	Wall #2					Aver
10ft	4.4	4.4	4.7	4.2	3.0	4.1
6 ft	17.5	8.6	17.6	9.4	6.7	12.0
3 ft	13.3	14.6	15.3	15.0	13.2	14.3
						10.1

AFF	Wall #3			Aver
9ft	4.2	3.9	3.5	3.9
6 ft	8.2	5.0	4.6	5.9
3 ft	14.0	13.1	10.9	12.7
				7.5

AFF	Wall #4							Aver
10ft	3.0	3.7	3.9	4.1	4.2	4.0	3.4	3.8
6 ft	3.5	5.5	5.6	6.9	5.5	6.3	3.9	5.3
3 ft	6.3	9.5	10.6	11.0	10.4	8.9	7.1	9.1
								6.1

4 Wall Average
7.5

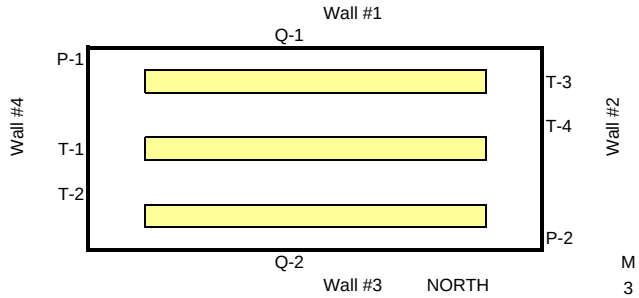
Coyote Creek School Room 15

Room Dimensions: 29.3 L (parallel to luminaires) 30.8 W 11.5 H 902.4 SF **Ceiling:** Vault (10' - 12'10" peak)
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:**
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT3x32T8UNVPSXTC 3 Lamp 0.74 BF 0.26 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QTP3x32T8/277DIM5QNL 3 Lamp 0.88 BF 0.34 Amps 6 Quan
Electrical Data: 277 Volts 3.1 Amps Uplight 2.0 Downlight Amps 858.7 Watts Uplight **0.95 W/SF**

Ceiling Reflectance:
Tile Floor Reflectance:
Carpet Reflectance:
Desktop Reflectance:
Wall Reflectance:
Chalkboard Reflectance:

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 4
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

Average						
M	N	P	Q	**R**	T	**Horizontal Average**
3	6	0.0	0.0	**0.0**	0.0	**0**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

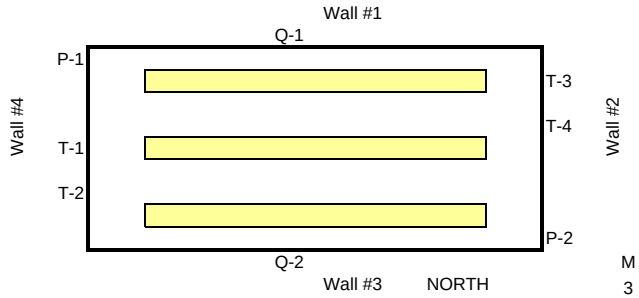
AFF	Wall #1	Aver	Wall #2	Aver	Wall #3	Aver	Wall #4	Aver
9ft								
6 ft								
3 ft								

Data not collected. Room 15 is identical to Room 14.

4 Wall Average
0.0

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

Average						
M	N	P	Q	**R**	T	**Horizontal Average**
3	6	0.0	0.0	**0.0**	0.0	**0**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1	Aver	Wall #2	Aver	Wall #3	Aver	Wall #4	Aver
9ft								
6 ft								
3 ft								

4 Wall Average
0.0

Country Club Elementary Control Room

Country Club Elementary ICLS Room

Country Club School — Room 1

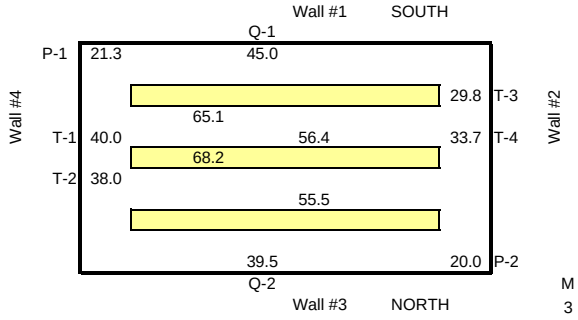
Date Data Collected: October 10, 2003

Room Dimensions: 27.6 L (parallel to luminaires) 31.3 W 12.83 H 863.9 SF **Ceiling:** Vault (9' - 12'10" peak)
Lumianire Layout: 3 rows 20 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 30 Up 15 Down
Ballast Description (Uplight): Sylvania - QT(3/2)x32T8UNVPSXTC 3 Lamp 0.74 BF 0.62 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QT(3/2)x32T8UNVPSXTC 2 Lamp 0.74 BF 0.41 Amps 6 Quan
Electrical Data: 120 Volts 6.0 Amps Uplight 2.5 Downlight Amps 720 Watts Uplight **0.83 W/SF**

Ceiling Reflectance: 90%
Tile Floor Reflectance: 67%
Carpet Reflectance: 6%
Desktop Reflectance: 15%
Wall Reflectance: 77%
Dark Wall Reflectance: 7%
Chalkboard Reflectance: 75%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 4
The secondary teaching wall is # 2

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
3	5	20.7	42.3	61.3	35.4	**Horizontal Average 51**

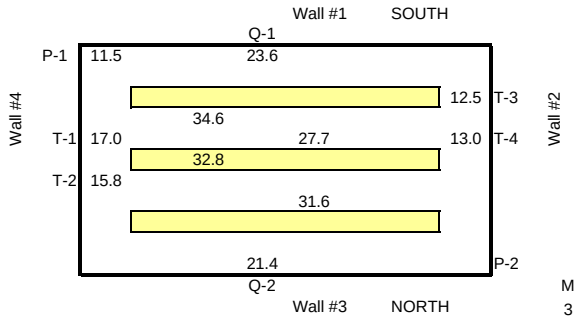
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1					Wall #2									Wall #3					Wall #4								
AFF				Aver	AFF								Aver	AFF				Aver	AFF								Aver
8 ft	18.3	21.7	16.0	18.7	10 ft	16.1	22.1	23.5	24.8	23.3	21.4	13.5	20.7	8 ft	17.2	18.8	18.5	18.2	10 ft	16.3	24.7	25.9	30.7	26.6	26.3	17.2	24.0
6 ft	22.9	28.8	19.3	23.7	6 ft	21.0	21.9	24.1	25.2	24.7	22.2	15.7	22.1	6 ft	24.5	30.2	23.6	26.1	6 ft	20.6	24.2	19.6	26.6	26.2	24.0	21.3	23.2
3 ft	20.4	28.2	15.3	21.3	3 ft	16.3	22.0	18.9	26.1	28.1	24.2	17.7	21.9	3 ft	21.9	28.2	19.1	23.1	3 ft	17.1	18.2	19.4	23.9	24.5	24.7	16.9	20.7
				21.2									**21.6**					**22.4**									**22.6**

4 Wall Average 22.0

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

M	N	P	Q	R	T	Average
3	5	11.5	22.5	31.7	14.6	**Horizontal Average 26**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1					Wall #2									Wall #3					Wall #4								
AFF				Aver	AFF								Aver	AFF				Aver	AFF								Aver
8 ft	3.6	3.7	2.8	3.4	10 ft	3.3	3.2	2.9	2.9	2.9	3.3	3.2	3.1	8 ft	3.8	4.4	3.8	4.0	10 ft	3.6	3.7	3.1	3.2	3.1	3.2	2.9	3.3
6 ft	15.5	16.1	7.9	13.2	6 ft	4.3	4.8	3.3	4.2	3.3	5.0	5.7	4.4	6 ft	8.4	7.8	5.9	7.4	6 ft	5.8	7.4	3.2	7.4	4.4	7.3	4.9	5.8
3 ft	13.1	14.4	9.3	12.3	3 ft	6.4	7.6	8.2	8.3	9.5	8.5	7.7	8.0	3 ft	11.3	5.6	10.3	9.1	3 ft	7.8	7.6	9.4	9.6	11.0	8.7	7.1	8.7
				9.6									**5.2**					**6.8**									**5.9**

4 Wall Average 6.9

Country Club School Room 2

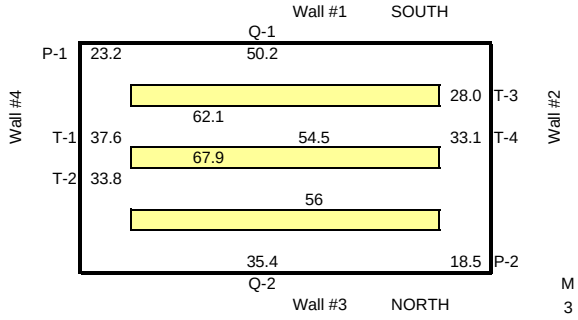
Date Data Collected: October 10, 2003

Room Dimensions: 27.6 L (parallel to luminaires) 31.3 W 12.83 H 863.9 SF **Ceiling:** Vault (9' - 12'10" peak)
Lumianire Layout: 3 rows 20 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 30 Up 15 Down
Ballast Description (Uplight): Sylvania - QT(3/2)x32T8UNVPSXTC 3 Lamp 0.74 BF 0.62 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QT(3/2)x32T8UNVPSXTC 2 Lamp 0.74 BF 0.41 Amps 6 Quan
Electrical Data: 120 Volts 6.1 Amps Uplight 2.5 Downlight Amps 732 Watts Uplight **0.85 W/SF**

Ceiling Reflectance: 90%
Tile Floor Reflectance: 67%
Carpet Reflectance: 6%
Desktop Reflectance: 15%
Wall Reflectance: 77%
Dark Wall Reflectance: 7%
Chalkboard Reflectance: 75%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 4
The secondary teaching wall is # 2

M = Number of rows of luminaires
N = Number of luminaires per Row

Average						
M	N	P	Q	R	T	**Horizontal Average**
3	5	20.9	42.8	60.1	33.1	**50**

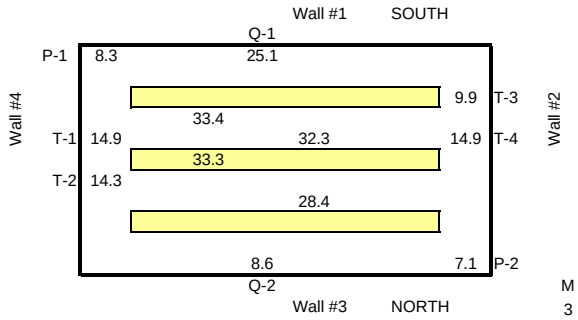
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1					Wall #2									Wall #3					Wall #4								
AFF				Aver	AFF								Aver	AFF				Aver	AFF								Aver
8 ft	17.1	19.2	13.8	16.7	10 ft	13.6	22.1	23.2	25.3	22.5	20.3	12.3	19.9	8 ft	17.6	19.1	15.6	17.4	10 ft	12.2	23.0	23.8	27.5	24.6	22.7	15.7	21.4
6 ft	24.2	27.6	18.7	23.5	6 ft	18.5	21.8	23.0	24.3	22.7	21.6	15.7	21.1	6 ft	25.2	27.4	20.8	24.5	6 ft	16.1	23.9	19.9	22.9	23.5	20.4	13.7	20.1
3 ft	22.0	27.4	17.6	22.3	3 ft	15.6	20.2	19.2	21.7	17.0	18.3	15.6	18.2	3 ft	23.3	28.0	19.5	23.6	3 ft	17.1	21.8	22.2	24.5	22.7	19.6	12.4	20.0
				20.8									**19.7**					**21.8**									**20.5**

4 Wall Average 20.7

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

Average						
M	N	P	Q	R	T	**Horizontal Average**
3	5	7.7	16.9	31.9	13.5	**24**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1					Wall #2									Wall #3					Wall #4								
AFF				Aver	AFF								Aver	AFF				Aver	AFF								Aver
8 ft	3.3	3.7	3.4	3.5	10 ft	3.6	3.6	3.2	3.3	3.2	3.4	3.2	3.4	8 ft	4.1	3.9	3.3	3.8	10 ft	3.3	3.2	2.8	2.7	2.9	2.8	2.2	2.8
6 ft	10.4	8.2	6.5	8.4	6 ft	5.8	6.5	3.6	6.3	4.7	4.8	4.7	5.2	6 ft	11.4	9.2	5.2	8.6	6 ft	5.7	6.4	3.7	7.0	4.2	8.4	6.2	5.9
3 ft	12.4	13.8	8.8	11.7	3 ft	7.4	7.7	7.3	7.6	8.6	8.4	7.1	7.7	3 ft	14.8	14.5	9.7	13.0	3 ft	7.8	9.0	8.5	8.8	8.8	9.2	5.5	8.2
				7.8									**5.4**					**8.5**									**5.7**

4 Wall Average 6.8

Country Club School Room 3

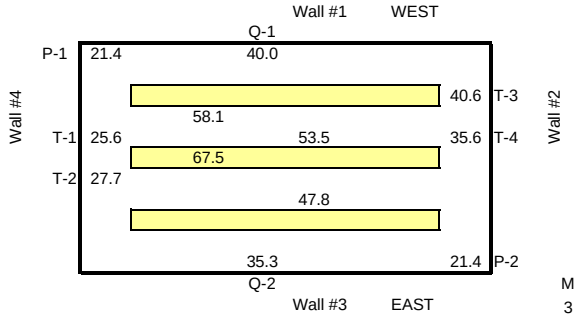
Date Data Collected: October 10, 2003

Room Dimensions: 27.6 L (parallel to luminaires) 31.3 W 12.83 H 863.9 SF **Ceiling:** Vault (9' - 12'10" peak)
Lumianire Layout: 3 rows 20 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 30 Up 15 Down
Ballast Description (Uplight): Sylvania - QT(3/2)x32T8UNVPSXTC 3 Lamp 0.74 BF 0.62 Amps 12 Quan
Ballast Description (Downlight): Sylvania - QTP(3/2)x32T8/120DIM5QNL 3 Lamp 0.88 BF 0.78 Amps 6 Quan
Electrical Data: 120 Volts 6.1 Amps Uplight 4.7 Downlight Amps 732 Watts Uplight **0.85 W/SF**

Ceiling Reflectance: 90%
Tile Floor Reflectance: 67%
Carpet Reflectance: 6%
Desktop Reflectance: 15%
Wall Reflectance: 77%
Dark Wall Reflectance: 7%
Chalkboard Reflectance: 75%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # --

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
3	5	21.4	37.7	56.7	32.4	**Horizontal Average 47**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1				
AFF				Aver
8 ft	14.5	19.9	15.1	16.5
6 ft	19.9	32.9	19.8	24.2
3 ft	17.3	26.5	22.4	22.1
				20.9

Wall #2								
AFF								Aver
10 ft	14.1	25.1	25.4	29.0	25.5	26.2	12.0	22.5
6 ft	19.9	22.2	16.5	24.9	24.4	23.5	16.4	21.1
3 ft	16.4	23.3	20.1	31.5	24.5	17.4	16.8	21.4
								21.7

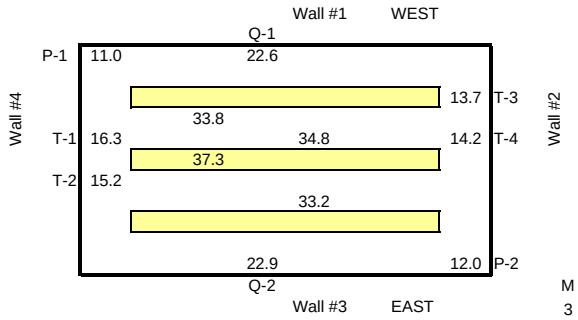
Wall #3				
AFF				Aver
8 ft	16.7	15.8	14.4	15.6
6 ft	22.0	28.0	19.0	23.0
3 ft	19.2	27.6	18.2	21.7
				20.1

Wall #4								
AFF								Aver
10 ft	12.0	18.3	25.7	30.9	20.1	18.4	12.4	19.7
6 ft	16.5	19.0	26.5	32.4	22.5	19.4	16.9	21.9
3 ft	15.0	19.6	24.1	33.8	23.1	21.7	14.8	21.7
								21.1

4 Wall Average 20.9

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

M	N	P	Q	R	T	Average
3	5	11.5	22.8	34.8	14.9	**Horizontal Average 28**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1				
AFF				Aver
8 ft	3.0	3.4	2.9	3.1
6 ft	6.1	7.9	8.3	7.4
3 ft	8.6	15.5	10.6	11.6
				7.4

Wall #2								
AFF								Aver
10 ft	2.4	8.5	10.6	2.7	2.9	3.2	3.1	4.8
6 ft	5.8	2.7	2.5	8.6	4.3	7.9	5.0	5.3
3 ft	7.4	7.5	4.1	8.6	8.8	7.5	7.3	7.3
								5.8

Wall #3				
AFF				Aver
8 ft	3.2	3.9	3.6	3.6
6 ft	5.5	8.8	7.5	7.3
3 ft	9.7	16.4	12.6	12.9
				7.9

Wall #4								
AFF								Aver
10 ft	2.8	3.2	3.5	3.6	3.4	3.1	2.8	3.2
6 ft	4.6	3.7	8.2	14.6	4.0	5.9	4.9	6.6
3 ft	7.6	8.7	12.4	18.0	11.6	8.2	7.5	10.6
								6.8

4 Wall Average 7.0

Country Club School Room 4

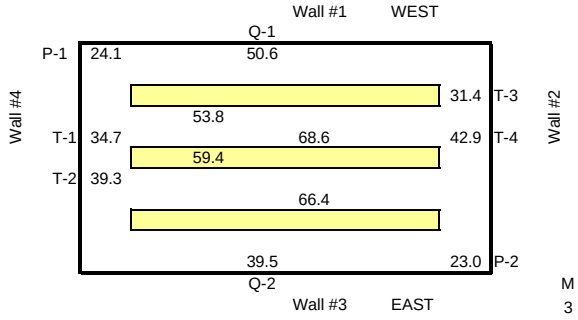
Date Data Collected: October 10, 2003

Room Dimensions: 27.6 L (parallel to luminaires) 31.3 W 12.83 H 863.9 SF **Ceiling:** Vault (9' - 12'10" peak)
Lumianire Layout: 3 rows 20 feet long
Luminaire Description: Fluor pendant up/down 2-lamp parabolic **Luminaire Mounting:** 9'5" AFF
Lamp Description: F032/735 **18 Up 0 Down
Ballast Description (Uplight): Advance REL1P32-SC 2 Lamp 0.00 BF 0.28 Amps 0 Quan
Ballast Description (Downlight): N/A
Electrical Data: 120 Volts 7.4 Amps Uplight 0.0 Downlight Amps 888 Watts Uplight **1.03 W/SF**

Ceiling Reflectance: 90%
Tile Floor Reflectance: 67%
Carpet Reflectance: 6%
Desktop Reflectance: 15%
Wall Reflectance: 77%
Dark Wall Reflectance: 7%
Chalkboard Reflectance: 75%

ALL OF THE LAMPS TURNED ON

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # --

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
3	5	23.6	45.1	62.1	37.1	**Horizontal Average 52**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1				
AFF				Aver
8 ft	13.8	15.0	12.6	13.8
6 ft	21.2	22.7	17.3	20.4
3 ft	27.7	24.5	22.4	24.9
				19.7

Wall #2								
AFF								Aver
10 ft	12.0	19.6	20.2	20.6	20.5	19.9	19.9	19.0
6 ft	18.2	25.8	20.1	20.2	15.9	20.4	15.6	19.5
3 ft	18.6	20.9	19.7	20.8	23.0	23.3	18.1	20.6
								19.7

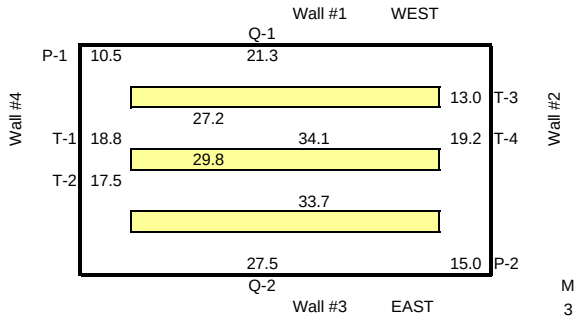
Wall #3				
AFF				Aver
8 ft	15.4	16.0	13.0	14.8
6 ft	22.1	22.8	18.2	21.0
3 ft	26.9	30.2	24.0	27.0
				21.0

Wall #4								
AFF								Aver
10 ft	12.6	18.7	20.5	21.7	19.4	19.5	13.8	18.0
6 ft	19.7	22.1	20.5	21.5	19.6	20.8	19.6	20.5
3 ft	18.6	20.6	25.1	22.3	26.8	20.7	20.1	22.0
								20.2

4 Wall Average 20.1

HALF OF THE LAMPS TURNED ON

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

M	N	P	Q	R	T	Average
3	5	12.8	24.4	31.2	17.1	**Horizontal Average 27**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

Wall #1				
AFF				Aver
8 ft	7.6	7.7	6.0	7.1
6 ft	10.7	10.4	7.7	9.6
3 ft	12.7	13.7	10.1	12.2
				9.6

Wall #2								
AFF								Aver
10 ft	6.4	9.5	10.0	11.3	10.7	10.0	6.5	9.2
6 ft	9.0	11.1	9.9	10.8	8.1	11.0	8.7	9.8
3 ft	8.9	10.9	11.2	10.4	12.4	10.4	12.5	11.0
								10.0

Wall #3				
AFF				Aver
8 ft	8.5	8.5	7.3	8.1
6 ft	12.5	12.6	10.1	11.7
3 ft	15.8	19.5	15.4	16.9
				12.2

Wall #4								
AFF								Aver
10 ft	7.5	10.7	10.5	10.9	9.9	9.4	6.1	9.3
6 ft	11.7	11.2	10.2	10.6	9.7	10.2	8.9	10.4
3 ft	10.9	13.1	12.5	11.7	10.9	9.8	8.9	11.1
								10.3

4 Wall Average 10.5

Dudley Elementary School Room A2

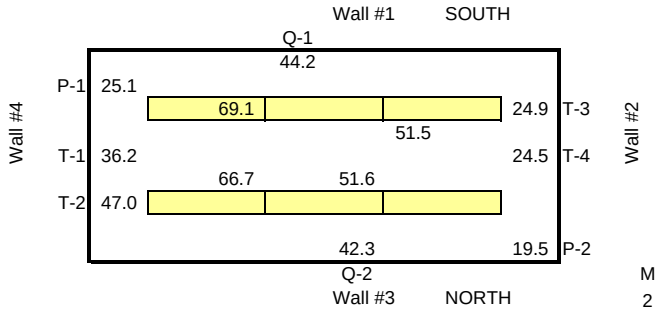
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 31.5 L (parallel to luminaires) 29.1 W 10.63 H 916 SF **Ceiling:** Slope (10'2" - 11'5")
Lumianire Layout: 2 rows 24 feet long
Luminaire Description: 4-Lamp, Cross Baffle, white glass sides **Luminaire Mounting:** 21" Pendant
Lamp Description: Philips - F96T12CW/EW60W Alto 6 Up 0 Down
Ballast Description: Advance - SEQM-275-S 2 Lamp ? BF 1.5 Amps 12 Quan
* (2) 74w96", 55w72", 50w64" / T12 Slimline 122V/60H
Electrical Data: 120 Volts 11.0 Amps Uplight 0.0 Downlight Amps 1320 Watts Uplight **1.44 W/SF**

Ceiling Reflectance: 83%
Tile Floor Reflectance: 31%
Carpet Reflectance: 11%
Desktop Reflectance: 41%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
2	6	22.3	43.3	59.7	33.2	**Horizontal Average 48**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2			Aver	Wall #3			Aver	Wall #4			Aver
9.5ft	25.8	34.8	23.0	27.9	19.0	12.5	9.6	13.7	10.4	16.5	26.8	17.9	21.6	30.5	36.0	29.4
6 ft	30.6	38.3	45.6	38.2	26.4	15.3	12.6	18.1	12.9	16.0	21.8	16.9	20.4	28.7	30.1	26.4
3 ft	26.3	29.7	23.0	26.3	22.4	19.1	12.5	18.0	14.7	21.5	26.8	21.0	20.7	27.8	27.5	25.3
				30.8				**16.6**				**18.6**				**27.0**

4 Wall Average 23.3

Dudley Elementary School Room A3

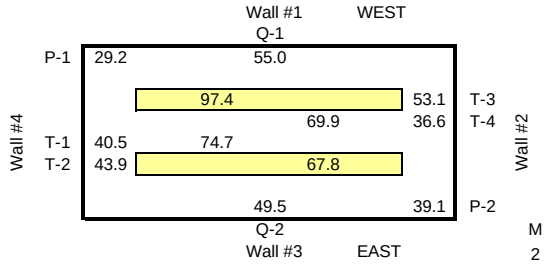
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 31.5 L (parallel to luminaires) 29.1 W 10.63 H avg. 916 SF **Ceiling:** 2x4 lay-in acoustical tile
Lumianire Layout: 2 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 25" Pendant, 8'-10" & 8'3" AFF/BOF
Lamp Description: Sylvania - FO32T8/835 24 Up 12 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/120PLUS 2 Lamp 1.20 BF 0.67 Amps 6 Quan
Ballast Description (Downlight): Sylvania - QTP3x32T8/120PLUS 2 Lamp 1.20 BF 0.67 Amps 3 Quan
Electrical Data: 120 Volts 7.1 Amps Uplight 2.0 Downlight Amps 855.6 Watts Uplight **0.93 W/SF**

Ceiling Reflectance: 83%
Tile Floor Reflectance: 31%
Carpet Reflectance: 11%
Desktop Reflectance: 41%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout
The primary teaching wall is # 2
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

Average							
M	N	P	Q	R	T	**Horizontal Average**
2	6	34.2	52.3	77.5	43.5	**61**

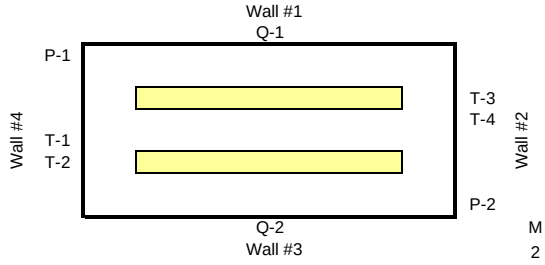
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2					Aver	Wall #3			Aver	Wall #4					Aver
9.5 ft	26.1	32.6	24.0	27.6	18.0	29.5	21.0	28.8	20.6	23.6	14.1	25.8	30.2	23.4	28.4	67.3	23.0	64.5	28.5	42.3
6 ft	28.0	36.0	26.5	30.2	18.0	29.2	23.0	25.4	20.9	23.3	11.9	22.2	23.3	19.1	26.6	44.0	30.0	40.0	25.7	33.3
3 ft	26.0	26.8	28.2	27.0	19.0	26.0	24.7	25.4	19.9	23.0	17.4	31.6	28.5	25.8	23.7	39.8	28.2	33.8	25.1	30.1
				28.2						**23.3**				**22.8**						**35.2**

4-Wall Average 27.4

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.
= Lighting layout

Average						
M	N	P	Q	R	T	**Horizontal Average**
2	6	0.0	0.0	0.0	0.0	**0**

Horizontal downlight data not collected.

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2					Aver	Wall #3			Aver	Wall #4					Aver
9.5 ft	3.9	4.6	3.4	4.0	2.6	3.9	3.4	3.3	2.8	3.2	1.8	2.4	3.2	2.5	3.3	5.8	4.4	5.0	3.6	4.4
6 ft	5.1	6.3	5.3	5.6	3.1	7.7	3.7	4.7	3.4	4.5	2.8	5.2	4.4	4.1	4.0	26.1	5.7	14.2	6.2	11.2
3 ft	11.2	22.0	17.4	16.9	7.2	12.0	6.0	12.1	8.4	9.1	8.0	14.2	10.8	11.0	9.0	19.8	11.8	15.0	11.4	13.4
				8.8						**5.6**				**5.9**						**9.7**

4-Wall Average 7.5

Dudley Elementary School Room A4

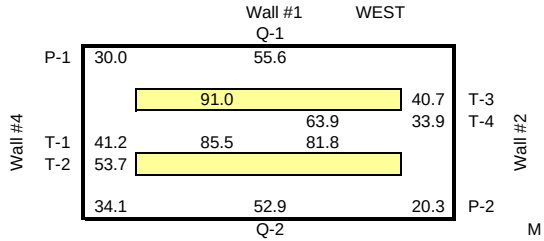
Date Data Collected: September 22, 2003

Room Dimensions: 31.5 L (parallel to luminaires) 29.1 W 10.63 H 916.1 SF **Ceiling:** Slope 10'2" - 11'5"
Lumianire Layout: 2 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 25" Pendant, 8'-10" & 8'3" AFF
Lamp Description: Sylvania - FO32T8/835 24 Up 12 Down
Ballast Description (Uplight): Sylvania - QT3x32T8/120PLUS 2 Lamp 1.20 BF 0.67 Amps 6 Quan
Ballast Description (Downlight): Sylvania - QTP3x32T8/120DIM5QNL 2 Lamp 0.88 BF 0.52 Amps 3 Quan
Electrical Data: 120 Volts 7.1 Amps Uplight 1.6 Downlight Amps 856.8 Watts Uplight **0.94 W/SF**

Ceiling Reflectance: 83%
Tile Floor Reflectance: 31%
Carpet Reflectance: 11%
Desktop Reflectance: 41%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
2	6	25.2	54.3	71.3	42.4	**Horizontal Average 59**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1 Aver	Wall #2 Aver	Wall #3 Aver	Wall #4 Aver
9 ft				
6 ft				
3 ft				

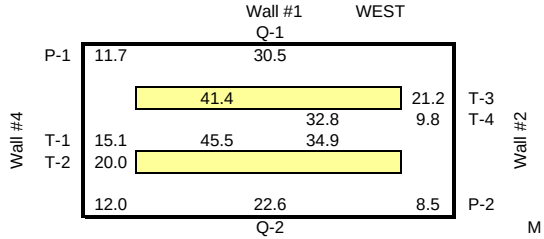
Data not collected.

Data not collected.

4 Wall Average

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.

= Lighting layout

M	N	P	Q	R	T	Average
2	6	10.1	26.6	33.3	16.5	**Horizontal Average 28**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1 Aver	Wall #2 Aver	Wall #3 Aver	Wall #4 Aver
9 ft				
6 ft				
3 ft				

Data not collected.

Data not collected.

4 Wall Average

Dudley Elementary School Room A5

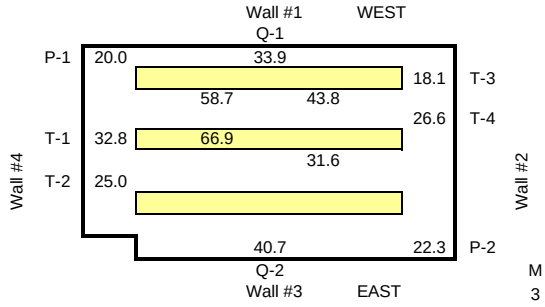
Date Data Collected: September 22, 2003

Room Dimensions: 31.6 L (parallel to luminaires) 39.0 W 10.63 H 1232 SF **Ceiling:** Slope 10'2" - 11'5"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 25" Pendant, 8'-10" & 8'3" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT2x32T8/120LP 2 Lamp 0.77 BF 0.43 Amps 6 Quan
Ballast Description (Downlight): Sylvania - QT2x32T8/120LP 2 Lamp 0.77 BF 0.43 Amps 3 Quan
Electrical Data: 120 Volts 7.7 Amps Uplight 1.3 Downlight Amps 922.8 Watts Uplight **0.75 W/SF**

Ceiling Reflectance: 83%
Tile Floor Reflectance: 31%
Carpet Reflectance: 11%
Desktop Reflectance: 41%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

							Average	
M	N	P	Q	R	T			Horizontal Average
3	6	21.2	37.3	50.3	25.6			43

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1 Aver	Wall #2 Aver	Wall #3 Aver	Wall #4 Aver
9 ft				
6 ft				
3 ft				

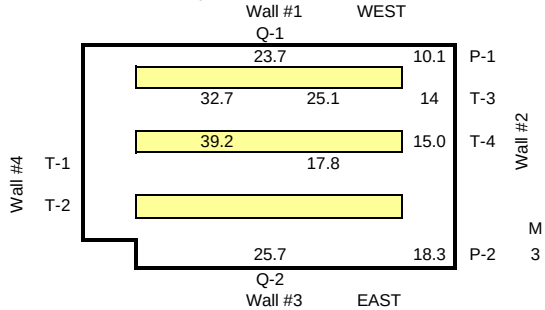
Data not collected.

Data not collected.

4 Wall Average

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.

= Lighting layout

							Average	
M	N	P	Q	R	T			Horizontal Average
3	6	14.2	24.7	28.7	14.5			26

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1 Aver	Wall #2 Aver	Wall #3 Aver	Wall #4 Aver
9 ft				
6 ft				
3 ft				

Data not collected.

Data not collected.

4 Wall Average

Dudley Elementary School Room A6

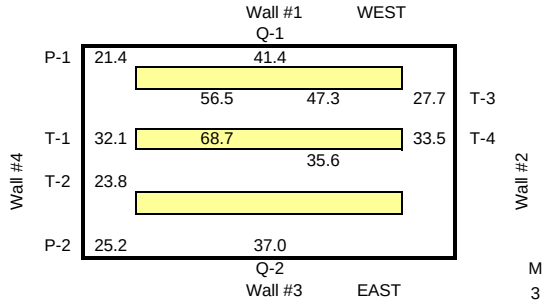
Date Data Collected: September 30, 2003
Date Data Collected: October 8, 2003

Room Dimensions: 31.6 L (parallel to luminaires) 39.0 W 10.63 H 1232 SF **Ceiling:** Slope 10'2" - 11'5"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 25" Pendant, 8'-10" & 8'3" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT2x32T8/120LP 2 Lamp 0.77 BF 0.43 Amps 6 Quan
Ballast Description (Downlight): Sylvania - QTP3x32T8/120DIM5QNL 2 Lamp 0.88 BF 0.52 Amps 3 Quan
Electrical Data: 120 Volts 7.6 Amps Uplight 1.6 Downlight Amps 912 Watts Uplight **0.74 W/SF**

Ceiling Reflectance: 83%
Tile Floor Reflectance: 31%
Carpet Reflectance: 11%
Desktop Reflectance: 41%
Wall Reflectance: Varies
Chalkboard Reflectance: 59%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout
The primary teaching wall is # 2
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

Average	M	N	P	Q	R	T	Horizontal Average
	3	6	23.3	39.2	52.0	29.3	**45**

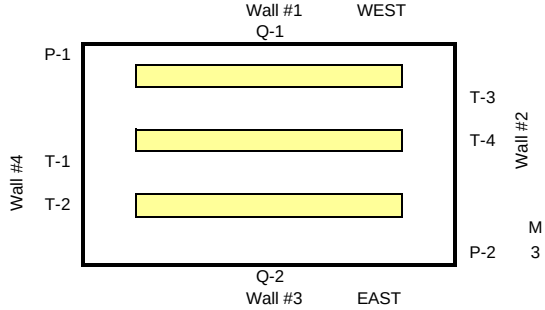
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2					Aver	Wall #3			Aver	Wall #4					Aver
9.5 ft	17.3	21.5	14.8	17.9	14.2	18.7	12.7	21.2	14.6	16.3	21.1	14.2	13.5	16.3	14.1	37.4	15.2	38.5	15.9	24.2
6 ft	20.6	27.5	17.9	22.0	15.7	18.9	16.8	18.5	17.0	17.4	14.8	17.6	16.3	16.2	18.1	27.9	20.5	26.4	17.0	22.0
3 ft	16.2	25.3	16.9	19.5	16.1	21.4	18.3	20.0	14.9	18.1	18.0	18.1	20.8	19.0	17.9	24.5	20.8	21.4	13.2	19.6
				19.8						**17.3**				**17.2**						**21.9**

4 Wall Average 19.0

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.



Wall #1 has windows.
= Lighting layout

Average	M	N	P	Q	R	T	Horizontal Average
P-2	3	6	0.0	0.0	0.0	0.0	**0**

Horizontal downlight data not collected.

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2					Aver	Wall #3		Aver	Wall #4					Aver
9.5 ft	3.3	3.5	2.9	3.2	2.6	3.1	3.0	3.7	4.1	3.3	3.6		3.6	4.4	4.1	3.2	3.9	2.8	3.7
6 ft	4.0	6.6	4.0	4.9	3.8	7.1	3.9	5.5	4.4	4.9	4.1		4.1	4.8	17.8	4.8	17.7	7.0	10.4
3 ft	9.9	18.0	9.1	12.3	8.3	10.5	8.9	10.5	6.4	8.9	5.8		5.8	8.9	15.2	10.6	13.6	10.6	11.8
				6.8						**5.7**			**4.5**						**8.6**

Limited data collected.

4 Wall Average 6.4

Highland Elementary Control Room

Highland Elementary ICLS Room

Highland Elementary School Room 1

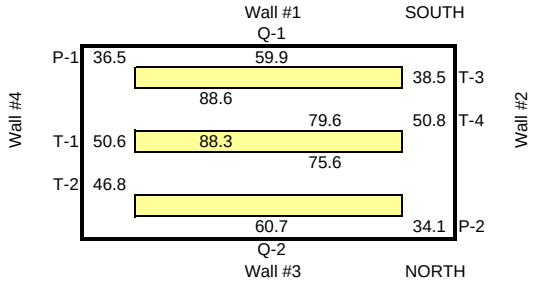
Date Data Collected: October 13, 2003

Room Dimensions: 28.25 L (parallel to luminaires) 30.00 W 11.54 H 848 SF **Ceiling:** Slope 10'4" - 12'9"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT(4/2)x32T8UNVPSXTC 4 Lamp 0.74 BF 0.82 Amps 9 Quan
Ballast Description (Downlight): Sylvania - QT(4/2)x32T8UNVPSXTC 2 Lamp 0.74 BF 0.41 Amps 9 Quan
Electrical Data: 120 Volts 7.4 Amps Uplight 3.7 Downlight Amps 888 Watts Uplight **1.05 W/SF**

Ceiling Reflectance:	89%	
White Tile Floor Reflectance:	59%	
Blue Tile Floor Reflectance:	12%	85 SF
Grey Carpet Reflectance:	11%	54 SF
Red Carpet Reflectance:	4%	24 SF
Desktop Reflectance:	46%	
Wall Reflectance:	65%	
Chalkboard Reflectance:	75%	

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout
The primary teaching wall is # 2
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
3	6	35.3	60.3	83.0	46.7	**Horizontal Average 71**

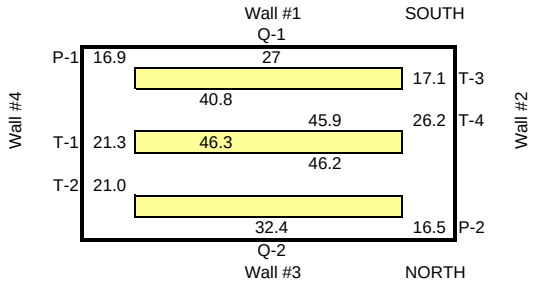
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2							Aver	Wall #3			Aver	Wall #2							Aver
9.5ft	25.9	33.0	26.9	28.6	22.9	32.6	34.2	38.1	37.0	34.2	29.0	32.6	33.0	42.0	41.5	38.8	28.9	52.0	43.3	47.7	33.0	33.8	22.7	37.3
6 ft	33.9	40.1	33.8	35.9	30.3	35.6	35.9	38.5	35.5	32.9	24.6	33.3	28.8	40.0	40.7	36.5	30.5	43.6	41.9	52.0	43.6	35.8	27.7	39.3
3 ft	28.0	32.1	27.4	29.2	25.6	33.7	33.5	35.0	33.9	31.0	23.1	30.8	25.2	37.7	37.3	33.4	26.3	34.0	38.5	39.8	38.9	33.4	24.0	33.6
				31.2								**32.2**				**36.2**								**36.7**

4 Wall Average 34.1

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout

M	N	P	Q	R	T	Average
3	6	16.7	29.7	44.8	21.4	**Horizontal Average 37**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2							Aver	Wall #3			Aver	Wall #2							Aver
9.5ft	7.2	7.3	7.0	7.2	4.7	6.0	7.0	7.5	7.5	7.2	4.8	6.4	7.5	8.3	7.9	7.9	5.6	6.6	8.5	7.2	6.5	6.9	5.1	6.6
6 ft	8.3	9.1	8.2	8.5	6.9	11.4	9.7	10.5	10.9	10.5	12.4	10.3	9.3	11.5	10.9	10.6	11.3	20.2	13.6	24.4	16.0	13.2	6.7	15.1
3 ft	18.2	16.5	17.5	17.4	10.4	14.0	15.5	14.5	15.5	15.4	11.1	13.8	16.9	18.8	17.4	17.7	11.4	16.5	18.1	17.8	20.6	15.2	9.3	15.6
				11.0								**10.2**				**12.1**								**12.4**

4 Wall Average 11.4

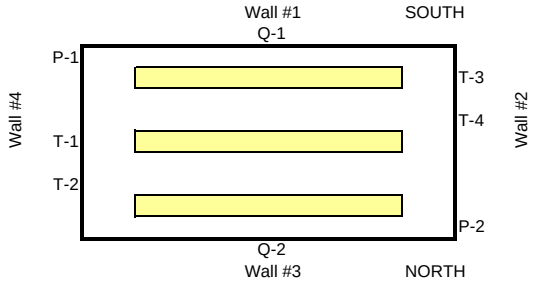
Highland Elementary School Room 2

Room Dimensions: 28.25 L (parallel to luminaires) 30.00 W 11.54 H 848 SF **Ceiling:** Slope 10'4" - 12'9"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 0 Up 0 Down
Ballast Description (Uplight): Sylvania - QT(4/2)x32T8UNVPSXTC 4 Lamp 0.74 BF 0.82 Amps 9 Quan
Ballast Description (Downlight): Sylvania - QT(4/2)x32T8UNVPSXTC 2 Lamp 0.74 BF 0.41 Amps 9 Quan
Electrical Data: 120 Volts 7.4 Amps Uplight 3.7 Downlight Amps 888 Watts Uplight **1.05 W/SF**

Ceiling Reflectance:
White Tile Floor Reflectance:
Blue Tile Floor Reflectance:
Grey Carpet Reflectance:
Red Carpet Reflectance:
Desktop Reflectance:
Wall Reflectance:
Chalkboard Reflectance:
*Verify that reflectances are same as Rm 1

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout
The primary teaching wall is #
The secondary teaching wall is #
M = Number of rows of luminaires
N = Number of luminaires per Row

						Average	
M	N	P	Q	R	T		**Horizontal Average**
3	6	0.0	0.0	0.0	0.0		**0**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

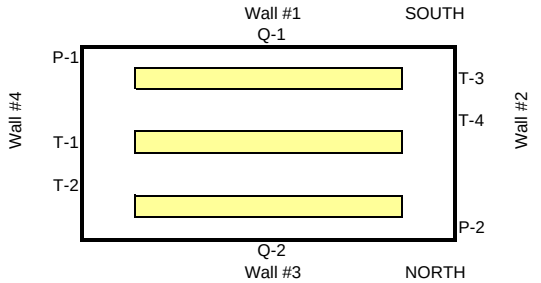
AFF	Wall #1	Aver	Wall #2	Aver	Wall #3	Aver	Wall #2	Aver
9.5ft								
6 ft								
3 ft								

Data not collected. Room 2 is identical to Room 1.

4 Wall Average
0.0

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout

						Average	
M	N	P	Q	R	T		**Horizontal Average**
3	6	0.0	0.0	0.0	0.0		**0**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1	Aver	Wall #2	Aver	Wall #3	Aver	Wall #2	Aver
9.5ft								
6 ft								
3 ft								

4 Wall Average
0.0

Highland Elementary School Room 3

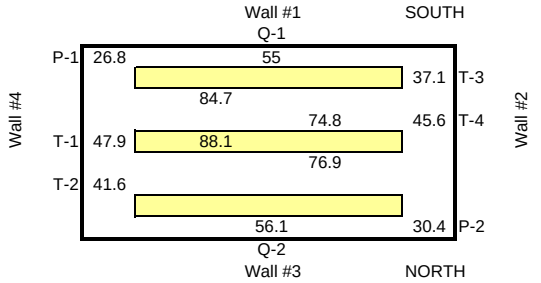
Date Data Collected: October 13, 2003

Room Dimensions: 28.25 L (parallel to luminaires) 30.00 W 11.54 H 848 SF **Ceiling:** Slope 10'4" - 12'9"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT(4/2)x32T8UNVPSXTC 4 Lamp 0.74 BF 0.82 Amps 9 Quan
Ballast Description (Downlight): Sylvania - QTP2x32T8/120DIM5QNL 2 Lamp 0.88 BF 0.52 Amps 9 Quan
Electrical Data: 120 Volts 7.4 Amps Uplight 4.7 Downlight Amps 888 Watts Uplight **1.05 W/SF**

Ceiling Reflectance: 89%
White Tile Floor Reflectance: 59%
Blue Tile Floor Reflectance: 12% 85 SF
Grey Carpet Reflectance: 11% 54 SF
Red Carpet Reflectance: 4% 24 SF
Desktop Reflectance: 46%
Wall Reflectance: 65%
Chalkboard Reflectance: 75%
*Verify that reflectances are same as Rm 1

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout
The primary teaching wall is # 2
The secondary teaching wall is # 3
M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
3	6	28.6	55.6	81.1	43.1	**Horizontal Average 68**

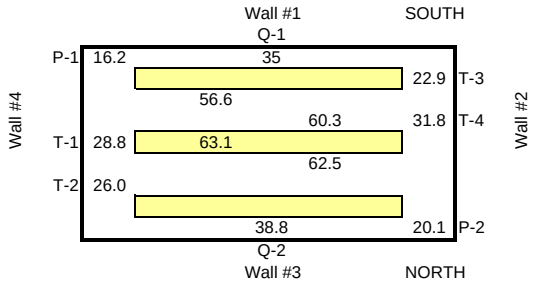
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2							Aver	Wall #3			Aver	Wall #2							Aver
9.5ft	28.8	34.1	28.9	30.6	27.0	33.9	35.1	37.3	36.1	35.2	25.5	32.9	36.2	40.5	40.0	38.9	25.9	31.3	38.7	40.1	39.2	34.1	22.9	33.2
6 ft	42.1	43.2	36.1	40.5	33.3	37.0	36.2	40.5	36.9	34.4	28.4	35.2	34.5	39.6	41.3	38.5	27.1	38.9	43.8	55.6	43.3	34.4	28.3	38.8
3 ft	38.4	41.2	34.0	37.9	29.7	38.2	36.5	38.1	35.5	42.2	25.2	35.1	29.2	38.0	40.4	35.9	24.8	34.6	36.4	42.3	35.4	36.8	26.4	33.8
				36.3								**34.4**				**37.7**								**35.3**

4 Wall Average 35.9

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.
= Lighting layout

M	N	P	Q	R	T	Average
3	6	18.2	36.9	60.6	27.4	**Horizontal Average 49**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2							Aver	Wall #3			Aver	Wall #2							Aver
9.5ft	8.4	11.4	9.5	9.8	8.3	9.4	9.6	9.6	9.4	8.8	7.2	8.9	8.7	10.6	10.1	9.8	7.9	9.3	10.5	11.5	10.5	9.9	8.5	9.7
6 ft	9.2	14.1	11.5	11.6	14.2	17.4	14.8	17.3	14.9	16.0	12.1	15.2	12.1	17.1	16.6	15.3	16.9	24.5	18.7	30.0	18.1	16.0	11.1	19.3
3 ft	13.4	24.2	21.7	19.8	15.0	18.4	21.2	20.4	20.8	15.3	12.8	17.7	17.6	25.9	22.6	22.0	16.1	20.0	26.5	24.6	22.6	17.5	15.4	20.4
				13.7								**13.9**				**15.7**								**16.5**

4 Wall Average 15.0

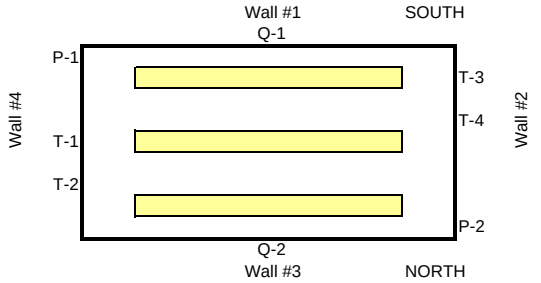
Highland Elementary School Room 4

Room Dimensions: 30.2 L (parallel to luminaires) 28.3 W 11.54 H avg. 855.8 SF **Ceiling:** Slope 10'4" - 12'9"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 9'4" AFF
Lamp Description: Sylvania - FO32T8/835 36 Up 18 Down
Ballast Description (Uplight): Sylvania - QT(4/2)x32T8UNVPSXTC 4 Lamp 0.74 BF 0.82 Amps 9 Quan
Ballast Description (Downlight): Sylvania - QTP2x32T8/120DIM5QNL 2 Lamp 0.88 BF 0.52 Amps 9 Quan
Electrical Data: 120 Volts 7.4 Amps Uplight 4.7 Downlight Amps 888 Watts Uplight **1.04 W/SF**

Ceiling Reflectance:
White Tile Floor Reflectance:
Blue Tile Floor Reflectance:
Grey Carpet Reflectance:
Red Carpet Reflectance:
Desktop Reflectance:
Wall Reflectance:
Chalkboard Reflectance:
*Verify that reflectances are same as Rm 1

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is #
The secondary teaching wall is #

M = Number of rows of luminaires
N = Number of luminaires per Row

						Average	
M	N	P	Q	R	T		Horizontal Average
3	6	0.0	0.0	0.0	0.0		0

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

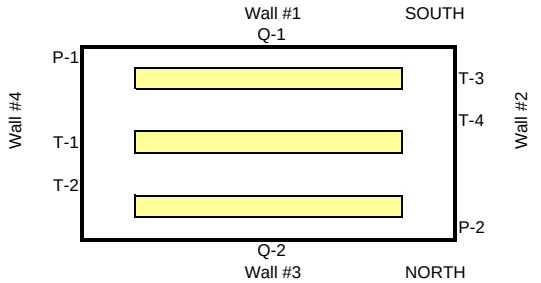
AFF	Wall #1	Aver	Wall #2	Aver	Wall #3	Aver	Wall #2	Aver
9.5ft								
6 ft								
3 ft								

Data not collected. Room 4 is identical to Room 3.

4 Wall Average
0.0

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

						Average	
M	N	P	Q	R	T		Horizontal Average
3	6	0.0	0.0	0.0	0.0		0

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1	Aver	Wall #2	Aver	Wall #3	Aver	Wall #2	Aver
9.5ft								
6 ft								
3 ft								

4 Wall Average
0.0

Highland Elementary School Room 5

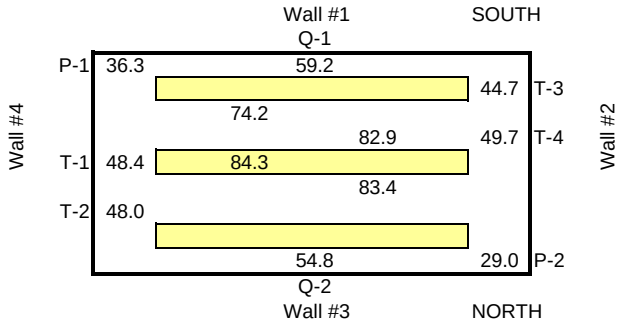
Date Data Collected: October 13, 2003

Room Dimensions: 30.00 L (parallel to luminaires) 28.25 W 11.54 H avg. 848 SF **Ceiling:** Slope 10'4" - 12'9"
Lumianire Layout: 3 rows 24 feet long
Luminaire Description: Pendant, up/down open lamp, side baffles **Luminaire Mounting:** 9'4" AFF
Lamp Description: F96T8-TL741 18 Up 0 Down
Ballast Description (Uplight): Syl QT-2X59-120-IS 2 Lamp 0.00 BF 0.94 Amps 9 Quan
Ballast Description (Downlight):
Electrical Data: 120 Volts 7.0 Amps Uplight 0.0 Downlight Amps 840 Watts Uplight **0.99 W/SF**

Ceiling Reflectance:	89%	
White Tile Floor Reflectance:	59%	
Blue Tile Floor Reflectance:	12%	85 SF
Grey Carpet Reflectance:	11%	54 SF
Red Carpet Reflectance:	4%	24 SF
Desktop Reflectance:	46%	
Wall Reflectance:	65%	
Chalkboard Reflectance:	75%	

UPLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # 3

M = Number of rows of luminaires
N = Number of luminaires per Row

						Average
M	N	P	Q	R	T	**Horizontal Average**
3	6	32.7	57.0	81.2	47.7	**69**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1			Aver	Wall #2							Aver	Wall #3			Aver	Wall #2							Aver
9.5ft	29.7	32.0	28.6	30.1	22.0	28.3	29.5	32.1	30.1	27.2	21.8	27.3	28.7	33.0	33.3	31.7	23.8	26.9	29.2	31.5	30.5	29.9	24.9	28.1
6 ft	31.6	37.0	32.6	33.7	26.0	34.7	33.8	37.7	36.0	33.6	34.2	33.7	28.3	32.1	31.0	30.5	25.6	36.3	34.5	49.3	40.9	34.0	27.2	35.4
3 ft	34.3	44.9	39.0	39.4	29.6	31.7	39.7	39.1	39.1	32.0	29.3	34.4	32.3	37.4	33.3	34.3	25.5	27.5	36.8	36.0	39.8	34.2	26.3	32.3
				34.4								**31.8**				**32.2**								**31.9**

4 Wall Average
32.6

Carlmont High School Room C3

Date Data Collected: October 14, 2003

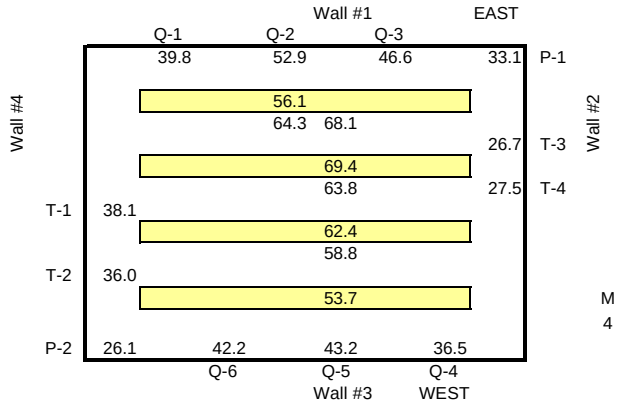
Room Dimensions: 46.0 L (parallel to luminaires) 24.0 W 13.5 H 1104 SF **Ceiling:**
Lumianire Layout: 4 rows 40 feet long
Luminaire Description: Fluor Pendant, Up/Down Baffle/Egg Crate **Luminaire Mounting:** 10' AFF
Lamp Description: Syl F96/T12/CW 60W Supersaver 40 Quan
Ballast Description: Not able to determine 2 Lamp 0.00 BF 0 Amps 20 Quan
Electrical Data: 120 Volts 17.5 Amps Uplight 0.0 Downlight Amps 2100 Watts Uplight **1.90 W/SF**

Ceiling Reflectance: 75%
Tile Floor Reflectance: 31%
Cabinet Door Reflectance: 18%
Desktop Reflectance: 4%
Upper End Wall Reflectance: 70%
Chalkboard Reflectance: 65%
Blinds Reflectance: 13%

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 30 inches above the floor. = lighting layout

According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

The primary teaching wall is # 2
The secondary teaching wall is # --

M = Number of rows of luminaires
N = Number of luminaires per Row

							Average
M	N	P	Q	R	T		**Horizontal Average**
4	10	29.6	43.5	62.1	32.1		**55**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1					Aver	Wall #2							Aver	Wall #3					Aver	Wall #4							Aver
9 ft	24.8	30.1	31.2	30.9	22.1	27.8	14.6	13.9	15.4	15.3	15.4	13.9	14.6	14.7	35.7	30.1	38.5	39.9	38.7	36.6	13.6	13.2	16.6	15.0	14.8	11.7	11.3	13.7
6 ft	35.4	40.6	44.8	43.2	27.6	38.3	19.6	19.1	21.1	19.4	20.1	20.3	20.5	20.0	32.2	34.6	36.9	38.7	35.6	35.6	22.5	22.9	23.4	21.5	26.7	20.4	20.1	22.5
3 ft	19.6	27.3	28.9	28.6	19.0	24.7	16.7	19.3	19.3	21.0	21.2	22.1	21.7	20.2	23.9	26.4	29.4	29.1	27.0	27.2	20.7	22.5	24.6	22.9	24.1	20.7	19.1	22.1
						30.3								**18.3**						**33.1**								**19.4**

4 Wall Average
25.3

Carlmont High School — Room C4

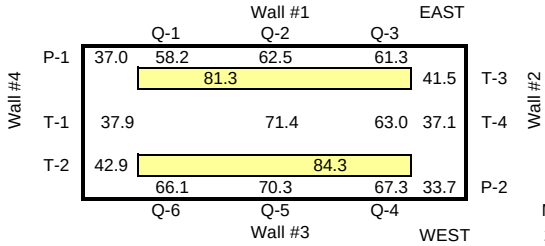
Date Data Collected: October 14, 2003

Room Dimensions: 46.0 L (parallel to luminaires) 28.0 W 15 H 1288 SF **Ceiling:**
Lumianire Layout: 2 rows 40 feet long
Luminaire Description: Finelite - Model S10 **Luminaire Mounting:** 11'-10" AFF
Lamp Description: Sylvania - FO32T8/835 40 Up 20 Down
Ballast Descp (Uplight): Sylvania - QT(3/2)x32T8/120PLUS 3 Lamp 1.20 BF 0.96 Amps 14 Quan
Ballast Descp (Dwnlight): Sylvania - QTP(3/1)x32T8/120DIM5QNL 3 Lamp 0.88 BF 0.78 Amps 16 Quan
Electrical Data: 120 Volts 13.6 Amps Uplight 12.5 Downlight Amps 1632 Watts Uplight **1.27 W/SF**

Ceiling Reflectance: 75%
Wall Reflectance: 76%
Whiteboard Reflectance: 75%
Chalkboard Reflectance: 15%
Desktop Reflectance: 4%
Gray Tile Floor Reflectance: 20%
Blue Tile Floor Reflectance: 7%
Blinds Reflectance: 61%

UPLIGHT

Horizontal illuminance in footcandles on a workplane 36 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

The primary teaching wall is # 2
The secondary teaching wall is # --

M = Number of rows of luminaires
N = Number of luminaires per Row

M	N	P	Q	R	T	Average
2	10	35.4	64.3	75.0	39.9	**Horizontal Average 67**

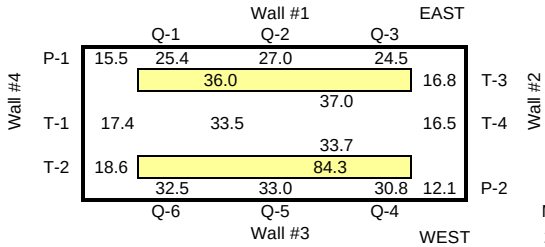
Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1					Aver	Wall #2							Aver	Wall #3					Aver	Wall #4							Aver
9 ft	36.7	40.3	41.0	39.6	36.3	38.8	32.2	34.5	28.2	31.0	35.5	39.5	31.5	33.2	39.7	47.7	46.7	48.6	40.7	44.7	29.6	37.3	32.8	32.1	30.8	37.5	30.4	32.9
6 ft	35	40.3	41.6	40.7	39.0	39.3	30.2	35.1	29.4	32.2	33.2	37.0	29.2	32.3	38.3	45.0	45.7	43.7	38.7	42.3	33.0	40.5	35.0	34.7	32.4	37.5	30.8	34.8
3 ft	30	35.8	36.3	34.7	30.0	33.4	26.0	30.9	23.7	27.9	27.9	31.0	20.0	26.8	32.4	40.2	41.2	40.2	33.6	37.5	26.4	33.0	30.3	31.2	29.4	30.7	27.1	29.7
						37.2								**30.8**						**41.5**								**32.5**

4 Wall Average 35.5

DOWNLIGHT

Horizontal illuminance in footcandles on a workplane 36 inches above the floor.
According to the procedure on page 2-35 of the Ninth Edition of the IESNA Handbook.



Wall #1 has windows.

= Lighting layout

M	N	P	Q	R	T	Average
2	10	13.8	28.9	44.9	17.3	**Horizontal Average 35**

Vertical illuminance in footcandles on respective walls at indicated heights AFF (above the finished floor).

AFF	Wall #1					Aver	Wall #2							Aver	Wall #3					Aver	Wall #4							Aver
9 ft	6.2	6.1	6.3	6.2	6.1	6.2	6.4	11.3	6.9	6.3	12.7	12.6	6.3	8.9	6.7	7.1	7.1	7.2	7.4	7.1	6.3	12.7	6.9	5.6	6.0	12.6	6.5	8.1
6 ft	18.2	17.7	8.6	19.9	19.2	16.7	11.7	13.0	13.1	12.2	13.4	14.4	10.4	12.6	13.9	19.5	20.3	21.1	19.7	18.9	14.4	16.4	14.3	11.7	15.3	14.2	11.7	14.0
3 ft	11.4	13.8	15.4	14.2	13.6	13.7	11.1	11.9	10.3	10.5	10.8	11.3	10.0	10.8	16.6	17.0	16.4	16.4	15.2	16.3	12.7	13.2	13.7	12.7	13.0	11.9	10.0	12.5
						12.2								**10.8**						**14.1**								**11.5**

4 Wall Average 12.2

APPENDIX D: TEACHERS SURVEY REPORT

Appendix D

Teacher Survey Numerical Trends and Comments

This report summarizes the major findings from the analysis of the teacher comfort surveys for the PIER Classroom Lighting Control System (ICLS) lighting research project. AEC evaluated the questionnaire data according to three different cases. The first was an overall evaluation of the ICLS lighting system compared to the base case lighting system. The second compared two rows of fixtures to three rows of fixtures. The last case looked at rooms with the dimming control compared to rooms without the dimming control. The demographic portion of the survey found that on average 64% of the teachers wear glasses, their average age is 41, and they have been teaching for 13 years with the last 5 years being in the same classroom.

Note: When the reader sees a comment in italics such as this, the comment was added in preparation for the final report. For example, since the questionnaires were originally analyzed, teacher feedback helped identify several parts of the ICLS for redesign. Examples include:

1. *Location of the sensor was moved from the corner of the room to the center of the room.*
2. *The Quiet Time - 1 Hour On feature was added to the Teacher Control Center at the front teaching wall.*
3. *The ballast manufacturer redesigned their .77 BF ballast to reduce hum.*
4. *Components in the low voltage, remodel system that was used to retrofit classrooms were changed to cut out a 10-second delay that occurred on entering the room. (This was due to a power-up cycle that was changed.)*
5. *A high-performance, dedicated whiteboard luminaire was developed and will be introduced in 2005 to provide more light on the main teaching wall. When this luminaire is used, the run length can be reduced from 24 feet to 20 feet.*

Teacher satisfaction levels were taken BEFORE these changes were implemented. We anticipate that that satisfaction levels for the enhanced ICLS will be measurably higher than the high satisfaction levels already documented.

Also, please note that the analysis was done at a point where the system was often referred to as a Classroom Lighting and Control System (CLCS.) This label is shown on the graphs and is imbedded in them. Accordingly, the reader should interpret CLCS and ICLS as the same thing. CLCS only refers to the original manifestation of the system.

Base Case Lighting Compared to ICLS

The analysis between the baseline and the Integrated Classroom Lighting System found a number of interesting trends within the data. As illustrated in Figures 1-4, the ICLS case (on average for all installations) compared favorably to the base case according to occupant satisfaction. According to the surveys, the ICLS reduced glare and eye fatigue while increasing overall lighting levels on the teaching surfaces compared to the base case. In addition, the lighting from the ICLS was deemed a higher quality light that increased the overall satisfaction with the lighting system. The ICLS lighting system was also considered more user-friendly and convenient than the base case system.

On the other hand, Figure 3 shows that the ICLS was considered to have marginally increased the ceiling brightness and the fixtures were also noted to be brighter and more noticeable than the base case. Additionally, there were some comments from individual teachers regarding decreased lighting levels. In reality, average lighting levels were indeed reduced, yet the results of the survey show a majority of teachers actually felt the lighting levels were increased. See Figure 1 on the next page. Quantitatively, specific footcandle measurements at Heritage School showed the base case produced an average of 73 fc, the 2 rows (with only the uplight lamps illuminated) produced an average of 57 fc, and the 3 rows (with only the uplight lamps illuminated) produced an average of 52 fc. The major findings are summarized below and Figures 1-4 follow.

Summary of Findings for the Base Case Compared to ICLS

Reduced glare with ICLS
Increased control of lighting system with ICLS
Decreased eye fatigue with ICLS
Increased lighting on front teacher wall with ICLS
Increased lighting on student desks with ICLS
Increased lighting on teacher desk with ICLS
Lighting levels improved on walls and desktops with ICLS
ICLS was noted to have increased ceiling brightness and overall the fixture was brighter (to some degree too bright)
The ICLS lighting fixtures are more noticeable
More convenient with ICLS
Higher quality of light with ICLS
Increased overall lighting system satisfaction with ICLS
ICLS is more user friendly

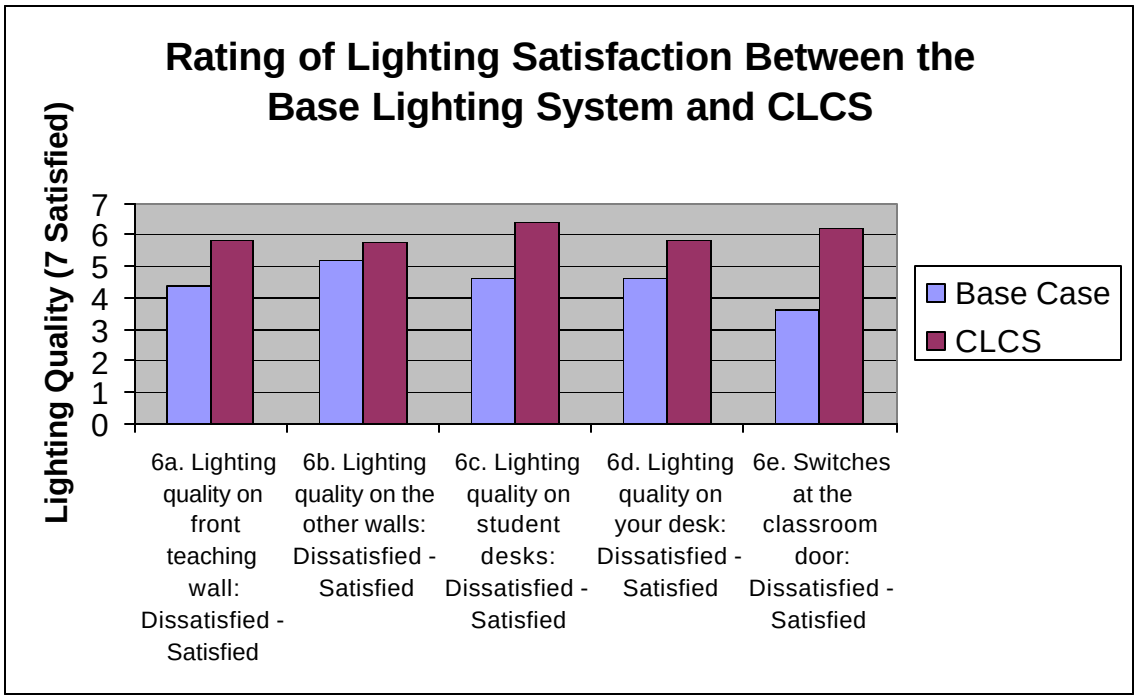


Figure 1

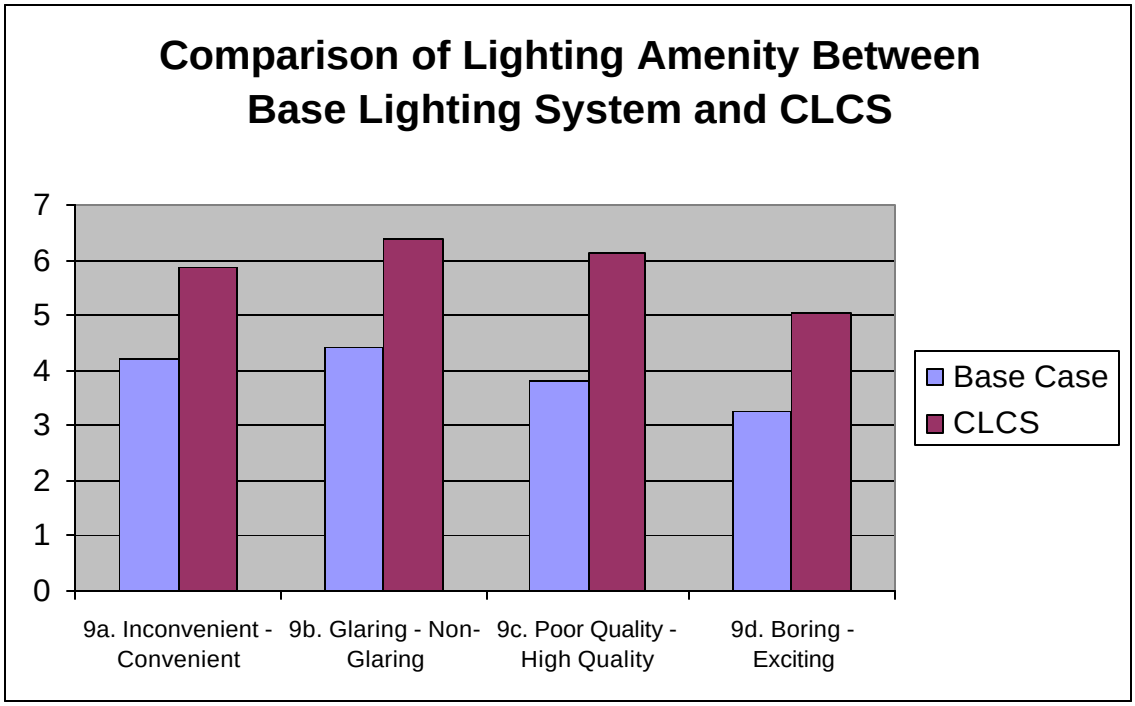


Figure 2

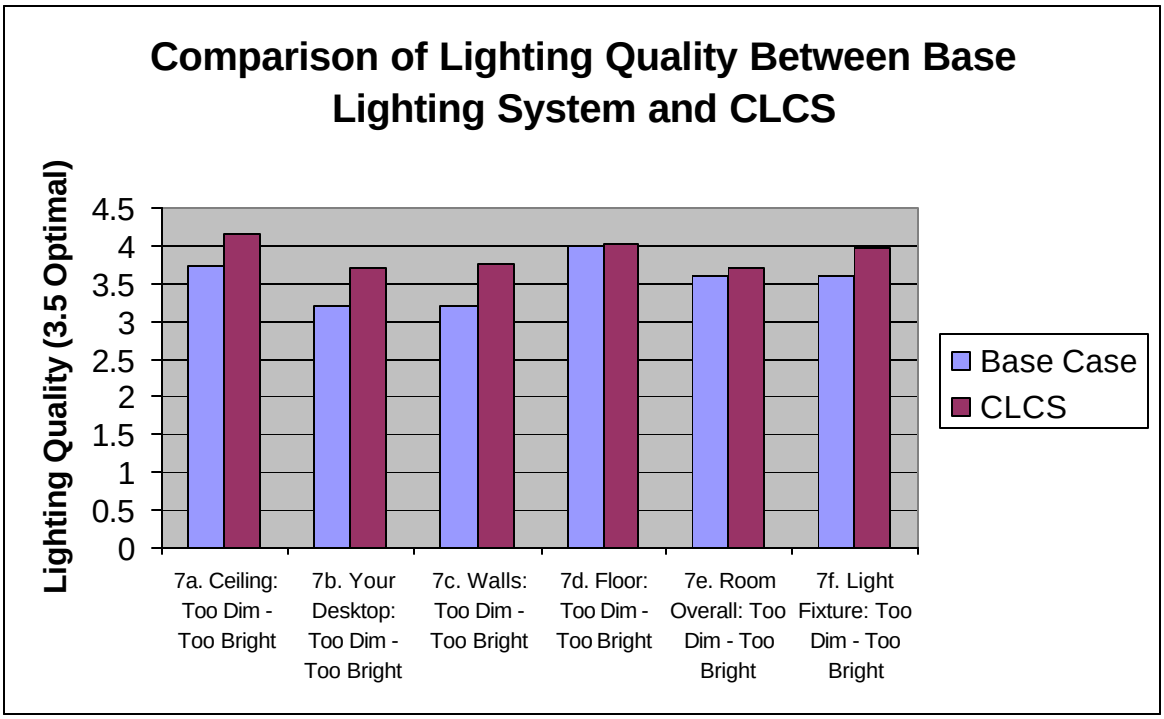


Figure 3

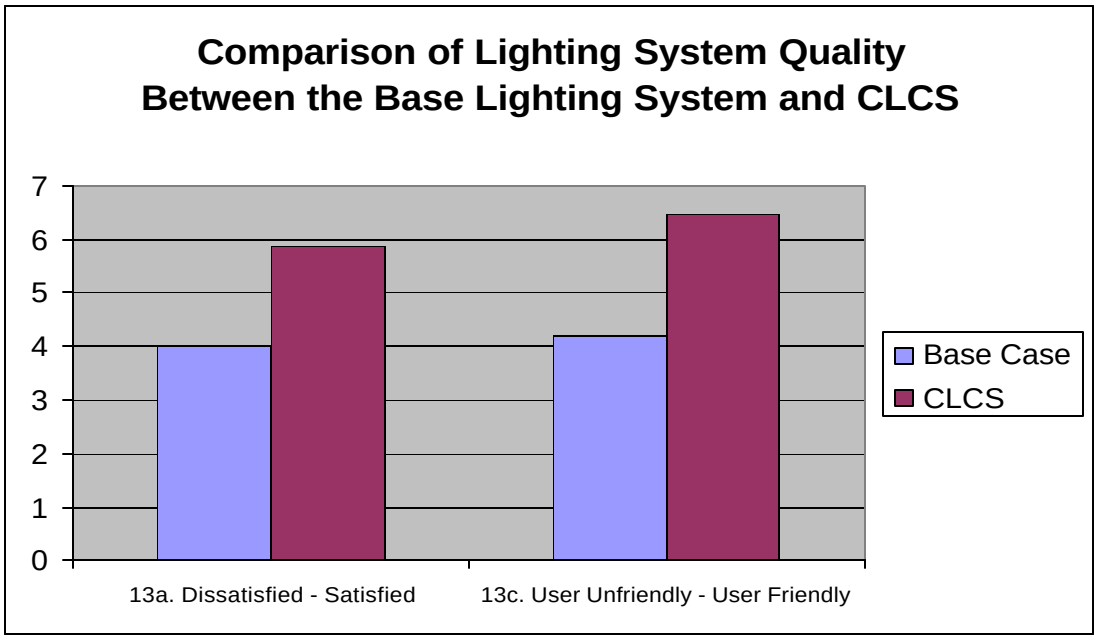


Figure 4

Two Rows of Lighting Compared to Three Rows

A comparison between two rows and three rows of indirect/direct lighting showed a preference for three rows. Increased lighting levels on all walls as well as on the teacher desktop were the most noted differences between the two cases. Foot-candle measurements at Heritage School support these findings since the three-row configuration produced higher average desktop illumination with lower contrast ratios. The measurements show decreased overall fc levels directly underneath the fixtures (high of 88 fc for three rows compared to 111 fc for two rows) and increased illuminance near the walls (low of 30 fc for three rows compared to 22 fc for two rows). Aside from these differences, both cases scored well on overall lighting levels and teacher satisfaction. The major findings are summarized below. Figures 5 and 6 on the next page demonstrate graphically the findings of the analysis.

Summary of Findings for the Two Row vs. Three Row Case

Higher lighting levels on main teaching wall with 3 rows
Higher lighting levels on non teaching walls with 3 rows
Higher lighting levels on teacher desk with 3 rows
Both cases significantly reduced glare, had better control, and reduced eye fatigue

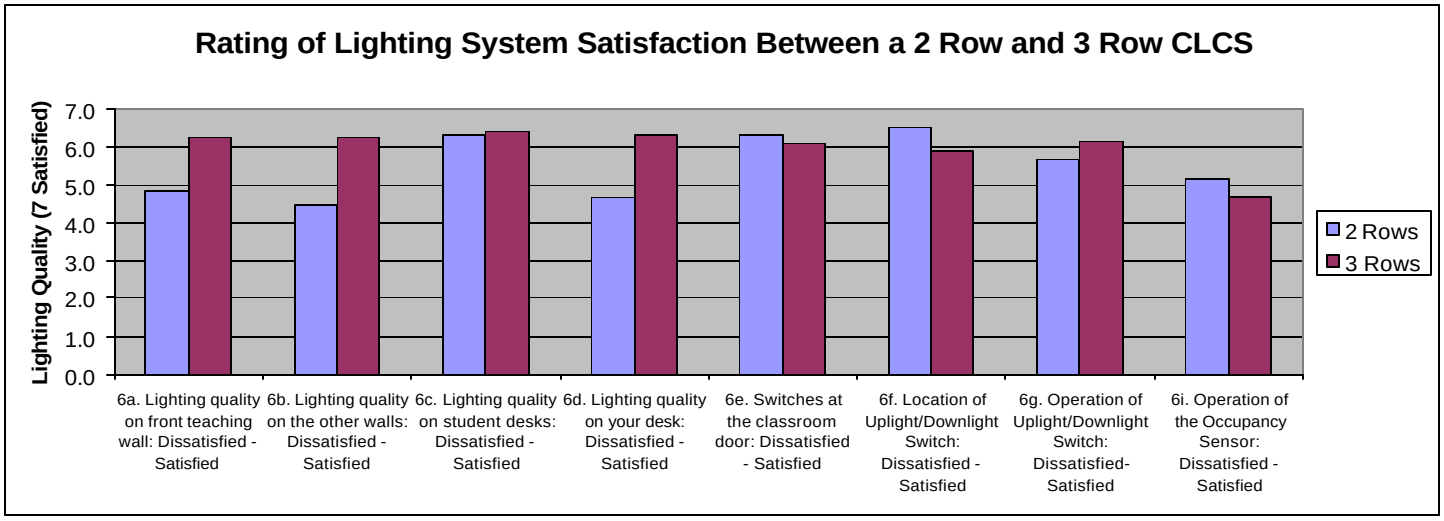


Figure 5

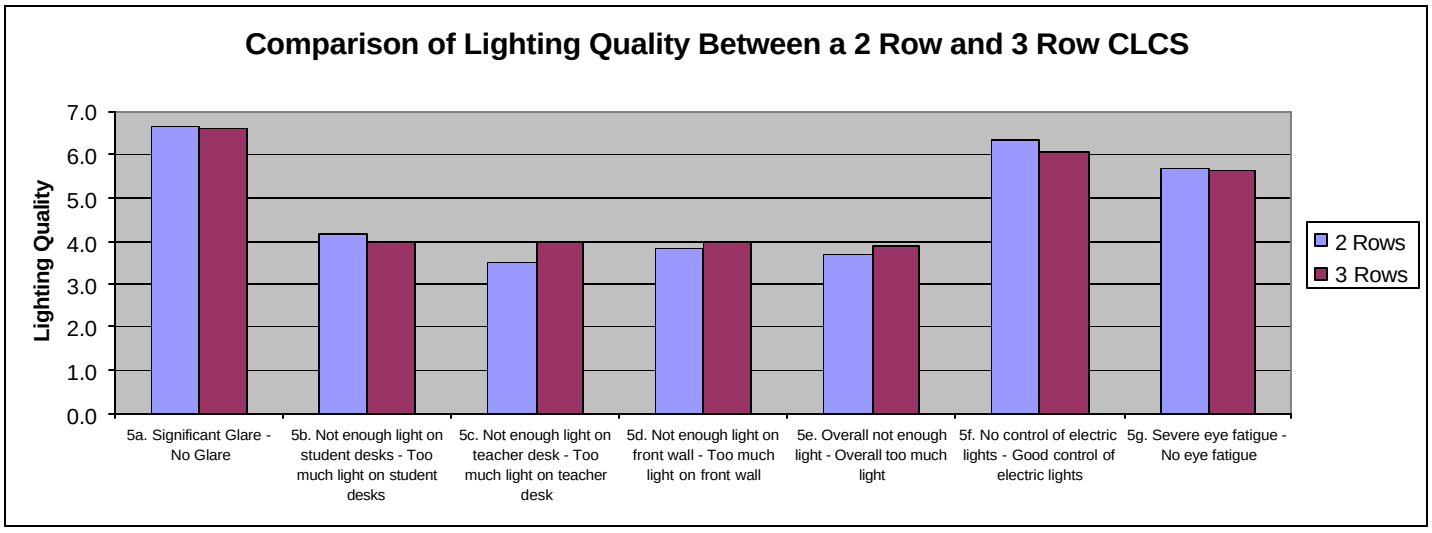


Figure 6

This section describes the analysis between the classrooms that received dimming control and those that did not. The teacher written comments showed that the dimming function was rarely used. A few teachers noted the calming effect on the students and these teachers used the dimming in the mornings and after breaks. In general, the teachers only used the downlights during A/V presentations or for small focused periods.

The most prominent findings showed that the dimming allowed for increased lighting control and there was a high level of overall satisfaction with the dimming function. Figure 7 shows these results. It should also be noted that the dimming case was more convenient and provided a higher quality of light according to the teachers surveyed.

Dimming Control Compared to No Dimming Control

Very high level of satisfaction with operation of dimming switch

An improved control of the lighting system compared to no dimming control

Dimming case was found to be more convenient and provide a higher quality of light

Higher level of overall satisfaction with dimming case

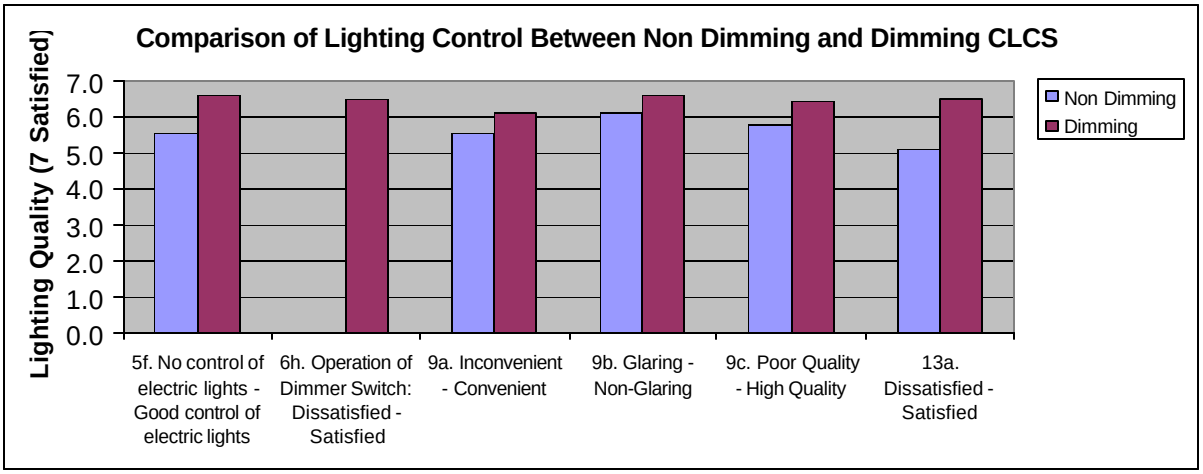


Figure 7

The participating teachers filled out the Questionnaire below.

CEC - PIER 4.5 **Classroom Lighting Questionnaire**
9/22/03

School Name: _____
Room Number: _____
Date: _____

This confidential survey is to get your feedback on the PIER lighting system that was recently installed in your classroom. Your answers are confidential. When all the results are compiled, we will send you a summary of the research findings. Thank you for helping with this important California Energy Commission sponsored research.
Indicate your response by circling choice or by placing an X between the colons as follows:
:_X_:

1. Gender (F, M) Age: 20-29, 30-39, 40-49, 50-59, 60-69 Do you wear glasses? (Yes / No)
2. How many years of teaching experience do you have? 1-2, 3-5, 6-10, 11-15, 16-20, over 20
3. How many years have you been teaching in this same classroom? _____
4. Describe your classroom **before** the installation of the PIER lighting system.
   a. Significant Glare :___:___:___:___:___:___:___:___: No Glare
   b. Not enough light on student desks :___:___:___:___:___:___:___:___: Too much light on student desks
   c. Not enough light on teacher desk :___:___:___:___:___:___:___:___: Too much light on teacher desk
   d. Not enough light on front wall :___:___:___:___:___:___:___:___: Too much light on front wall
   e. Overall not enough light :___:___:___:___:___:___:___:___: Overall too much light
   f. No control of electric lights :___:___:___:___:___:___:___:___: Good control of electric lights
   g. Severe eye fatigue :___:___:___:___:___:___:___:___: No eye fatigue
5. Describe your classroom **after** the installation of the PIER lighting system. Circle if Not Applicable
   a. Significant Glare :___:___:___:___:___:___:___:___: No Glare
   b. Not enough light on student desks :___:___:___:___:___:___:___:___: Too much light on student desks

c. Not enough light on teacher desk :___:___:___:___:___:___:___: Too much light on teacher desk

d. Not enough light on front wall :___:___:___:___:___:___:___: Too much light on front wall

e. Overall not enough light :___:___:___:___:___:___:___: Overall too much light

f. No control of electric lights :___:___:___:___:___:___:___: Good control of electric lights

g. Severe eye fatigue :___:___:___:___:___:___:___: No eye fatigue

6. Please let us know your opinion about the following specific areas of your current classroom.

a. Lighting quality on front teaching-wall Dissatisfied :___:___:___:___:___:___:___: Satisfied

b. Lighting quality on the other walls Dissatisfied :___:___:___:___:___:___:___: Satisfied

c. Lighting quality on student desks Dissatisfied :___:___:___:___:___:___:___: Satisfied

d. Lighting quality on your desk Dissatisfied :___:___:___:___:___:___:___: Satisfied

e. Switches at the classroom door Dissatisfied :___:___:___:___:___:___:___: Satisfied

f. Location of Uplight/Downlight Switch Dissatisfied :___:___:___:___:___:___:___: Satisfied

g. Operation of Uplight/Downlight Switch Dissatisfied :___:___:___:___:___:___:___: Satisfied

h. Operation of Dimmer Switch Dissatisfied :___:___:___:___:___:___:___: Satisfied

i. Operation of the Occupancy Sensor Dissatisfied :___:___:___:___:___:___:___: Satisfied

7. Indicate your perception of the brightness for each of the different areas of your classroom.

a. Ceiling Too Dim :___:___:___:___:___:___:___: Too Bright

b. Your Desktop Too Dim :___:___:___:___:___:___:___: Too Bright

c. Walls Too Dim :___:___:___:___:___:___:___: Too Bright

d. Floor Too Dim :___:___:___:___:___:___:___: Too Bright

e. Room Overall Too Dim :___:___:___:___:___:___:___: Too Bright

f. Light Fixture Too Dim :___:___:___:___:___:___:___: Too Bright

8. How do you usually arrange the window blinds/curtains? ? No blinds/curtains in classroom.

   a. Never Open, Sometimes Open, Open In Morning Only, Open In Afternoon Only, Always Open

   b. What percentage of classroom time do you close the window blinds/curtains for:

   Too much sun _____, Simple light reduction _____, Exterior distraction _____,

   Reading time _____, Relaxation time _____, Overhead projection _____,

   LCD projection from computer _____, TV_____, Other _____.

9. Please evaluate your experience with the current lighting system.

   a. Inconvenient : ___:___:___:___:___:___:___: Convenient

   b. Glaring : ___:___:___:___:___:___:___: Non-Glaring

   c. Poor Quality : ___:___:___:___:___:___:___: High Quality

   d. Boring : ___:___:___:___:___:___:___: Exciting

10. When and why do you use the Uplight option (general instruction, reading, relaxation, A/V presentations, etc)?

    a. _____ _____

11. When and why do you use the Downlight option (general instruction, reading, relaxation, A/V presentations, etc)?

    a. _____ _____

12. When and why do you use the Dimmer option (general instruction, reading, relaxation, A/V presentations, etc)?

    a. _____ _____

13. Please indicate your overall impression of the lighting and lighting control in your classroom.

    a. Dissatisfied :___:___:___:___:___:___:___: Satisfied

    b. Not Energy Efficient :___:___:___:___:___:___:___: Energy Efficient
    Don't know:_____

    c. User Unfriendly :___:___:___:___:___:___:___: User Friendly

14. Do you have any additional comments about the lighting in your classroom that you want to share?

_____ _____

_____ _____

_____
_____
_____
_____
_____
_____

Thank you.

Please return this questionnaire in the attached preaddressed and stamped envelope.

APPENDIX E: CLASSROOM LIGHTING TEMPLATES

FINELITE

ICLS Lighting Template

30′x32′ Classroom, 2-Row, No Whiteboard Luminaire

SITE INFORMATION

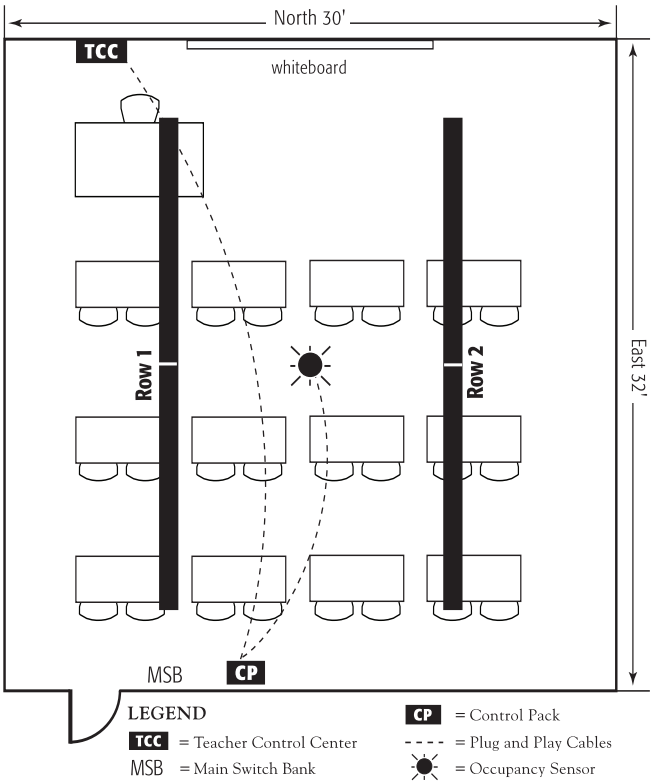
Dimensions:	30′ x 32′ (960 sq. ft.)
Daylight Contribution:	None
Ceiling Height:	10′
Whiteboard Dimensions:	4′ x 12′
Reflectances:	80/50/20
Fixture Suspension:	21″
Row Centers:	14′
Lamp Lumens:	3100
Light Loss Factor:	0.75
Ballast Factor:	1.18

EQUIPMENT LIST

Description – ICLS system with (2) 24′ rows of Series 10 with parabolic louver, and a 2-row non-dimming Plug and Play control package with no daylight control options.

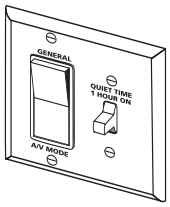
(2) 24′ Series 10 luminaire with semi-specular Parabolic Louver
(1) Teacher Control Center
(1) Dual Technology Occupancy Sensor
(1) Control Pack
(1) Row Pack
(1) Expansion Pack
(2) 50′ Plug and Play cables
(2) 2′ Plug and Play cables

INTEGRATED CLASSROOM LIGHTING SYSTEM



CONTROL STRATEGIES

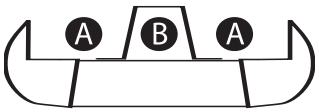
TCC - Teacher Control Center



The Teacher Control Center provides clear, simple scene control.

Quiet Time—momentary switch overrides occupancy sensor for one hour.

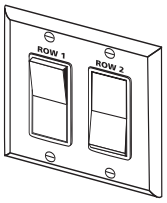
Lighting Modes



General Mode: Activates A
Disconnects B

A/V Mode: Activates B
Disconnects A

MSB - Main Switch Bank



The Main Switch Bank provides manual row control.

ICLS Integrated Classroom Lighting System

The ICLS system results in superior energy savings. The chart (right) shows the yearly energy savings compared to other energy design standards. In addition to the ICLS energy load design goal, the Average Usage number was developed from empirical data gathered from our multi-year study of 30 classrooms. The ICLS system can be run in either General (2T8) or A/V (1T8) mode but not both. The net affect energy load is less than the design goal.

ANNUAL SYSTEM ENERGY SAVINGS

Energy Savings	ICLS Avg. Usage 0.8 w/ft.^{2}	ICLS Design Goal 1.0 w/ft.^{2}	Title 24 (2005) 1.2 w/ft.^{2}	Ashrae 90.1 (2004) 1.4 w/ft.^{2}
Cost/year	$135.17	$168.96	$202.75	$236.54
Savings**	$101.38	$67.58	$33.79	–

Assumptions
960 sq. ft. classroom • 200 days/school yr • 8 hrs of operation/day • $0.11/kwh
** Savings per Classroom per year vs. Ashrae 90.1

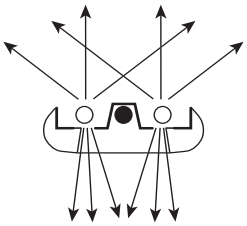
Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

ICLS Lighting Template

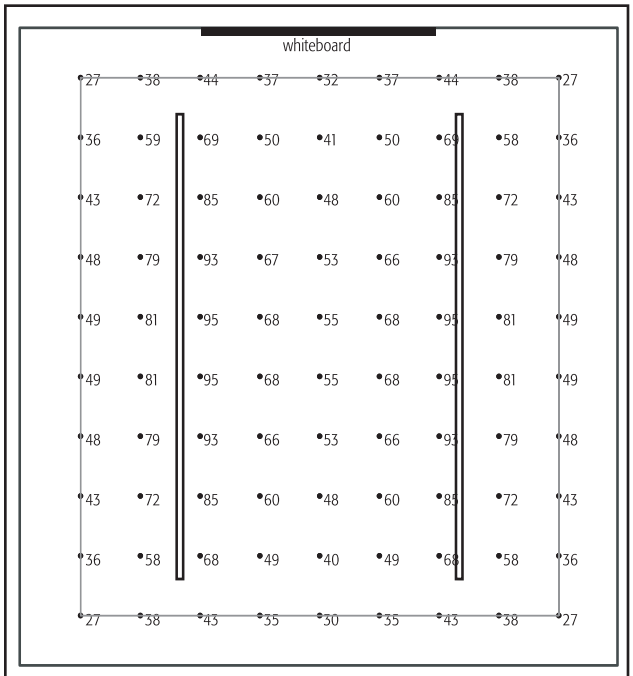
30′x32′ Classroom, 2-Row, No Whiteboard Luminaire

GENERAL MODE



Luminaire will:

- Provide appropriate balance of uplight and downlight.
- Minimize direct glare.
- Evenly light the ceilings and walls.

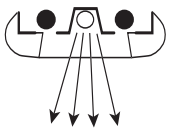


PLAN: Classroom work plane Illuminance

25	24	23	23	22	21	21	21	22	23	23	24	25	
26	26	25	24	24	23	23	23	24	24	25	25	26	
28	27	26	25	25	24	24	24	25	25	26	27	28	
29	27	26	26	25	24	24	24	25	26	26	27	29	
29	28	26	26	25	25	24	25	25	26	26	28	29	

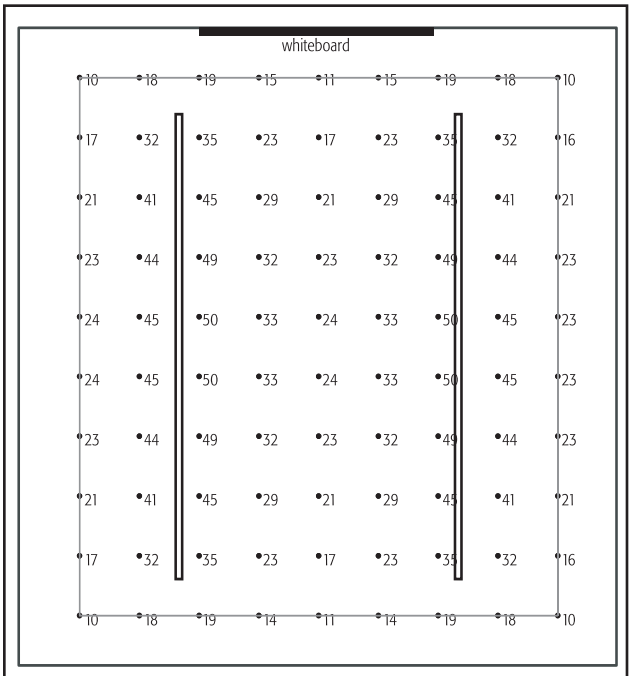
Whiteboard Illumination

A/V MODE



Luminaire will:

- Direct 100% of light downward.
- Minimize fc levels and veiling reflections on A/V screen for excellent contrast.
- Provide appropriate fc levels on desks for note taking.



PLAN: A/V Classroom work plane Illuminance

5	5	5	5	5	4	4	4	5	5	5	5	5	
5	5	5	5	5	5	5	5	5	5	5	5	5	
8	8	7	6	5	5	5	5	5	6	7	8	8	
10	10	8	7	6	5	5	5	6	7	8	10	10	
11	10	9	8	7	7	6	7	7	8	9	10	11	

A/V Whiteboard Illumination

ILLUMINANCE SUMMARY

ICLS Integrated Classroom Lighting System

	General Mode	A/V Mode
Avg. Horizontal FC	58.3	29.0
Avg. Vertical FC North Wall	22.1	6.16
Avg. Vertical FC Whiteboard	25.0	7.37
Avg. Vertical FC East Wall	25.0	6.34
W/ Sq. Ft.	0.98	0.44

Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

ICLS Lighting Template

30'x32' Classroom, 2-Row, With Whiteboard Luminaire

SITE INFORMATION

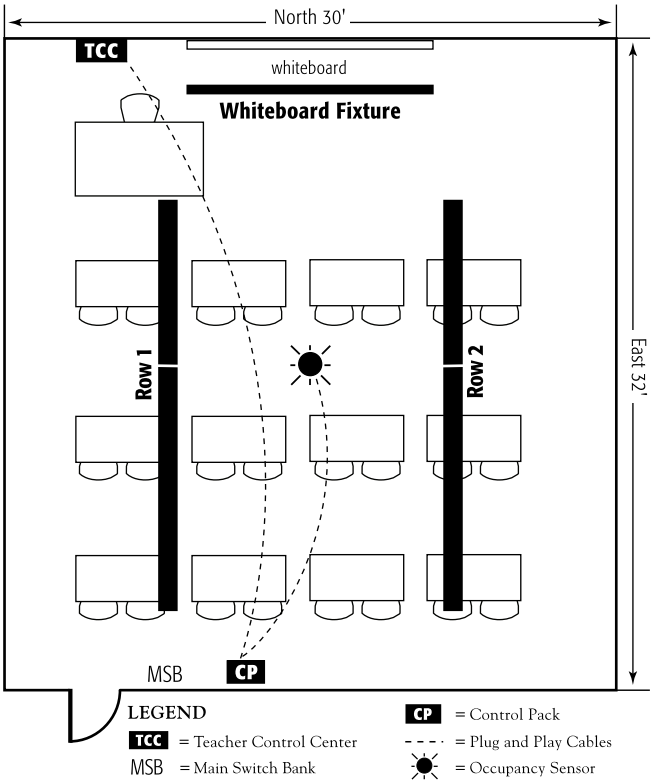
Dimensions:	30' x 32' (960 sq. ft.)
Daylight Contribution:	None
Ceiling Height:	10'
Whiteboard Dimensions:	4' x 12'
Reflectances:	80/50/20
Fixture Suspension:	21"
Row Centers:	14'
Lamp Lumens:	3100
Light Loss Factor:	0.75
Ballast Factor Series 10:	1.18
Ballast Factor Series X2:	0.88

EQUIPMENT LIST

Description – ICLS system with (2) 20' rows of Series 10 with parabolic louver, (1) 12' Series X2 Whiteboard luminaire, and a non-dimming Plug and Play control package with no daylight control options.

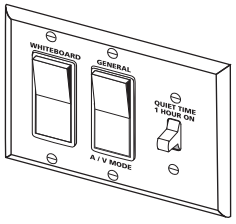
(2) 20' Series 10 luminaire with semi-specular Parabolic Louver
(1) 12' Series X2 Whiteboard luminaire
(1) Teacher Control Center
(1) Dual Technology Occupancy Sensor
(1) Control Pack
(1) Row Pack
(1) Expansion Pack
(2) 50' Plug and Play cables
(3) 2' Plug and Play cables
(1) Whiteboard Pack

INTEGRATED CLASSROOM LIGHTING SYSTEM



CONTROL STRATEGIES

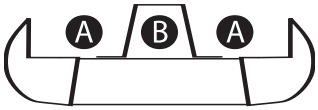
TCC - Teacher Control Center



The Teacher Control Center provides clear, simple scene control.

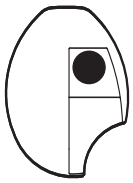
Quiet Time—momentary switch overrides occupancy sensor for one hour.

Lighting Modes



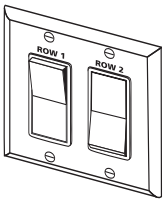
General Mode: Activates A
Disconnects B

A/V Mode: Activates B
Disconnects A



Whiteboard: Activates luminaire for added fc levels on whiteboard.

MSB - Main Switch Bank



The Main Switch Bank provides manual row control.

The ICLS system results in superior energy savings. The chart (right) shows the yearly energy savings compared to other energy design standards. In addition to the ICLS energy load design goal, the Average Usage number was developed from empirical data gathered from our multi-year study of 30 classrooms. The ICLS system can be run in either General (2T8) or A/V (1T8) mode but not both. The net affect energy load is less than the design goal.

ANNUAL SYSTEM ENERGY SAVINGS

Energy Savings	ICLS Avg. Usage 0.8 w/ft.^{2}	ICLS Design Goal 1.0 w/ft.^{2}	Title 24 (2005) 1.2 w/ft.^{2}	Ashrae 90.1 (2004) 1.4 w/ft.^{2}
Cost/year	$135.17	$168.96	$202.75	$236.54
Savings**	$101.38	$67.58	$33.79	–

Assumptions
960 sq. ft. classroom • 200 days/school yr • 8 hrs of operation/day • $0.11/kwh
** Savings per Classroom per year vs. Ashrae 90.1

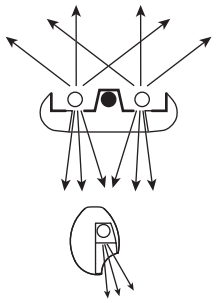
Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

ICLS Lighting Template

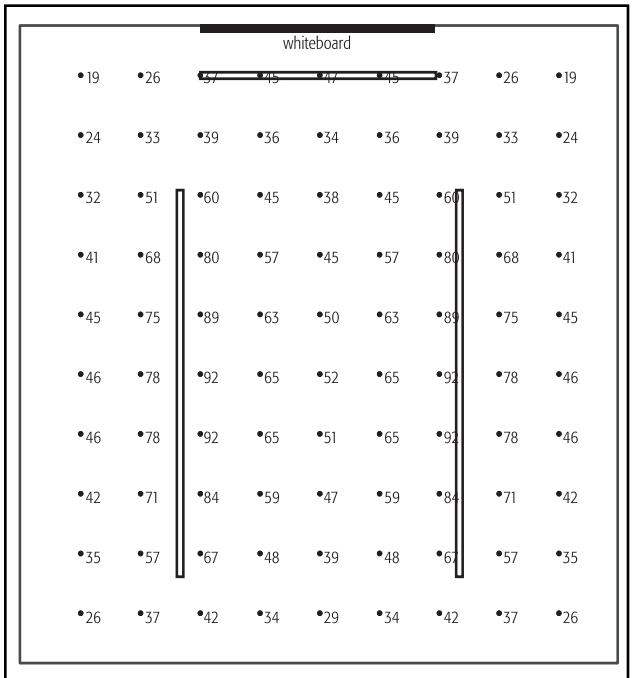
30'x32' Classroom, 2-Row, With Whiteboard Luminaire

GENERAL MODE with Whiteboard On

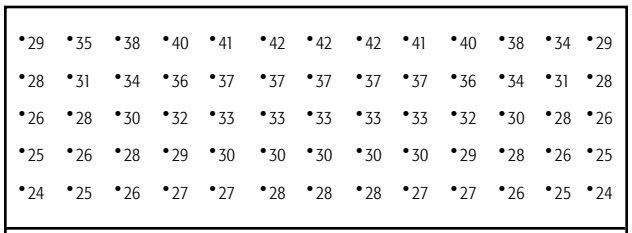


Luminaires will:

- Provide appropriate balance of uplight and downlight.
- Minimize direct glare.
- Evenly light the ceilings and walls.
- Increase fc levels on whiteboard.

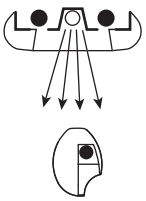


PLAN: CLASSROOM WORK PLANE ILLUMINANCE



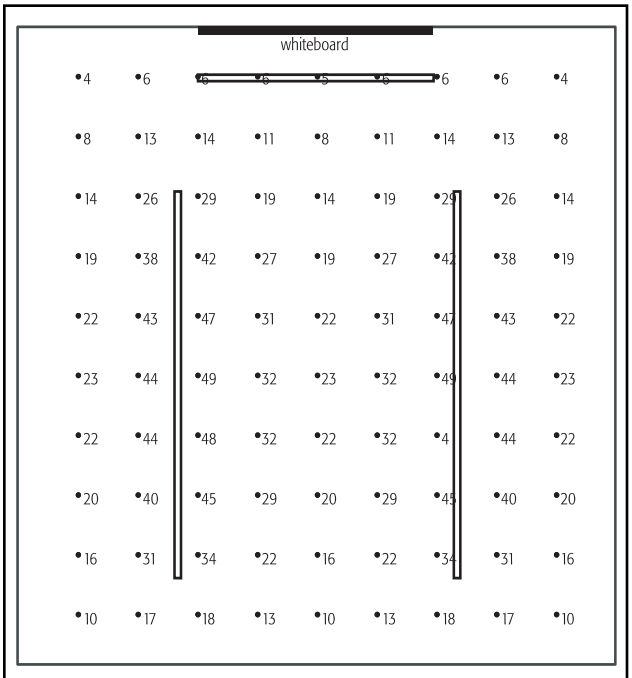
WHITEBOARD ILLUMINATION

A/V MODE with Whiteboard Off

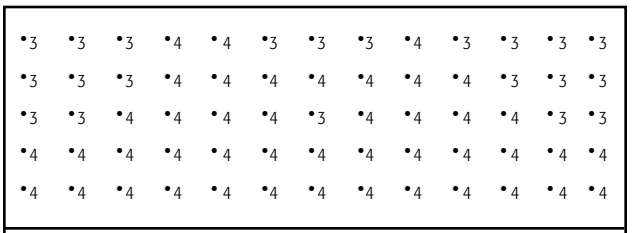


Luminaires will:

- Direct 100% of light downward.
- Minimize fc levels and veiling reflections on A/V screen for excellent contrast.
- Provide appropriate fc levels on desks for note taking.



PLAN: A/V CLASSROOM WORK PLANE ILLUMINANCE



A/V WHITEBOARD ILLUMINATION

ILLUMINANCE SUMMARY

	General Mode	A/V Mode
Avg. Horizontal FC	52.1	24.3
Avg. Vertical FC North Wall	20.5	3.73
Avg. Vertical FC Whiteboard	22.4	6.13
Avg. Vertical FC East Wall	31.4	3.65
W/ Sq. Ft.	0.91	0.40

Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

ICLS Lighting Template

28'x28' Classroom, 2-Row, No Whiteboard Luminaire

SITE INFORMATION

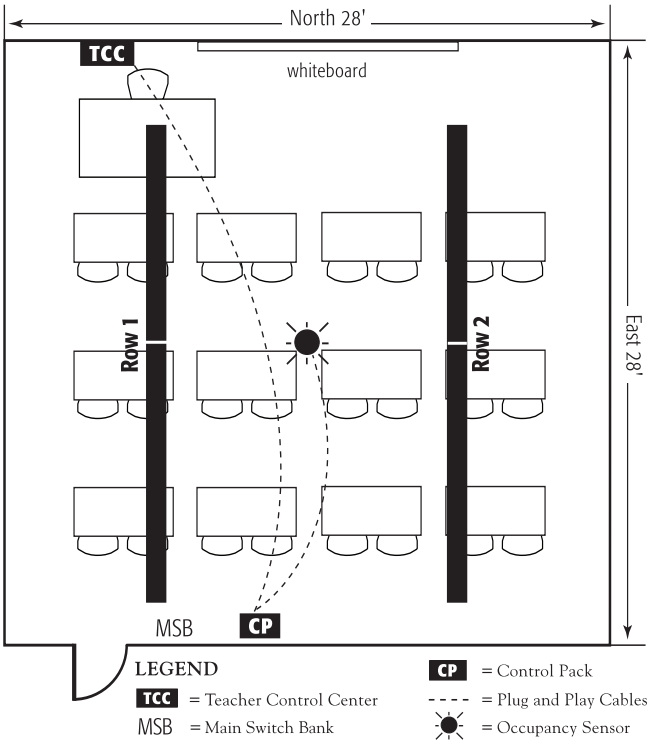
Dimensions:	28' x 28' (784 sq. ft.)
Daylight Contribution:	None
Ceiling Height:	10'
Whiteboard Dimensions:	4' x 12'
Reflectances:	80/50/20
Fixture Suspension:	21"
Row Centers:	14'
Lamp Lumens:	3100
Light Loss Factor:	0.75
Ballast Factor:	0.88

EQUIPMENT LIST

Description – ICLS system with (2) 24' rows of Series 10 with parabolic louver, and a 2-row non-dimming Plug and Play control package with no daylight control options.

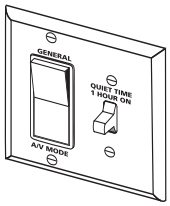
(2) 24' Series 10 luminaire with semi-specular Parabolic Louver
(1) Teacher Control Center
(1) Dual Technology Occupancy Sensor
(1) Control Pack
(1) Row Pack
(1) Expansion Pack
(2) 50' Plug and Play cables
(2) 2' Plug and Play cables

INTEGRATED CLASSROOM LIGHTING SYSTEM



CONTROL STRATEGIES

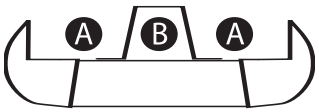
TCC - Teacher Control Center



The Teacher Control Center provides clear, simple scene control.

Quiet Time—momentary switch overrides occupancy sensor for one hour.

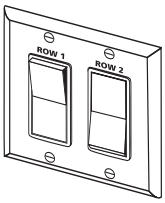
Lighting Modes



General Mode: Activates A
Disconnects B

A/V Mode: Activates B
Disconnects A

MSB - Main Switch Bank



The Main Switch Bank provides manual row control.

ICLS Integrated Classroom Lighting System

The ICLS system results in superior energy savings. The chart (right) shows the yearly energy savings compared to other energy design standards. In addition to the ICLS energy load design goal, the Average Usage number was developed from empirical data gathered from our multi-year study of 30 classrooms. The ICLS system can be run in either General (2T8) or A/V (1T8) mode but not both. The net affect energy load is less than the design goal.

ANNUAL SYSTEM ENERGY SAVINGS

Energy Savings	ICLS Avg. Usage 0.8 w/ft.²	ICLS Design Goal 1.0 w/ft.²	Title 24 (2005) 1.2 w/ft.²	Ashrae 90.1 (2004) 1.4 w/ft.²
Cost/year	$135.17	$168.96	$202.75	$236.54
Savings**	$101.38	$67.58	$33.79	–

Assumptions
960 sq. ft. classroom • 200 days/school yr • 8 hrs of operation/day • $0.11/kwh
** Savings per Classroom per year vs. Ashrae 90.1

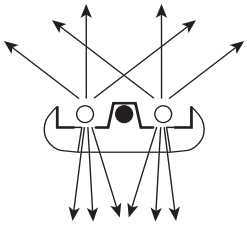
Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

ICLS Lighting Template

28'x28' Classroom, 2-Row, No Whiteboard Luminaire

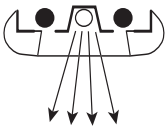
GENERAL MODE



Luminaire will:

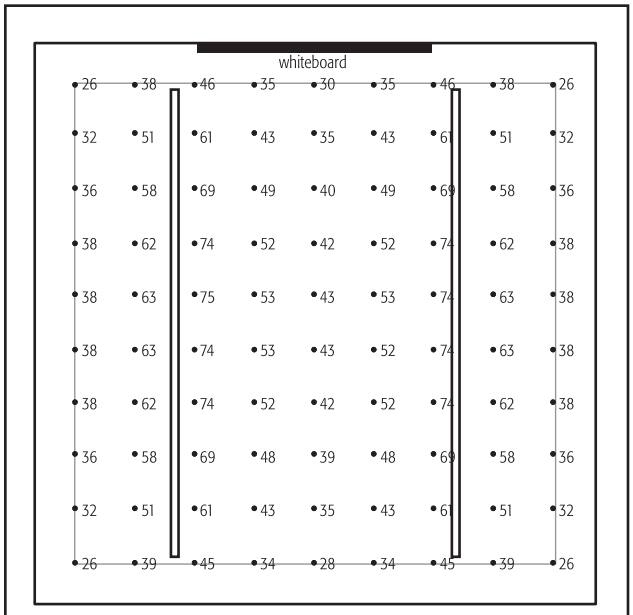
- Provide appropriate balance of uplight and downlight.
- Minimize direct glare.
- Evenly light the ceilings and walls.

A/V MODE

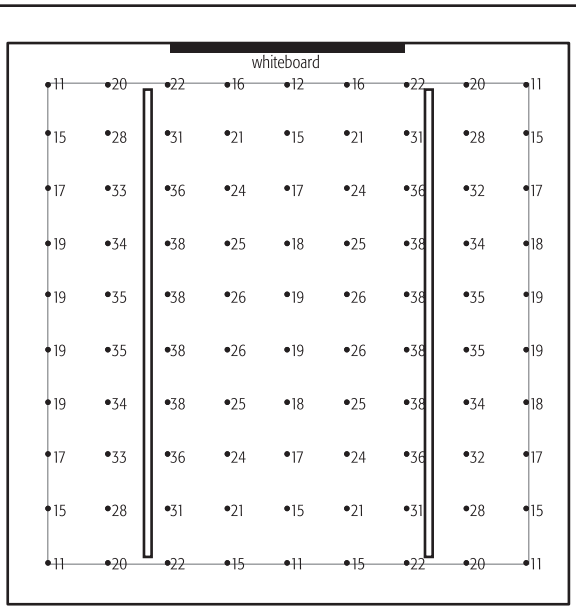


Luminaire will:

- Direct 100% of light downward.
- Minimize fc levels and veiling reflections on A/V screen for excellent contrast.
- Provide appropriate fc levels on desks for note taking.



PLAN: Classroom work plane Illuminance



PLAN: A/V Classroom work plane Illuminance

27	26	24	22	21	20	19	20	21	22	24	26	27
30	27	25	23	22	21	20	21	22	23	25	27	30
30	27	25	23	22	22	21	22	22	23	25	26	30
29	26	25	23	22	22	21	22	22	23	25	26	29
28	26	24	23	22	22	21	22	22	23	24	26	28

Whiteboard Illumination

6	5	5	4	4	4	4	4	4	4	4	5	6
12	9	6	5	4	4	4	4	4	5	6	9	12
13	10	8	6	5	5	4	5	5	6	8	10	13
13	11	9	7	6	5	5	5	6	7	9	11	13
12	11	9	8	7	6	6	6	7	8	9	11	12

A/V Whiteboard Illumination

ILLUMINANCE SUMMARY

	General Mode	A/V Mode
Avg. Horizontal FC	49.9	25.0
Avg. Vertical FC North Wall	23.2	6.7
Avg. Vertical FC Whiteboard	23.3	7.4
Avg. Vertical FC East Wall	23.9	7.1
W/ Sq. Ft.	0.87	0.54

Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

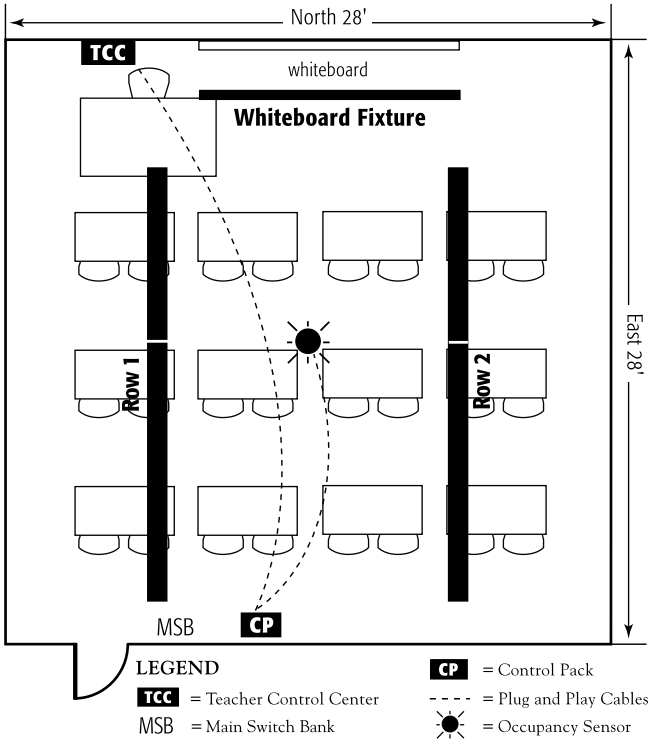
ICLS Lighting Template

28'x28' Classroom, 2-Row, With Whiteboard Luminaire

SITE INFORMATION

Dimensions:	28' x 28' (784 sq. ft.)
Daylight Contribution:	None
Ceiling Height:	10'
Whiteboard Dimensions:	4' x 12'
Reflectances:	80/50/20
Fixture Suspension:	21"
Row Centers:	14'
Lamp Lumens:	3100
Light Loss Factor:	0.75
Ballast Factor Series 10:	0.88
Ballast Factor Series X2:	0.88

INTEGRATED CLASSROOM LIGHTING SYSTEM



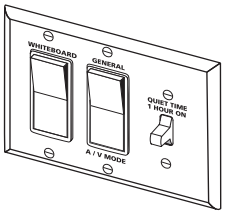
EQUIPMENT LIST

Description – ICLS system with (2) 20' rows of Series 10 with parabolic louver, (1) 12' Series X2 Whiteboard luminaire, and a non-dimming Plug and Play control package with no daylight control options.

(2) 20' Series 10 luminaire with semi-specular Parabolic Louver
(1) 12' Series X2 Whiteboard luminaire
(1) Teacher Control Center
(1) Dual Technology Occupancy Sensor
(1) Control Pack
(1) Row Pack
(1) Expansion Pack
(2) 50' Plug and Play cables
(3) 2' Plug and Play cables
(1) Whiteboard Pack

CONTROL STRATEGIES

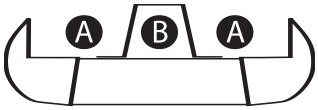
TCC - Teacher Control Center



The Teacher Control Center provides clear, simple scene control.

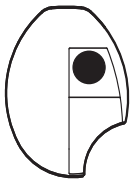
Quiet Time—momentary switch overrides occupancy sensor for one hour.

Lighting Modes



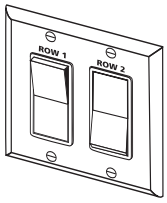
General Mode: Activates A
Disconnects B

A/V Mode: Activates B
Disconnects A



Whiteboard: Activates luminaire for added fc levels on whiteboard.

MSB - Main Switch Bank



The Main Switch Bank provides manual row control.

ICLS Integrated Classroom Lighting System

The ICLS system results in superior energy savings. The chart (right) shows the yearly energy savings compared to other energy design standards. In addition to the ICLS energy load design goal, the Average Usage number was developed from empirical data gathered from our multi-year study of 30 classrooms. The ICLS system can be run in either General (2T8) or A/V (1T8) mode but not both. The net affect energy load is less than the design goal.

ANNUAL SYSTEM ENERGY SAVINGS

Energy Savings	ICLS Avg. Usage 0.8 w/ft.²	ICLS Design Goal 1.0 w/ft.²	Title 24 (2005) 1.2 w/ft.²	Ashrae 90.1 (2004) 1.4 w/ft.²
Cost/year	$135.17	$168.96	$202.75	$236.54
Savings**	$101.38	$67.58	$33.79	–

Assumptions
960 sq. ft. classroom • 200 days/school yr • 8 hrs of operation/day • $0.11/kwh
** Savings per Classroom per year vs. Ashrae 90.1

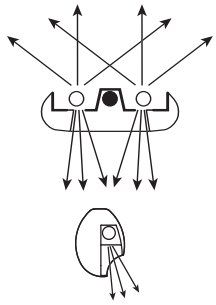
Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

FINELITE

ICLS Lighting Template

28'x28' Classroom, 2-Row, With Whiteboard Luminaire

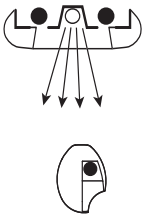
GENERAL MODE with Whiteboard On



Luminaires will:

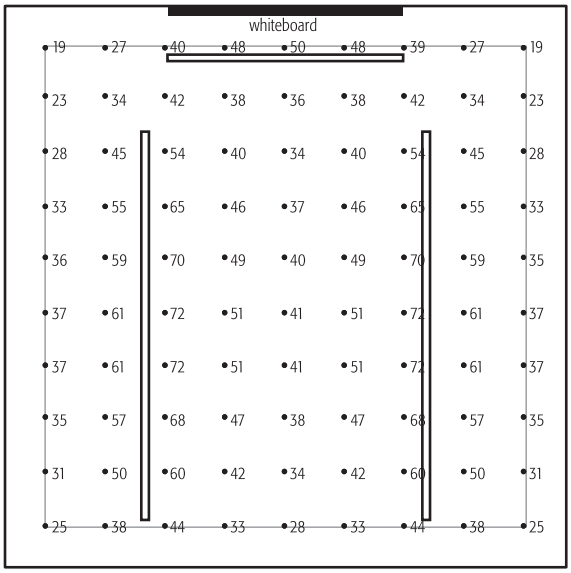
- Provide appropriate balance of uplight and downlight.
- Minimize direct glare.
- Evenly light the ceilings and walls.
- Increase fc levels on whiteboard.

A/V MODE with Whiteboard Off

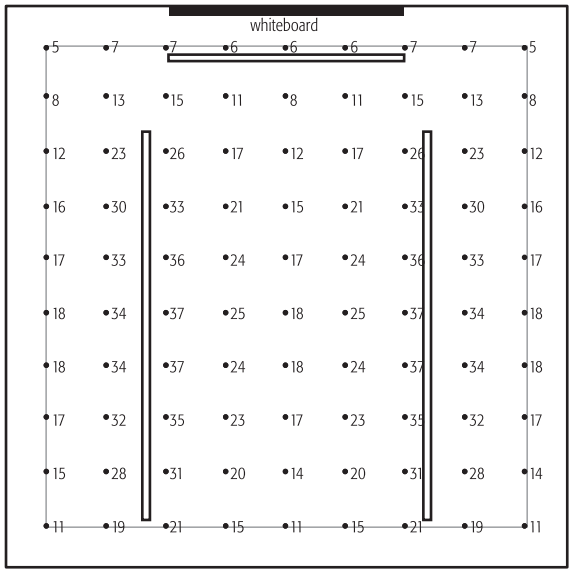


Luminaires will:

- Direct 100% of light downward.
- Minimize fc levels and veiling reflections on A/V screen for excellent contrast.
- Provide appropriate fc levels on desks for note taking.



PLAN: Classroom work plane Illuminance



PLAN: A/V Classroom work plane Illuminance

30	35	39	40	41	42	41	42	41	40	38	35	30
28	31	34	35	36	37	37	37	36	35	34	31	28
26	28	30	31	32	33	32	33	32	31	30	28	26
25	27	28	28	29	29	29	29	29	28	28	26	25
24	25	26	26	27	27	27	27	27	26	26	25	24

Whiteboard Illumination

3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	3	3	3	3	3	4	4	4	4
5	5	4	4	4	4	4	4	4	4	4	5	5
6	6	5	5	4	4	4	4	4	5	5	6	6

A/V Whiteboard Illumination

ILLUMINANCE SUMMARY

ICLS Integrated Classroom Lighting System

	General Mode	A/V Mode
Avg. Horizontal FC	45.9	21.1
Avg. Vertical FC North Wall	21.1	4.01
Avg. Vertical FC Whiteboard	21.2	6.05
Avg. Vertical FC East Wall	31.1	3.89
W/ Sq. Ft.	0.84	0.37

Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

APPENDIX F: MANUFACTURER LITERATURE

ICLS Specification Manual

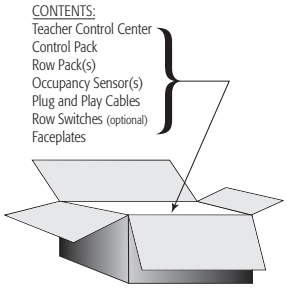
FINELITE

Better Lighting For A Better Workplace

Integrated Classroom
ICLS
Lighting System

Integrated Classroom Lighting System

The Integrated Classroom Lighting System **(ICLS)** is designed for use in general-purpose classrooms at the K-12 through university level. Further, ICLS has applications in a wide range of conference rooms and multi-purpose rooms found in commercial facilities. ICLS incorporates high quality indirect/direct luminaires with unique controls to improve lighting quality, deliver two distinct lighting modes, and reduce energy.



Controls Package

Finelite Services

Finelite set the standard for service in the linear lighting market. ICLS is supported by new levels of service developed with the school construction market in mind.

Controls Packages

All the controls for each classroom are packaged together and typed by classroom for faster installation. Control Packages include the Teacher Control Center, Control Pack, Row Pack(s), Occupancy Sensor(s), Plug and Play cables, optional Row Switches and all the necessary face plates. Specify voltage.

Layout Design

Finelite inside sales teams are available to layout your project to ensure it meets recommended classroom lighting practices and will assist in driving your project to attain energy loads of 1 w/ft^2.

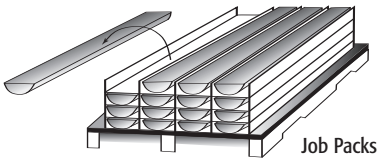
100%
TESTED

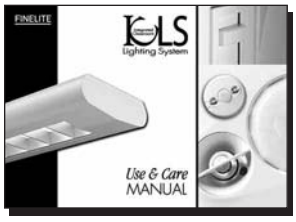
100% Tested

Finelite tests each project 100% as a system before shipping them to your job site. This saves you time and money.

Job Packs

By request, Finelite will ship your project on cardboard saddles. Eliminating cartons improves installation times and reduces jobsite waste.


Job Packs



Use & Care Manual

Use and Care Manual

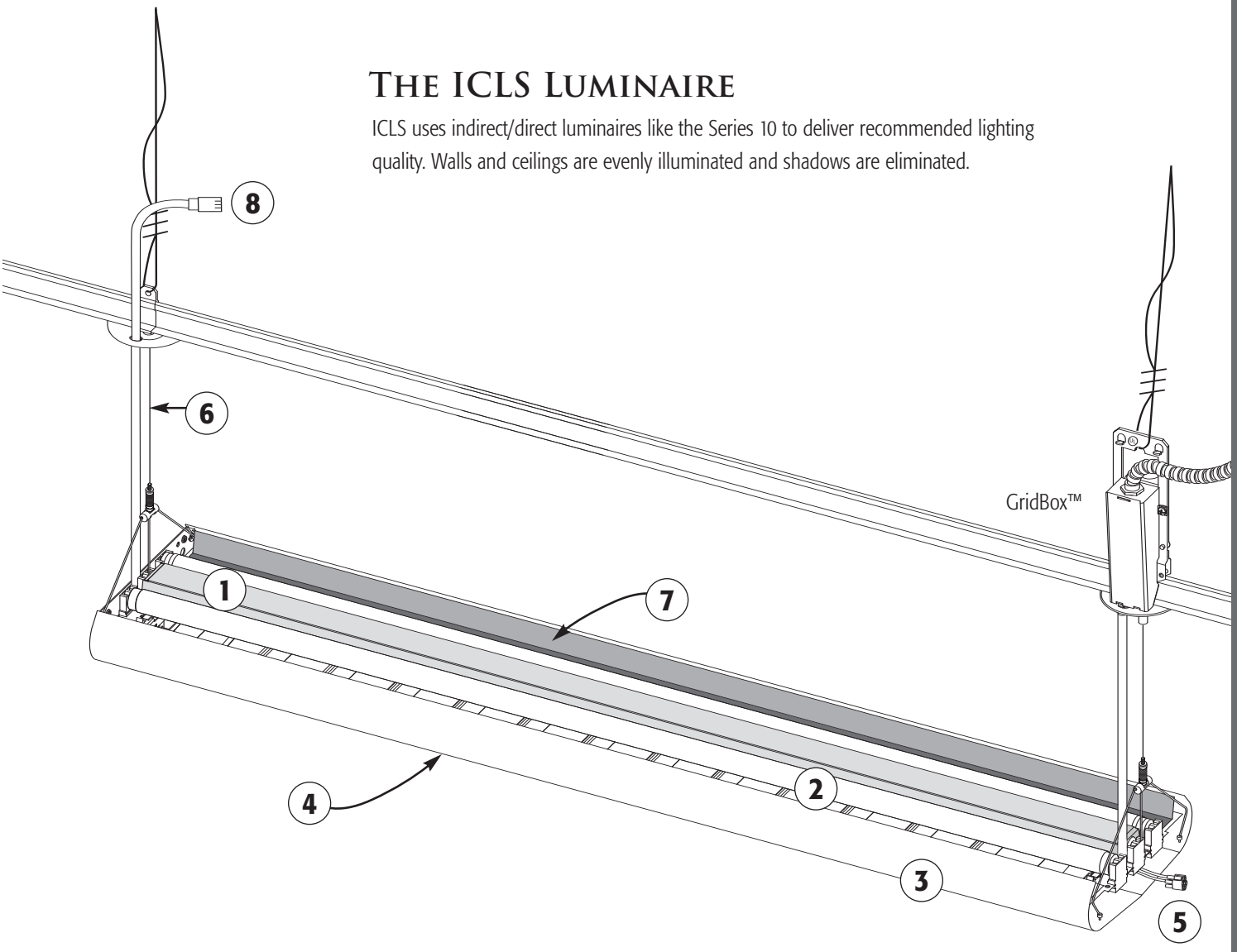
Every classroom will include an ICLS Use and Care Manual, clearly detailing how the system works, how to maximize energy savings, and how to troubleshoot the system. A clear plastic sleeve is included, and we suggest locating it directly below the Teacher Control Center.

Single Source Warranty

In addition to the Finelite fixture warranty, we will provide a single source warranty on all ICLS electronic and interconnection components for a period of 5 years. Finelite will coordinate repairs and directly pass through to the unique part manufacturers as required. See *www.finelite.com* for full warranty details. Lamps will be covered with a 2-year pass through warranty to the manufacturer.

The ICLS Luminaire

ICLS uses indirect/direct luminaires like the Series 10 to deliver recommended lighting quality. Walls and ceilings are evenly illuminated and shadows are eliminated.



1 Controlled Center Optics

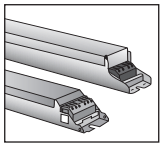
- 96% reflective paint for maximum efficiency
- Directs 100% of light down in A/V mode

2 Lamps

- 3100 lumen XPS T8 lamps
- High efficacy lamps feature excellent lumen maintenance and maximize energy savings

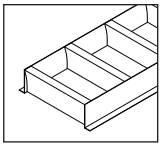
3 Ballasts

- High ballast factor ballasts
- Increases light output without affecting lamp life
- Different ballast factor ballasts can be used to balance energy usage and light output
- ICLS is available with 0.77, 0.88, and 1.18 ballast factor electronic ballasts



4 Louver

- Semi-Specular parabolic louver
- Excellent shielding – prevents glare



5 Wiring

- Pre-wired luminaires for easy installation
- Plug-together wiring ensures proper connection

6 Aircraft Cable

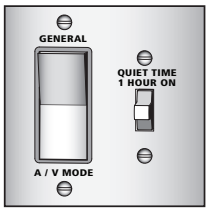
- Semi-adjustable and fully adjustable aircraft cable available
- Standard cable load is 480 lbs.
- Optional cable load of 920 lbs. is available (fully adjustable only)
- Fully adjustable cable includes standard safety bar for added security

7 EP Reflectors

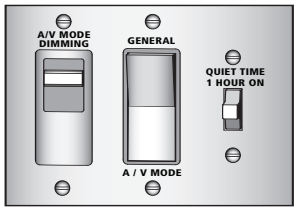
- Highly specular side reflectors enhance performance

8 Dimming Plug and Play

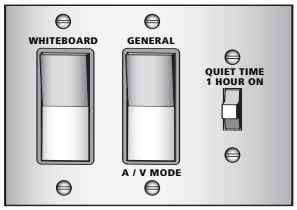
- Optional dimming features plug and play connections
- The plug is quickly and easily connected to the ICLS system above the ceiling
- Plug and play wiring is provided by Finelite



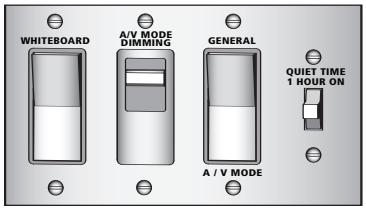
TCC



TCC with A/V Dimming

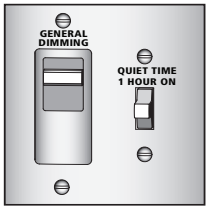


TCC with Whiteboard

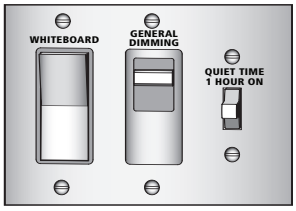


TCC with A/V Dimming & Whiteboard

Whiteboard



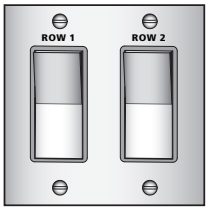
General Dimming with Quiet Time



General Dimming with Whiteboard & Quiet Time

ROW CONTROLS are available in the following configurations.

- 2 & 3 Row Control
- 2 & 3 Row Control with Whiteboard



2 Row Control

Teacher Control Center (TCC)

The easy-to-use control provides the ability to switch from General Mode to A/V Mode. The standard features include:

- Quiet Time Switch – Bypasses the occupancy sensor for 1 hour to prevent false negatives during periods of limited movement.
- Laser Etched Face Plates – Switch labels are laser etched into the face plates for enhanced durability.
- Fully Assembled – The TCC arrives at the jobsite fully assembled. Plug-together wiring connects the assembly to the system.
- A/V Switch – 3-way specification grade decorator, white
- Back Box Dimensions – Two gang box, 2" deep

TCC with A/V dimming

Add the ability to dim the center lamp during A/V presentations for added control.

- Attractive Decora style dimmer
- Designed for 0-10v dimming ballasts
- Dims from 100% – 5% light output
- Back Box Dimension – Three gang box, 2" deep

TCC with Whiteboard

Add the ability to control secondary lighting systems such as a whiteboard luminaire.

- A/V Switch – 3-way 120/277v specification grade decorator, white
- Whiteboard Switch – 3-way 120/277v specification grade decorator, white
- Back Box Dimensions – Three-gang box, 2" deep

TCC with A/V Dimming and Whiteboard

Combine the ability to dim the A/V lamp and control a secondary lighting system.

- Dimmer – Decora style dimmer. Specify 120v or 277v.
- A/V Switch – 3-way 120/277v specification grade decorator, white
- Whiteboard Switch - 3-way 120/277v specification grade decorator, white
- Back Box Dimensions – Four-gang box, 2" deep

Optional Whiteboard Switch

A separate line voltage whiteboard switch is available for specification.

- Whiteboard Switch – 3-way 120/277v specification grade decorator, white
- Back Box Dimensions – Single 2" x 4" box, 2" deep

General Dimming with Quiet Time

This option adds the ability to use dimming as the primary A/V control and is designed for use with daylight dimming strategies.

- Dimmer – Decora style dimmer. Specify 120v or 277v.
- Designed for 0-10V dimming ballasts
- Dims from 100%- 5% light output
- Back box Dimensions – Two gang box, 2" deep

General Dimming with Whiteboard and Quiet Time

Add the optional control for a secondary luminaire such as a whiteboard luminaire.

- Dimmer – Decora style dimmer. Specify 120v or 277v
- Whiteboard Switch - 3-way 120/277v specification grade decorator, white
- Back box Dimensions – Three-gang box, 2" deep

Row Control

ICLS accommodates row control at primary entrances.

- Optional Finelite supplied switches and face plates

continued.

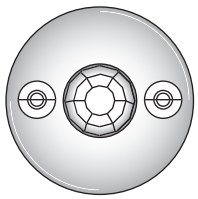
Master Room Control

- Optional laser etched face plates
- 3-way switches are wired into system according to normal practices
- Switches – 3-way 120/277v specification grade decorator, white
- Individual rows can be controlled for manual daylight control

Master Room Control

Provides optional on/off control for all rows and supplemental lighting. Located at the primary entrance.

- 3-way 120/277v specification grade decorator, white



Occupancy Sensor

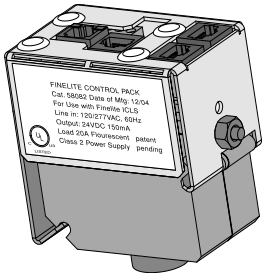
Occupancy Sensor

Low profile, ceiling mounted, dual technology occupancy sensor uses passive infrared (PIR) and ultrasonic technologies to detect room occupancy.

- 360º coverage pattern
- Coverage: PIR = 38', Ultrasonic = 40'

Factory Calibration:

- PIR and Ultrasonic are both required to turn the lights on and either technology keeps them on.
- Unit will turn the lights off when the room is unoccupied for 10 minutes.
  If a junction box is required or desired use a 4" octagonal box that is 1½" deep.

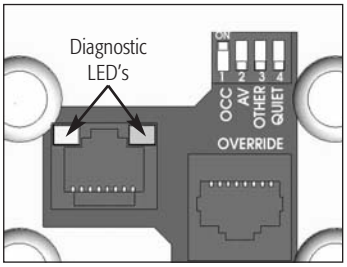


Control Pack

Control Pack

The Control Pack uses a proprietary printed circuit board to communicate with and deliver power to the sensors and relays.

- OmniPort design enables any component to be plugged into any port
- UL 2043 plenum rated plastic
- ½" nipple snaps into junction box for easy installation
- Available in 120v or 277v
- Delivers secondary voltage of 24VDC
- Dimensions 3.25" x 3.25" x 2"
- Contains (4) RJ45 connection points



Control Pack Detail

The Control Pack includes override and status indicator LED's.

Override #1 – Overrides Occupancy Sensor to enable a unit to be replaced.

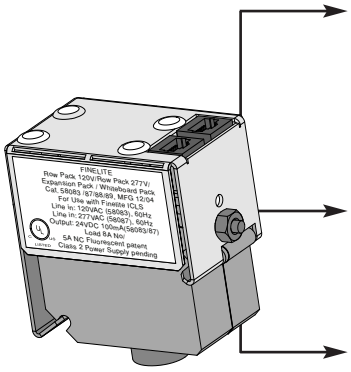
Override #2 – Forces the system into A/V mode, which allows the cables and TCC switch to be tested.

Override #3 – Turns on the supplemental classroom lighting. Typically this is the whiteboard luminaire.

Override #4 – Will activate the Quiet Time Switch for testing purposes.

Green diagnostic LED indicates unit is receiving power.

Yellow diagnostic LED indicates unit is receiving signals from occupancy sensor.



- Row Pack
- Expansion Pack
- Whiteboard Pack

Row Pack

The Row Pack provides power to sensors and relays in parallel with the Control Pack. The Row Pack contains a 3-way relay that controls the lighting mode choice *(A/V or General)*. The Row Pack is controlled by the Teacher Control Center. The Row Pack contains (2) RJ45 connection points. One Row Pack is included per classroom.

Expansion Pack

The Expansion Pack is similar to the Row Pack with the exception that it does not provide power to the sensors and relays. One Expansion Pack is required for a two-row installation and for each additional row.

Whiteboard Pack

The Whiteboard Pack contains a 3-way relay allowing the luminaire to be controlled via low voltage signal from the Teacher Control Center. The Whiteboard Pack contains (2) RJ45 connection points and is typically wired into the same box as the Control Pack and Row Pack.

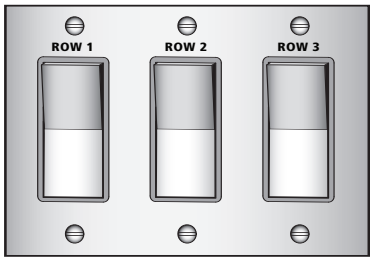
ICLS Installation Features

Low voltage plug and play wiring combined with patent pending protocol makes ICLS affordable and easy to install.

Control Pack / Row Pack

The Control Pack and Row Packs are easily attached to a four square junction box with extension ring. This unit should be placed near the row controls so building power can be brought to the system.

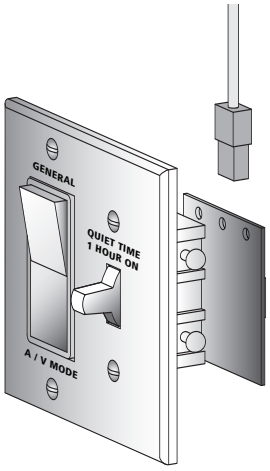
Low voltage wiring (supplied) is plugged in as shown above. Flex is brought from the junction box to each of the luminaire rows. See wiring diagrams on pages 8 and 9 for more information.



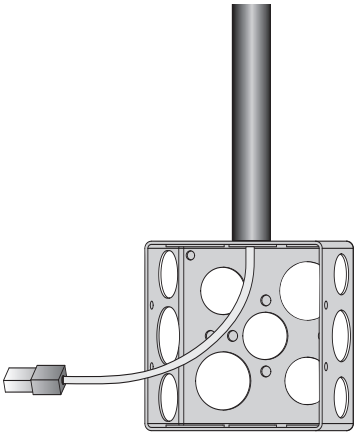
Row Switches

Row Switches are line voltage and are wired in the same manner as other Row Switches. All switches are standard 3-way to accommodate multiple location row switching.

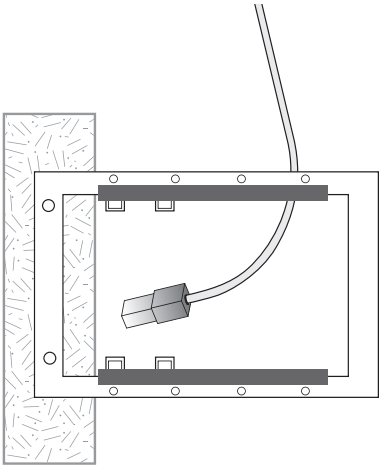
Teacher Control Center



The Teacher Control Center is easy to install. Simply plug in the low voltage wiring to the back of the TCC and mount the unit.



If conduit is required, the installer shall use ¾" conduit and use large radius bends to prevent kinks from forming in the cable.



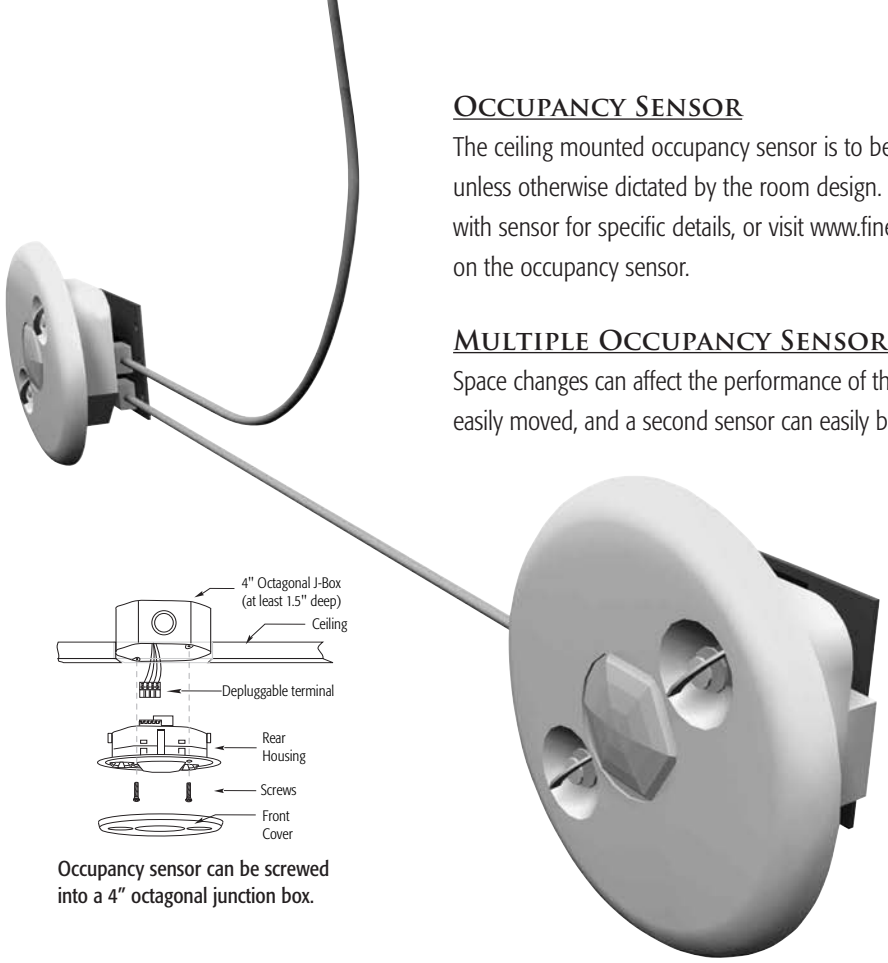
Network wiring brackets are a good solution for low voltage situations.

Occupancy Sensor

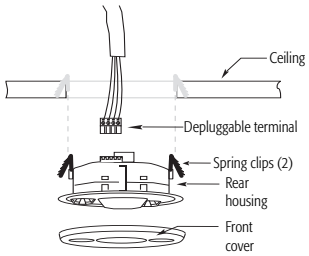
The ceiling mounted occupancy sensor is to be placed in the center of the room unless otherwise dictated by the room design. See installation instructions included with sensor for specific details, or visit www.finelite.com for more detailed information on the occupancy sensor.

Multiple Occupancy Sensors

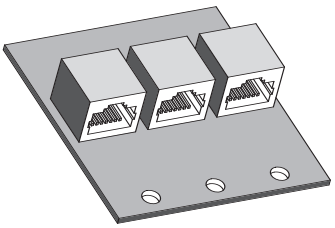
Space changes can affect the performance of the occupancy sensor. These sensors are easily moved, and a second sensor can easily be plugged directly into the other sensor.



Occupancy sensor can be screwed into a 4" octagonal junction box.



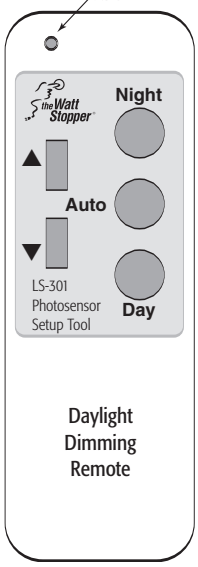
The occupancy sensor can be installed in the ceiling tile without a junction box. Spring clips are included with the sensor.



Low Voltage Splitter

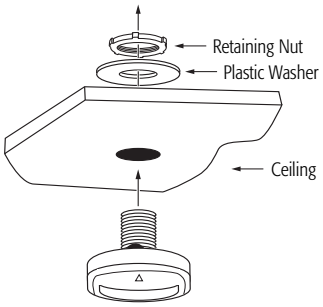
The low voltage splitter is included for ICLS systems using dimming. Low voltage plugs from the luminaire are simply plugged into the low voltage splitter.

Daylight Dimming Sensor

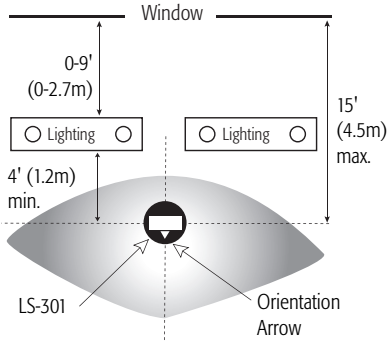


Daylight Dimming Remote

The optional daylight dimming sensor is ceiling mounted and features a closed loop system. The unit considers both daylight and electric light when adjusting the light levels. Photosensor adjustment is accomplished through the use of a handheld remote supplied with each unit. The sensor is plugged into its own low voltage dimming splitter.



Install as shown.



Place the unit as shown here.

ICLS Standard 2 Row Cost Example

The patented ICLS protocol makes installing the system easy. Row switches and luminaires are installed and wired per established practices. Control elements are connected via Finelite supplied plug and play cables.

Contractor Supplied Parts	Cost per Item	Total Cost
4" Sq. J-Box - CP/RP	$1.00 each	$1.00
4" Sq. Extender Ring - CP/RP	$0.65 each	$0.65
4" Sq. J-Box - TCC	$1.00 each	$1.00
4" Sq. J-Box - RS	$1.00 each	$1.00
J-Box Cover	4 @ $0.50 each	$2.00
50' of FC (power to fixtures)	$0.30 / ft	$15.00
FC Connectors	2 @ $0.25 each	$0.50
10' EMT (power to row switches)	$0.80 / ft.	$8.00
10' EMT (to run plug and play cable inside wall to TCC)	$0.80 / ft.	$8.00
EMT Connectors	2 @ $0.50 each	$1.00
Wirenuts	18 @ $0.05 each	$0.90
TOTAL COST OF CONTRACTOR SUPPLIED PARTS		**$39.05**

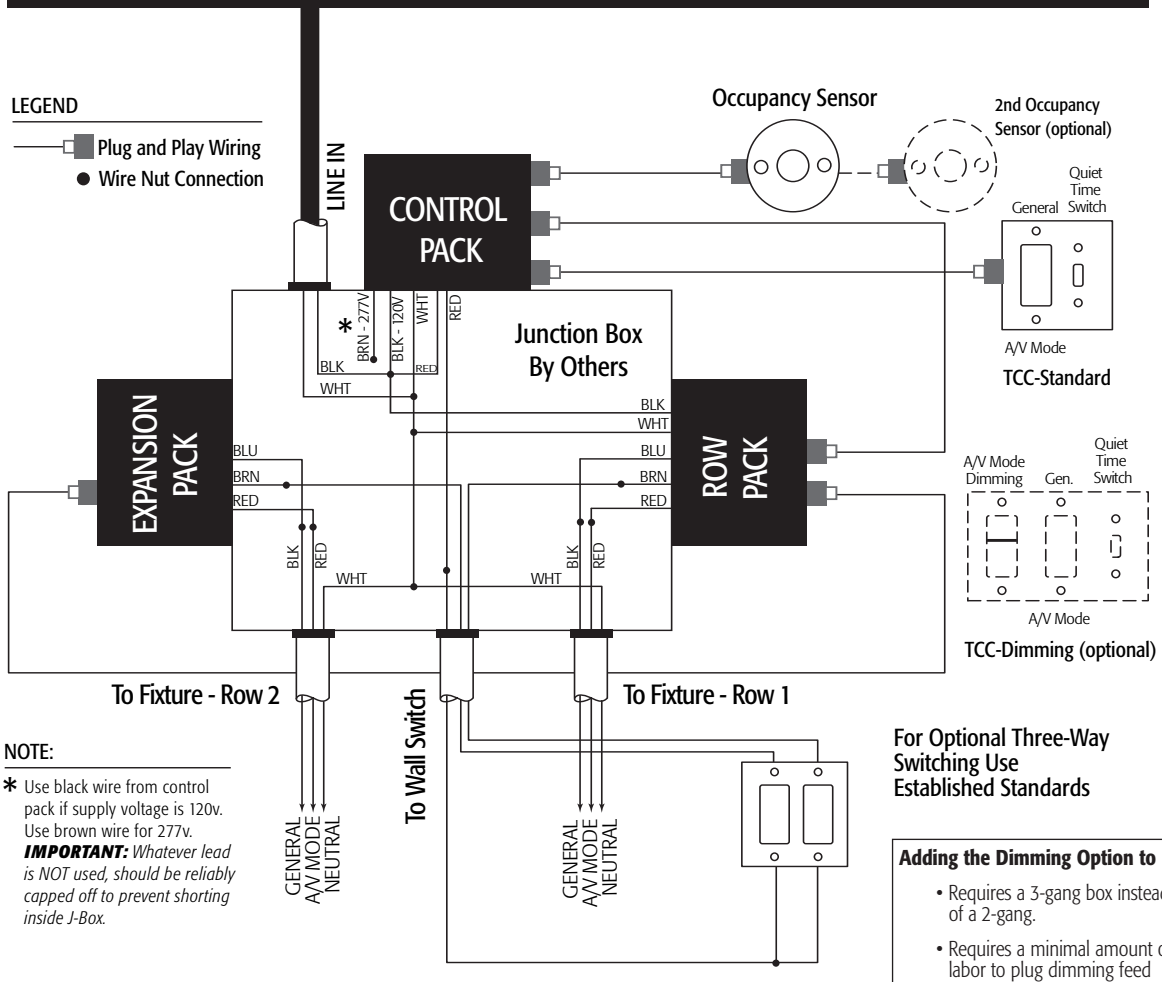
LEGEND:
CP/RP = Control Pack/Row Pack
FC = Flex Conduit
CP = Control Pack
EP = Expansion Pack
OS = Occupancy Sensor
TCC = Teacher Control Center
RMC = Electrical Metallic Tubing
RP = Row Pack
LV = Low Voltage Plug and Play

Contractor Supplied Labor	# of Operations	Qty: Minutes Per Operation	Total Time
Make Connections at Primary J-Box			
Connect J-Box to Line-in Conduit		45	45
Attach CP, RP, & EP	3 connections	5	15
Splice CP, RP, & EP	12 Splices	2.5	30
Connect flex for fixtures	2 connections	5	10
Connect EMT to RS	1 connection	10	10
Install Other Control Elements			
Install TCC, J-Box & EMT	1 Box	30	30
Install RS, J-Box, & EMT	1 Box	45	45
Connect LV wiring for system	4 Cables	5	20
Install Ceiling Mounted OS		30	30
TOTAL TIME INSTALLING CONTROL ELEMENTS			**235**
Installing Fixtures* – (2) 24' rows			
Install Suspension Points	6 Points	10 each	60
Install Fixtures	48 Feet	1.5 min / ft.	72
Wire Feeds into Gridbox™	2 Feeds	15 min each	30
TOTAL TIME INSTALLING FIXTURES			**162**
TOTAL INSTALLATION TIME			**397**
TOTAL LABOR COST @ $60 HR			**$397.00**

Notes: Line-In conduit not included in calculation.

***** See the Finelite Contractor Guide for more information on estimating fixture installation.

Standard 2 Row ICLS Wiring Detail



NOTE:

***** Use black wire from control pack if supply voltage is 120v. Use brown wire for 277v.
IMPORTANT: *Whatever lead is NOT used, should be reliably capped off to prevent shorting inside J-Box.*

For Optional Three-Way Switching Use Established Standards

Adding the Dimming Option to ICLS:

- Requires a 3-gang box instead of a 2-gang.
- Requires a minimal amount of labor to plug dimming feed (attached to fixture) to ICLS.

ICLS Standard 2 Row With Whiteboard Cost Example

Contractor Supplied Parts	Cost per Item	Total Cost
4" Sq. J-Box - CP/RP	$1.00 each	$1.00
4" Sq. Extender Ring - CP/RP	$0.65 each	$0.65
4" Sq. J-Box - TCC	$1.00 each	$1.00
4" Sq. J-Box - RS	$1.00 each	$1.00
J-Box Cover	4 @ $0.50 each	$2.00
75' of FC (power to fixtures)	$0.30 / ft	$22.50
FC Connectors	3 @ $0.25 each	$0.75
10' EMT (power to row switches)	$0.80 / ft.	$8.00
10' EMT (to run plug and play cable inside wall to TCC)	$0.80 / ft.	$8.00
EMT Connectors	2 @ $0.50 each	$1.00
Wirenuts	21 @ $0.05 each	$1.05
TOTAL COST OF CONTRACTOR SUPPLIED PARTS		**$46.95**

LEGEND:

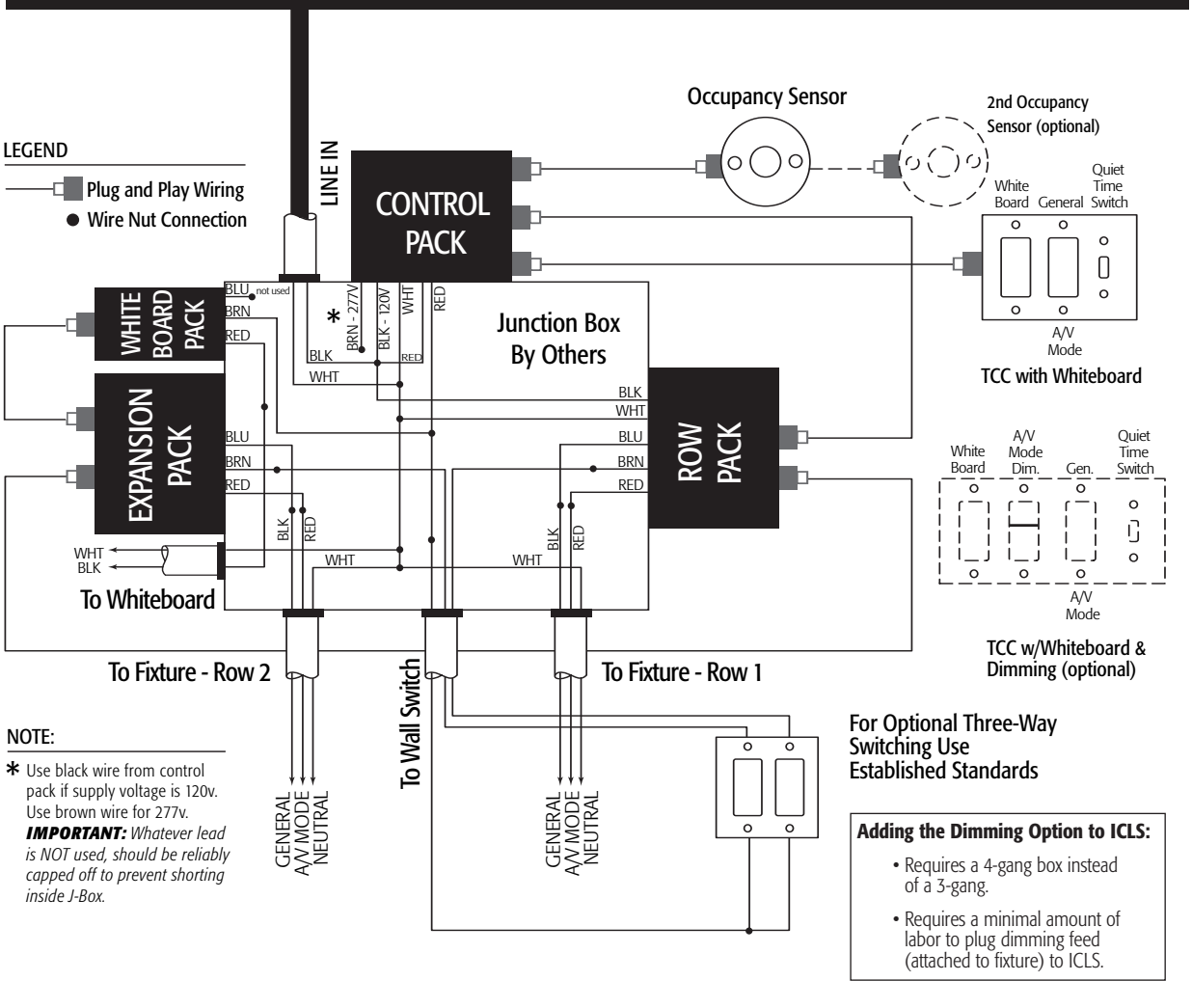
CP/RP = Control Pack/Row Pack
FC = Flex Conduit
CP = Control Pack
EP = Expansion Pack
OS = Occupancy Sensor
TCC = Teacher Control Center
RMC = Electrical Metallic Tubing
RP = Row Pack
LV = Low Voltage Plug and Play
WBP = Whiteboard Pack

Contractor Supplied Labor	# of Operations	Qty: Minutes Per Operation	Total Time
Make Connections at Primary J-Box			
Connect J-Box to Line-in Conduit		45	45
Attach CP, RP, EP & WBP	4 connections	5	20
Splice CP, RP, EP, & WBP	15 Splices	2.5	37.5
Connect flex for fixtures	3 connections	5	15
Connect EMT to RS & TCC	2 connections	10	20
Install Other Control Elements			
Install TCC, J-Box & EMT	1 Box	30	30
Install RS, J-Box, & EMT	1 Box	45	45
Connect LV wiring for system	4 Cables	5	20
Install Ceiling Mounted OS		30	30
TOTAL TIME INSTALLING CONTROL ELEMENTS			**262.5**
Installing Fixtures* – (2) 24' rows			
Install Suspension Points	8 Points	10 each	80
Install Fixtures	52 Feet	1.5 min / ft.	78
Wire Feeds into Gridbox™	3 Feeds	15 min each	45
TOTAL TIME INSTALLING FIXTURES			**203**
TOTAL INSTALLATION TIME			**465.5**
TOTAL LABOR COST @ $60 HR			**$465.50**

Notes: Line-In conduit not included in calculation.

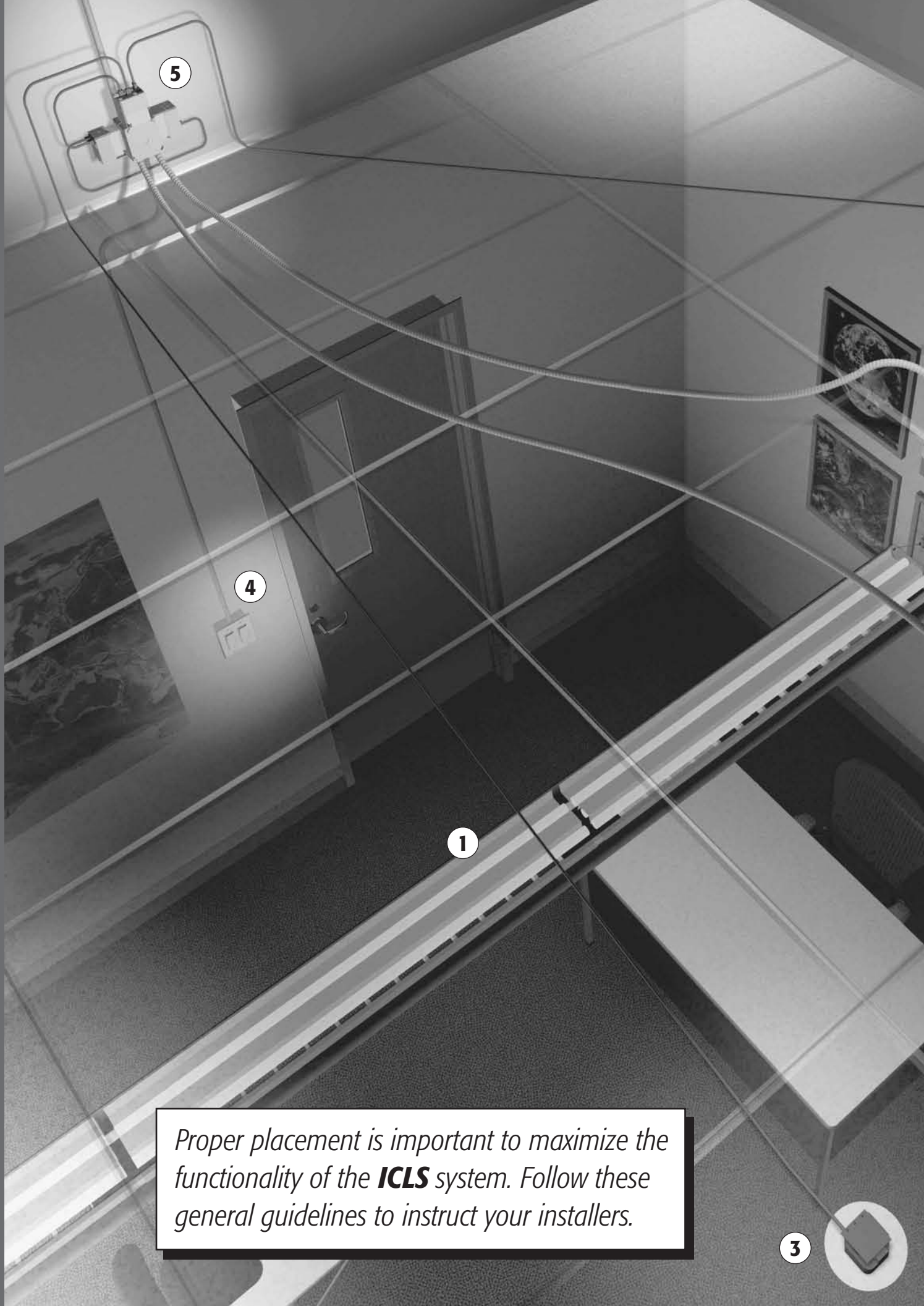
***** See the Finelite Contractor Guide for more information on estimating fixture installation.

Standard 2 Row ICLS with Whiteboard Wiring Detail



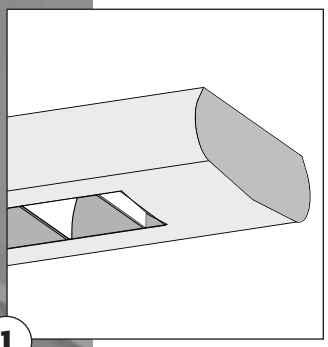
Adding the Dimming Option to ICLS:

- Requires a 4-gang box instead of a 3-gang.
- Requires a minimal amount of labor to plug dimming feed (attached to fixture) to ICLS.



*Proper placement is important to maximize the functionality of the **ICLS** system. Follow these general guidelines to instruct your installers.*

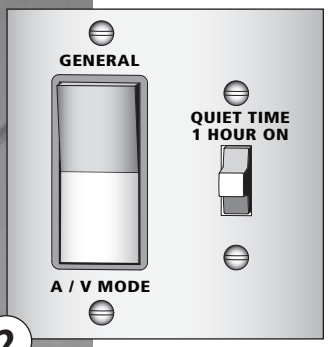
ICLS System Placement



1

Luminaires

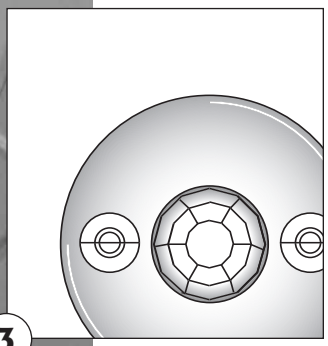
ICLS uses an indirect/direct luminaire to meet current recommended practices. The dual circuited luminaire has an efficiency of no less than 83% in the uplight and 57% in the downlight position. The luminaire uses a high reflectance (96-97%) painted white optical control device to direct light downward when in the A/V mode.



2

Teacher Control Center (TCC)

The Teacher Control Center places lighting control at the front of the classroom and should be placed on the main teaching wall closest to the teacher's desk. The default location is to the left of the whiteboard. Placing the control in this position improves teacher control and increases use of the system.

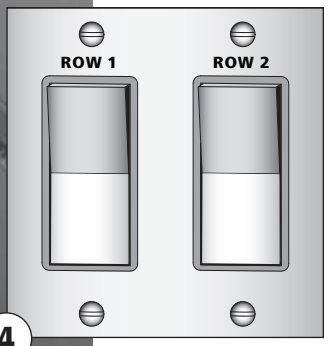


3

Occupancy Sensor

The ceiling mounted occupancy sensor should be positioned in the approximate center of the room in a 2-row design and between the two rows closest to the teacher's desk in a 3-row design.

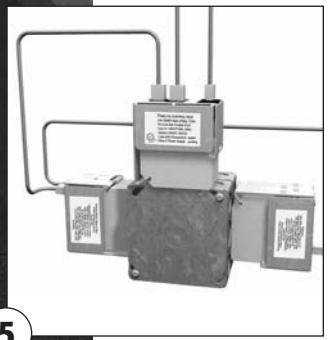
- Mount sensor 4-6' away from HVAC outlets or heating blowers.
- Certain room configurations may require the use of more than one sensor to provide adequate coverage. Contact factory for design assistance.



4

Row Switches

Row switches are available from Finelite with laser engraved face plates, or can be provided by others. Row switches are to be mounted near the primary room entrance. Switches shall also accommodate a 3-way installation if required.



5

Control Pack / Row Pack

The control pack/row pack unit requires building power and is generally placed near the row switches for the most economical use of materials. Connections from the control pack to the occupancy sensor, teacher control center, dimming units, and optional daylight sensor are made using plug-together low voltage wiring.

Integrated Classroom ICLS Lighting System

Ordering Information

Use the following to select the controls package for your specific classroom. Other configurations are available. Contact factory for more information. Order luminaires separately.

1 Room #

Include the actual classroom # so Finelite can include this type on each controls box.

2 # of Rows

Identify the number of luminaire rows in the classroom. Do not include Whiteboard Luminaire. Consult Factory for 4 or more rows.

2R = 2 Rows

3R = 3 Rows

3 Voltage

Identify site voltage: **120v, 277v**

4 Dimming

Identify dimming requirements. Select ALD dimming option when using Daylight Dimming (DD) controls.

00 = No Dimming

CLD = Center Lamp Dimming

ALD = All Lamp Dimming

5 Occupancy Sensor

Identify the number of occupancy sensors required in the space. (Contact the factory if the number of occupancy sensors exceeds the number of luminaire rows.)

OS1 = One Occupancy Sensor

OS2 = Two Occupancy sensors, plus one additional plug and play cable

6 Daylight Dimming

Identify daylight harvesting requirements. Select ALD dimming option when using Daylight Dimming (DD).

NDD = No Daylight Dimming

DD = Daylight Dimming

7 Whiteboard Luminaire Controls

Identify requirements for whiteboard luminaire control. In addition to adding necessary electrical equipment, selecting WL will yield a Teacher Control Center that includes a whiteboard switch. When selecting a whiteboard luminaire control we suggest selecting MSB3, 4, or 5 below.

NWL = No whiteboard luminaire control

WLLV = Add whiteboard luminaire control to the low volage teacher control center

WLHV = Add a separate line voltage control switch for Whiteboard

8 Main Switch Bank

Identify Main Switch Bank controls for providing on/off control at primary room entrance.

00 = No Finelite supplied main switchbank controls

MSB1 = Independent control for two luminaire rows

MSB2 = Independent control for three luminaire rows

MSB3 = Independent control for two luminaire rows and a whiteboard luminaire

MSB4 = Independent control for three luminaire rows and a whiteboard luminaire

MSB5 = One single master control for all luminaires.

Add X to any of the above to double controls for a 3-Way wiring installation. *Example = MSB1X will result in 2 sets of two independent row controls.*

9 Laser Engraving for Row Controls

We recommend having laser engraving for all the control switches for easy function identification. Teacher Control Center is always laser engraved.

NLE = No laser engraving.

LE = Laser engraving for TCC, & row switches.

Ordering Example

Room 1A – 2R – 120v – CLD – OS1 – NDD – WLLV – MSB3 – LE

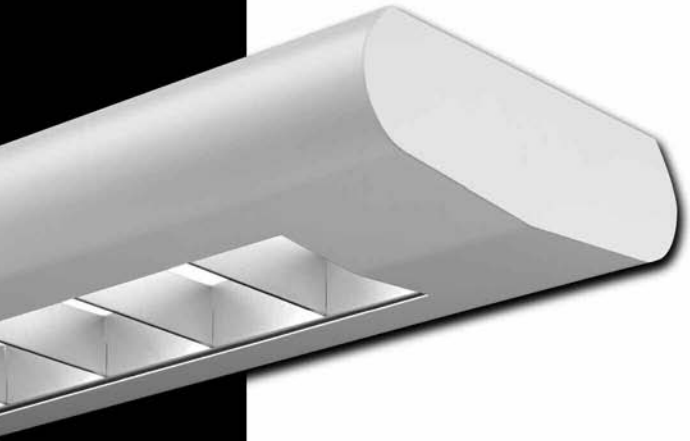
1 2 3 4 5 6 7 8 9

Finelite, Inc. ◇ 30300 Whipple Road ◇ Union City, CA 94587-1525 ◇ 510 / 441-1100 ◇ FAX: 510 / 441-1510 ◇ www.finelite.com

 Form CTK0034.1/05

FINELITE

ILS
Integrated Classroom
Lighting System



Use & Care
MANUAL

Table of Contents

Online Information

More product information, including technical information and installation instructions can be located at www.finelite.com.

Your School Selected ICLS Because:

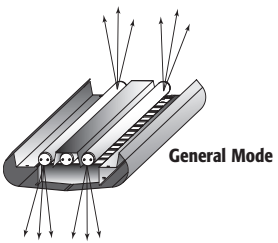
- ICLS gives the teacher another tool to ***improve the learning environment.***
- ICLS is ***affordable*** to install and maintain.
- ICLS ***reduces energy costs*** and money saved on energy can be put back into the school.
- ICLS uses ***recommended lighting*** and lighting control practices.

Read this Use & Care manual to familiarize yourself with the ICLS system and to maximize the benefit to yourself, your students, and the environment.

The ICLS System Explained

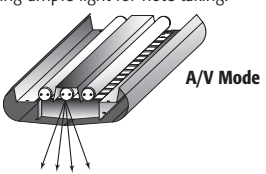
The Lights – The ICLS system uses high performance indirect/direct lighting designed to illuminate the ceiling and walls to reduce glare which causes distraction and eye fatigue. This type of lighting is endorsed by ANSI (American National Standards Institute), and CHPS (Collaborative for High Performance Schools). The ICLS system is designed to provide two distinct modes: **General and A/V**.

General – The General mode directs the light of the two outside lamps up to light the ceiling and walls. This mode is used to meet your general classroom needs.

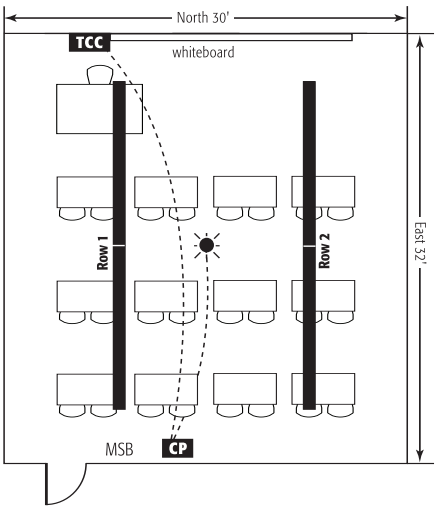


General Mode

A/V – The A/V mode is for use during *audiovisual presentations*. This mode directs light from the center lamp downward, improving screen contrast while providing ample light for note taking.



A/V Mode



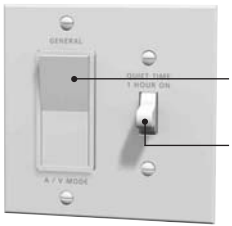
Finelite Classroom
2 - 24' Rows,
14' Row Centers

LEGEND

- TCC = Teacher Control Center
- = Occupancy Sensor
- MSB = Main Switch Board
- CP = Control Pack
- - - = Plug and Play Cables

The ICLS System Explained

Teacher Control Center – The Teacher Control Center (TCC) places the necessary controls near the front of the classroom. From this location you can do the following:



TCC – Option 1

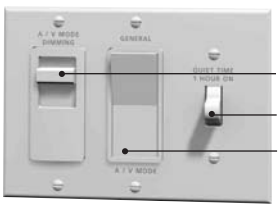
Change Lighting Mode *(General to A/V)*

Quiet Time Switch

Change Lighting Modes – Change from General to A/V mode.

Quiet Time Switch – The Quiet Time Switch is designed to bypass the occupancy sensor for **1 hour**. Use this switch when movement in the classroom is limited. For example, flip the switch during written tests, or when you are alone in the room grading papers and this will prevent the occupancy sensor from turning the lights off.

Note – The Quiet Time Switch resets itself.



TCC – Option 2

Dimming

Quiet Time Switch

Change Lighting Mode *(General to A/V)*

Dim the A/V Mode (Optional) – The optional dimming switch allows you to dim the center lamp when you have it switched to the A/V mode.

Row Switching – The row switches are located at the main entrance of the classroom. Each row is individually controlled.

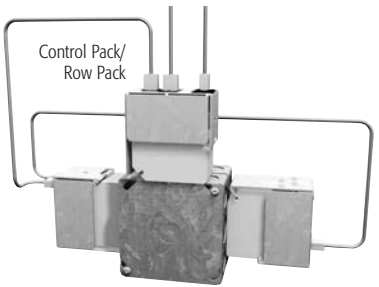
Row Switching

Row 1 & 2 On

The ICLS System Explained

Occupancy Sensor – The Occupancy Sensor detects movement by using two technologies **(infrared and ultrasonic)** in order to increase sensitivity and reliability. The unit is factory set to require both technologies to turn the lights on and either to keep them on. When no occupancy is detected for **10 minutes** (factory setting) the lights will turn off.

Daylight Sensor – The *optional* Daylight Sensor mounts on the ceiling and seamlessly adjusts the electric lighting to achieve the desired light level. A remote is included with the system to make adjustments.



Control Pack / Row Pack – This unit communicates with and delivers power to the Teacher Control Center and Occupancy Sensor. The unit is generally mounted above the ceiling near the row switches.

Using ICLS to be Energy Efficient

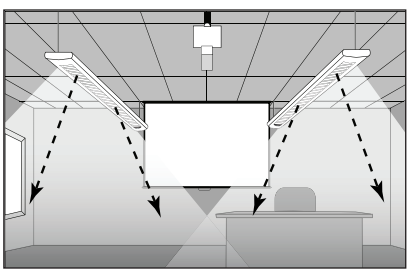
Utilities generally make up one of the largest components of a school district's monthly operating budget and lighting generally accounts for most of the electricity consumed in the school. ICLS is designed to reduce the amount of energy required to light the classroom. ***You can help save even more energy by doing the following:***

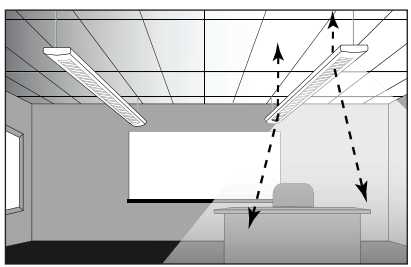
Use the A/V Mode – In addition to providing improved lighting quality for audiovisual presentations, the A/V mode cuts the energy used in half. Learn how to incorporate the A/V mode into your teaching methods and **SAVE ENERGY**.

Be Daylight Smart – Monitor the amount of sunlight in your classroom. You may find you can switch off one or more rows of lights during certain periods of the day.

Monitor your Lighting Needs – You may find when you are alone in the classroom that you can work with just one row of lights turned on.

A/V Mode (downlight only)



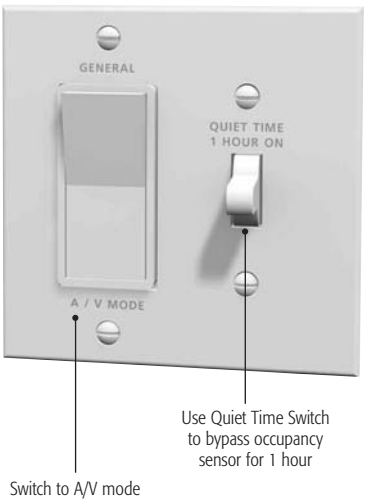


Daylight Smart (one row switched off)

Improving the Learning Environment

Finelite tested ICLS in 30 real world classrooms for an entire teaching cycle. Input from teachers just like you helped develop the system and identified methods for using the system to improve the learning environment. Their input included:

Teacher Control Center with Quiet Time Switch



- Use A/V mode when using TV's, overhead projectors, or movies on projection screens. In addition to improving screen contrast, the change in lighting focuses student attention.
- Use A/V mode to encourage quiet reading time.
- Use A/V mode to calm an excited class.
- Use the Quiet Time switch during tests, and after hours when grading papers to prevent the occupancy sensor from turning the lights off.

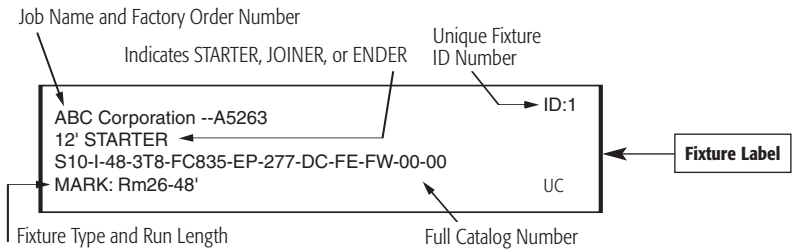
Warranty and Contact Information

Finelite Inc., warranties all electronic components, including ballast, occupancy sensor, optional daylight sensors, switches, and plug and play wiring to be free from defects in materials and workmanship for a period of **five years**. Lamps shall be warranted for a period of **two years**.

Contact Information:

Finelite, Inc.
30300 Whipple Road
Union City, CA 94587-1525
Phone: (510) 441-1100
Fax: (510) 441-1510

Reference Information – Inside each fixture is a product label. Please have the information listed on this label available when you call. This information will enable us to identify the exact parts configurations and manufacturers used on your fixtures.



Maintenance / Troubleshooting

How do I replace the ballast?

SAFETY FIRST – Ballasts should only be replaced by a qualified electrician. Expose ballast channel by removing reflectors as shown in ***Figure A & B***. With the electricity safely shut off, clip the wires and remove the ballast. Remove the old ballast and secure the new ballast in place. *(Note: check the parts list located in this manual to locate the correct ballast for this fixture).* Strip the wires to expose ½" of the wire, match up the same color wires and wire nut them together.

Figure A

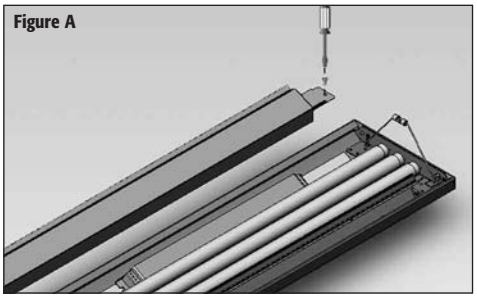
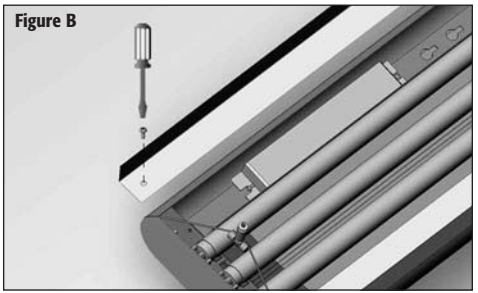


Figure B



Maintenance / Troubleshooting

How do I clean the fixtures?

Exterior – The exterior finish is powder coat paint making it extremely durable. Use a soft cloth and non-abrasive cleaning products like 409, Windex, or Simple Green to clean the exterior of the product. We suggest you spray the cleaning product on the cloth and then rub the surface to avoid spraying onto electrical components.

Interior – Wiping the interior with a soft cloth will remove most dirt that may have accumulated on the reflectors. If necessary, spray a mild glass cleaner on a soft cloth. Be careful not to spray directly onto electrical components.

Downlight Shield – The center downlight optical component should be cleaned with a soft cloth and a mild glass cleaner. Spray the cleaner on the soft cloth and then gently rub on metal.

Detailed Occupancy Senor Guide (DT-305)

How do I change the settings on the Occupancy Sensor?

Changing occupancy settings is explained in the installation instructions for the sensor (DT-305), which is included with this manual. Online instruction sheets for the Occupancy Sensor (DT-305) can be located at www.finelite.com.

How do I change the settings on the Daylight Sensor?

Changing the settings is explained in the installation instructions for the sensor (LS-301), which is included with this manual. Online instruction sheets for the Daylight Sensor (LS-301) can be located at www.finelite.com.

Detailed Daylight Senor Guide (LS-301)

Maintenance / Troubleshooting

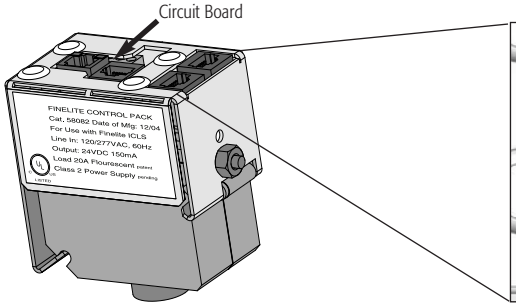
How do I troubleshoot the Occupancy Sensor?

Refer to specific occupancy sensor guide (DT-305) included for more extensive troubleshooting information.

Use the following instructions if the troubleshooting guide for the DT-305 does not solve your issue or if it appears the occupancy sensor may be broken.

We have included a bypass into the system to keep the lights on in the event that the occupancy sensor fails. There is a circuit board located in the Control Pack (**Figure C**). The Control Pack should be located above ceiling near the row switches at the main entrance of the room. [Instructions are located on a label on this junction box.] Flip the dip switch as indicated in (**Figure D**). Return power to the room and turn the lights on. As soon as possible, replace the Occupancy Sensor and return dip switches to their original position.

Figure C
Control Pack



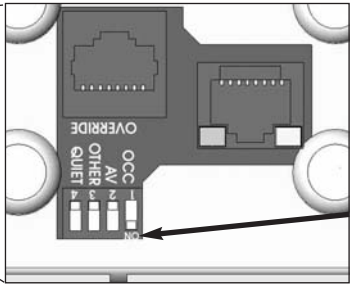


Figure D
Circuit Board
Detail

To override the occupancy sensor flip the "OCC" dip switch to the **ON** position as indicated.

Maintenance / Troubleshooting

One or some (not all) of the lamps are flickering or are off.

- Exchange flickering lamp with one that isn't flickering. If this corrects the problem, replace affected lamps. Consider group relamping.
- If the problem isn't corrected, consult a qualified electrician to inspect and possibly replace the ballast in the affected section.

All lamps flicker in an unpredictable fashion.

- With power turned off, check cable connections between Control Pack and Occupancy Sensor and Teacher Control Center. Replace cable if necessary.
- Check all wire connections at the Control Pack.

Lights do not turn on with occupancy.

- See Occupancy Sensor Installation Instructions included with this Use and Care Manual. This guide is also available at www.finelite.com.
- If the problem persists do the following:

  Override Occupancy Sensor by positioning dip switches in Control Pack as shown in **Figure D**.

Maintenance / Troubleshooting

– If the problem is corrected, replace occupancy sensor and return dip switches to original position.

– If problem persists, replace cable between Control Pack and Occupancy Sensor.

Lights do not turn off automatically.

• See occupancy sensor troubleshooting guide included with this Use and Care Manual. This guide is also available at www.finelite.com.

How do I troubleshoot the Daylight Sensor?

• Refer to the specific Daylight Sensor (LS-301) guide included for more extensive troubleshooting information. Online instruction sheets for the Daylight Sensor (LS-301) can be located at www.finelite.com.

Replacement Parts

Contact Finelite for price and availability of the parts below. **Note: Parts listed are standard parts. Customer specified parts might be different than listed here.**

Description	Manufacturer	Manufacturer Part #	Finelite Part #	Location of Part
Lamps - 32w T8 XPS	Osram Sylvania	FO32835/XPS ECO	93390	Inside Light Fixture
Ballast (non-dimming)	Osram Sylvania	QT2x32120ISSC 10/CS*	93054	Inside Light Fixture
Ballast (non-dimming)	Osram Sylvania	QT432120ISSC 10/CS*	93113	Inside Light Fixture
Dimming Ballast (optional)	Osram Sylvania	QTP3x32T8/120Dim5QNL	93183	Inside Light Fixture
Occupancy Sensor	Finelite/Wattstopper	DTF-305-O	58055	Ceiling Mounted
Occupancy Sensor RJ45 Interface (Plugs into sensor)	Finelite	58161	58161	Attached to Occupancy Sensor
Daylight Dimming Sensor (optional)	Finelite	LS-301 with RJ45 plug	58183	Ceiling Mounted
Daylight Dim. Sensor Setup Remote (optional)	The Watt Stopper	LSR-301-S	58036	Hand Held Remote
Daylight Dim. Sensor Occupant Remote (optional)	The Watt Stopper	LSR-301-P	58035	Hand Held Remote
Control Pack	Finelite	58082	58082	Above Ceiling
Row Pack 120V	Finelite	58083	58083	Above Ceiling
Row Pack 277V	Finelite	58087	58087	Above Ceiling
Expansion Pack	Finelite	58088	58088	Above Ceiling
Whiteboard Pack (optional)	Finelite	58089	58089	Above Ceiling
TCC Assembly - A/V, Quiet Time	Finelite	58065	58065	Teacher Control Center
TCC Assembly - A/V, Quiet Time, Dim.(optional)	Finelite	58066	58066	Teacher Control Center
TCC Assembly - A/V, QT, Whiteboard (optional)	Finelite	58031	58031	Teacher Control Center
TCC Faceplate - A/V, Quiet Time	Finelite	58069	58069	Teacher Control Center
TCC Faceplate - A/V, QT, Dim. (optional)	Finelite	58070	58070	Teacher Control Center
TCC Faceplate - A/V, QT, Whiteboard (optional)	Finelite	58024	58024	Teacher Control Center

* Replace with identical ballast.

FINELITE

Better Lighting For A Better Workplace

Finelite, Inc.
30300 Whipple Road
Union City, CA 94587-1525
Phone (510) 441-1100
Fax (510) 441-1510
www.finelite.com

Form No. 98057

FINELITE

Better Lighting For A Better Workplace

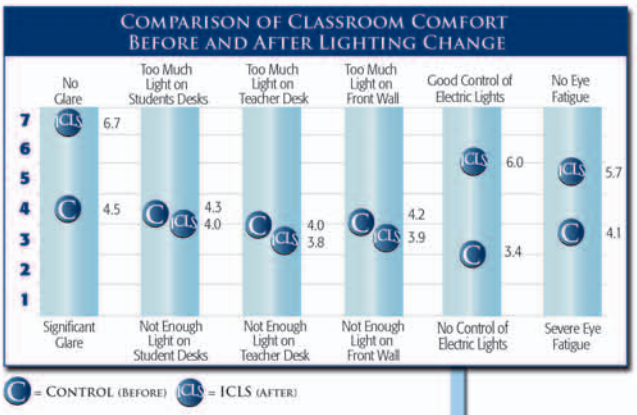
Integrated Classroom Lighting system

Integrated Classroom Lighting System

The Integrated Classroom Lighting System **(ICLS)** is the culmination of a multi-year research study sponsored in part by the California Energy Commission through the Public Interest Energy Research **(PIER)** program. Thirty real world test classrooms were monitored for an entire teaching cycle, and the study proved ICLS would improve the learning environment, increase teacher satisfaction and reduce energy consumption.

Increased Teachers Satisfaction 9:1

ICLS improves the quality of light, as well as instructor control over the learning environment. This chart summarizes a portion of independent surveys that show teachers prefer ICLS 9:1 over existing lighting.



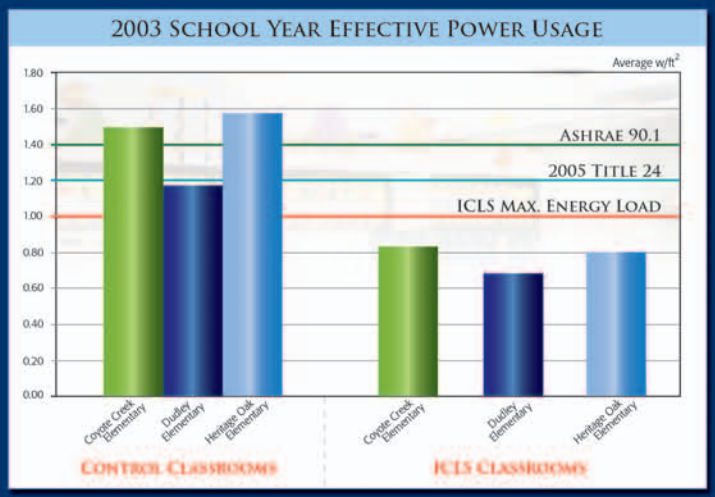
Installation Costs Reduced

ICLS is easy to install, requires fewer contractor-supplied parts, and installs much faster than traditional lighting products. The result is lower installation costs, making ICLS even more affordable.

Proven Energy Savings

15 million data points cannot be ignored. Our multi-year research project proved ICLS saves energy – 30 to 50% on average. This chart shows established standards, the ICLS target, and averages for schools we monitored.

Increased energy efficiency reduces operating costs, leaving more educational funds available for school programs.



The Learning Environment

ICLS increases teacher satisfaction by improving the learning environment. The lighting used is recommended for general classroom illumination, and includes a second lighting mode to enhance the effectiveness of audiovisual presentations. The controls are easy-to-use and include a Quiet Time Switch to bypass the occupancy sensor, giving the instructor added control.

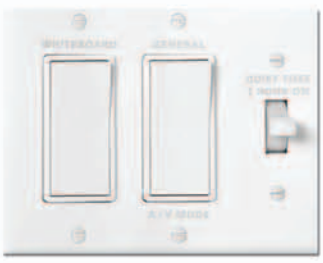
Tools That Enhance Learning

A / V Mode Dimming

ICLS can be specified with A/V mode dimming for enhanced teacher control over the learning environment. Lamps dim from 100% to 5% light output.

Daylight Harvesting

Improve the learning environment by choosing daylight harvesting products, designed to minimize classroom disruption. Closed loop daylight dimming systems seamlessly adjust the electric lighting to achieve the desired footcandle level.



Whiteboard Lighting

Supplemental lighting on the teaching wall increases student attention, and products such as optional whiteboard luminaires are easily integrated into the ICLS control system.

Contact Finelite for information regarding our Series X2 whiteboard luminaire.

More Teacher Control...

A / V Mode

The audiovisual mode directs 100% of light down on the work surface for improved screen contrast.

- Ample light is available for note taking during presentations
- Student attention is focused on the presentation

...At The Front Of The Classroom

The Teacher Control Center provides simple, effective control over the classroom environment.

The Quiet Time Switch will bypass the occupancy sensor for 1 hour to prevent false negatives during periods of limited movement.

General Mode

The general mode delivers an effective balance of uplight and downlight to evenly illuminate the ceiling and walls.

- Eliminates glare that causes distraction
- Eliminates harsh shadows

Components

1

Direct/Indirect Luminaire

ICLS uses direct/indirect luminaires like the Series 10 to deliver expert recommended lighting quality.

- Glare is eliminated for fewer classroom distractions
- Walls and ceilings are evenly illuminated
- High reflectance materials ensure optimum efficiency

2

Teacher Control Center

The Teacher Control Center places easy-to-use lighting control at the front of the classroom.

- Change from general to audiovisual mode at the flip of a switch
- Quiet Time Switch bypasses occupancy sensor for 1 hour to prevent false negatives during periods of limited movement
- Faceplates are laser engraved for long-lasting durability

3

Dual Technology Occupancy Sensor

The low profile, ceiling mounted sensor provides reliable occupancy control for improved energy savings.

- Uses passive infrared and ultrasonic technologies to detect occupancy
- Plug and play connections make installation and maintenance easy

4

Row Control

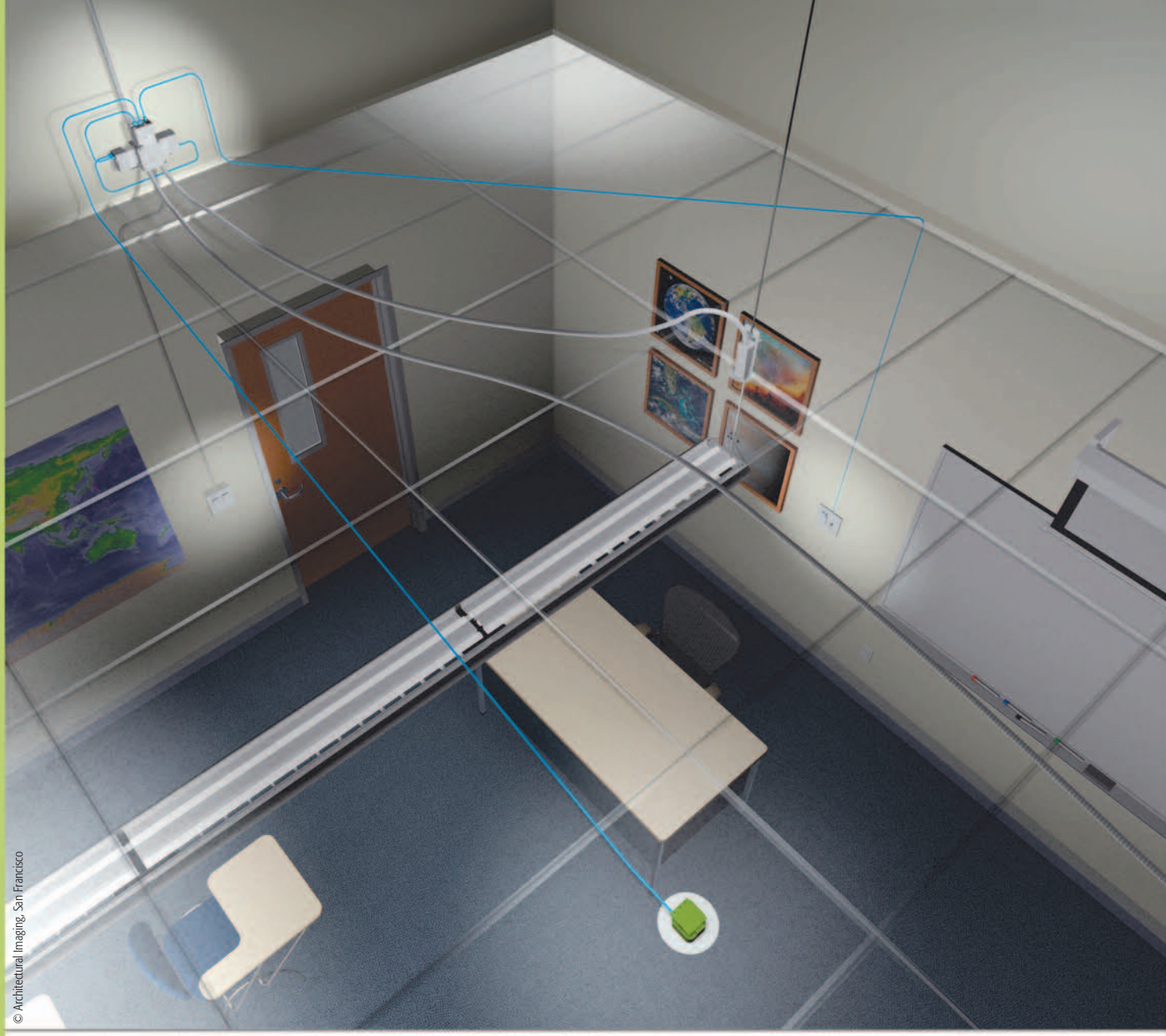
ICLS accommodates independent row control at primary entrances.

- Optional Finelite supplied switches include laser engraved faceplates
- Individual rows can be controlled for manual daylighting control
- Row control can be placed at multiple locations

Plug Together Wiring

Plug together wiring connects ICLS control elements, including the Teacher Control Center, occupancy sensor, and daylight harvesting sensors.

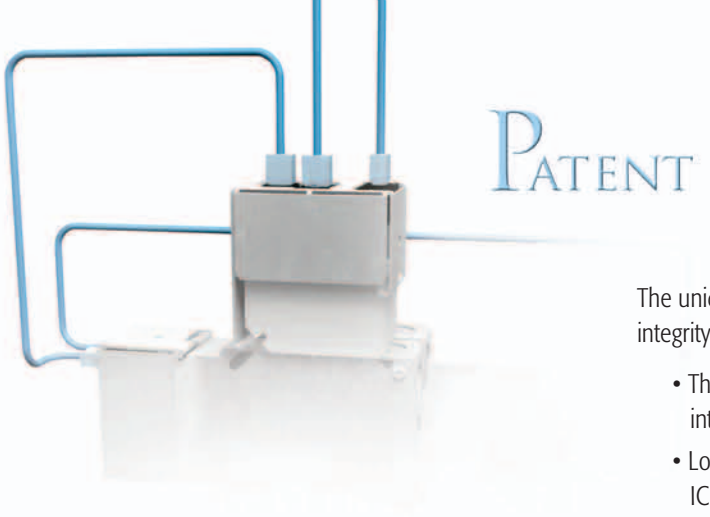
- Installation time and labor costs are reduced
- Sensors are easily moved to accommodate space changes
- Additional occupancy sensors can simply be plugged into the system



Plug and Play Makes The Difference

ICLS combines high performance luminaires, state-of-the-art components and a patent pending protocol to advance the quality and effectiveness of classroom lighting. Low voltage plug and play cables connect the components, and dramatically reduces installation costs, lowers on-site commissioning and accommodates system changes throughout the life of the classroom.

ICLS Integrated Classroom Lighting System



Patent Pending Approach

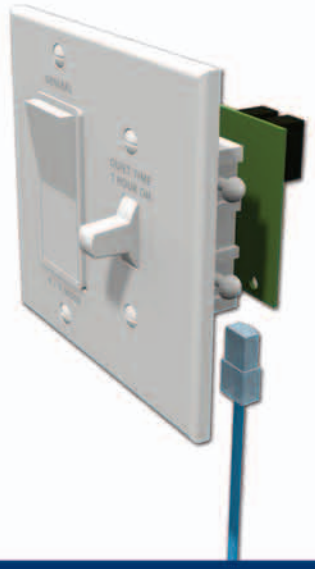
The unique patent pending protocol improves the flexibility and integrity of the ICLS system.

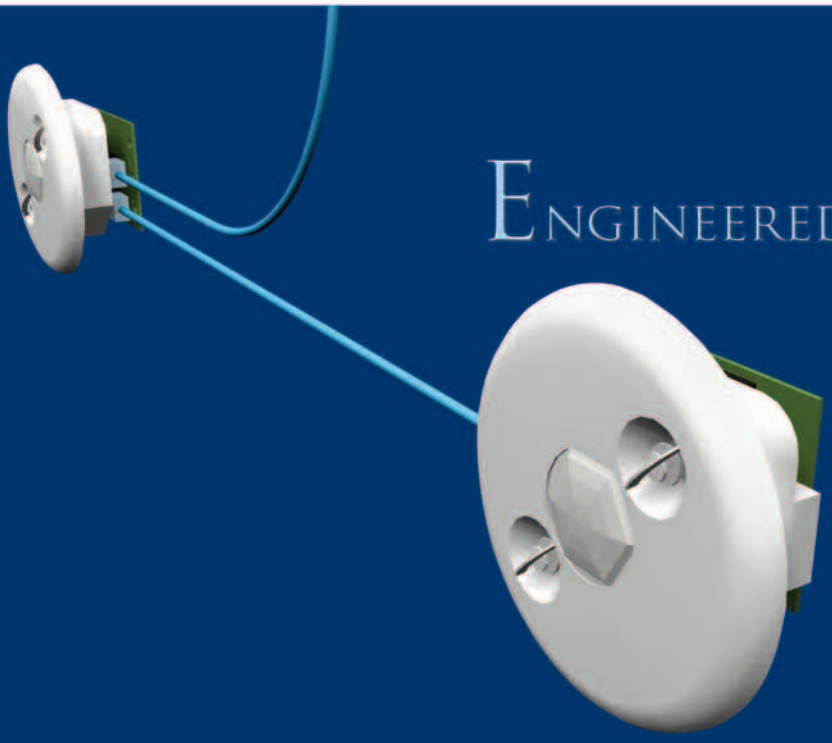
- The OmniPort design allows any component to be plugged into any port for error-free installation.
- Low voltage wiring carries power to, and communicates with, ICLS system components.
- Circuitry includes testing and override features to minimize classroom disruption during maintenance.

Easy Installation

ICLS reduces installation labor costs and contractor supplied parts.

- Teacher Control Center, occupancy sensors, and daylight dimming equipment require no contractor supplied wiring – simply plug it in!
- Plug and play low voltage wiring replaces conduit, making installation fast and affordable.
- The Finelite GridBox™ allows products to be installed On-Grid and have the power feed pass directly into the junction box.





Engineered To Accept

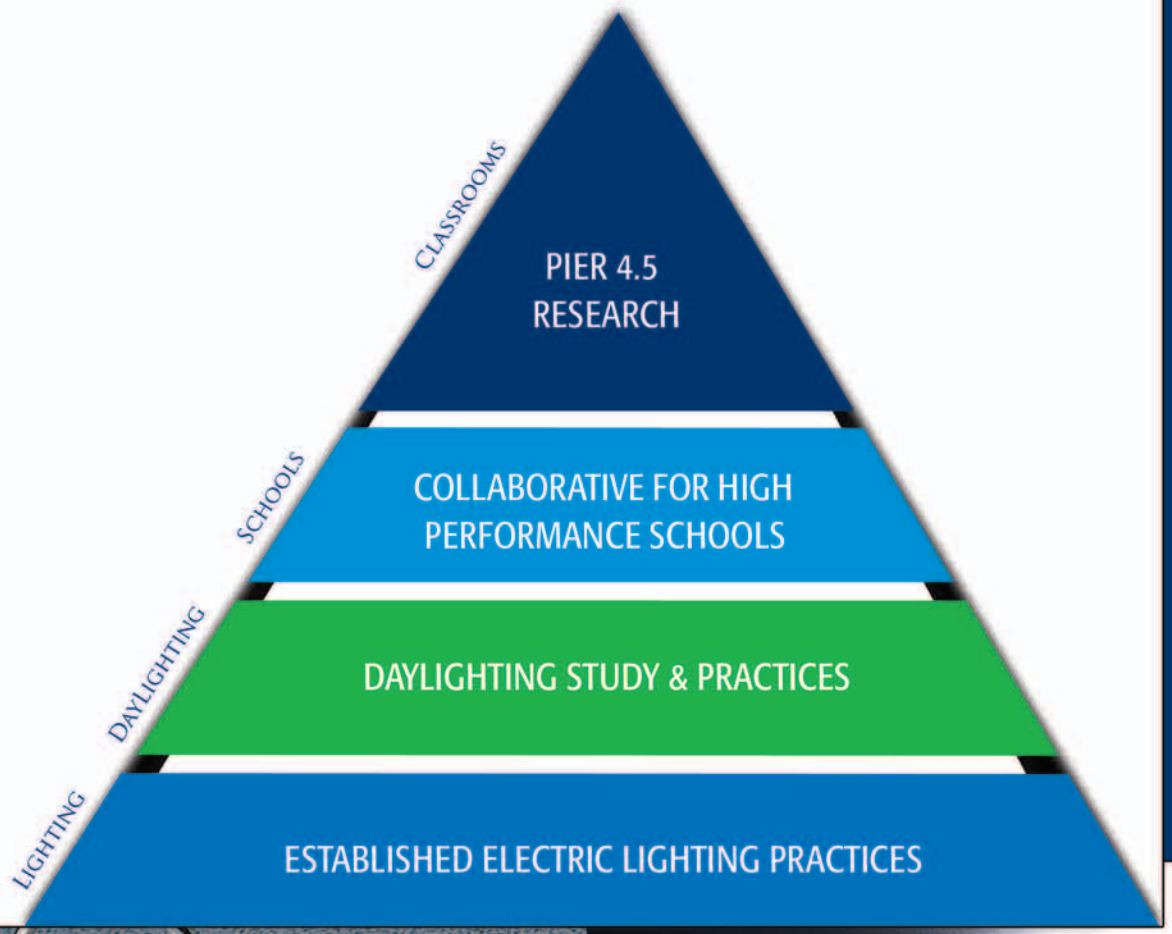
ICLS is designed to accommodate system expansions and changes.

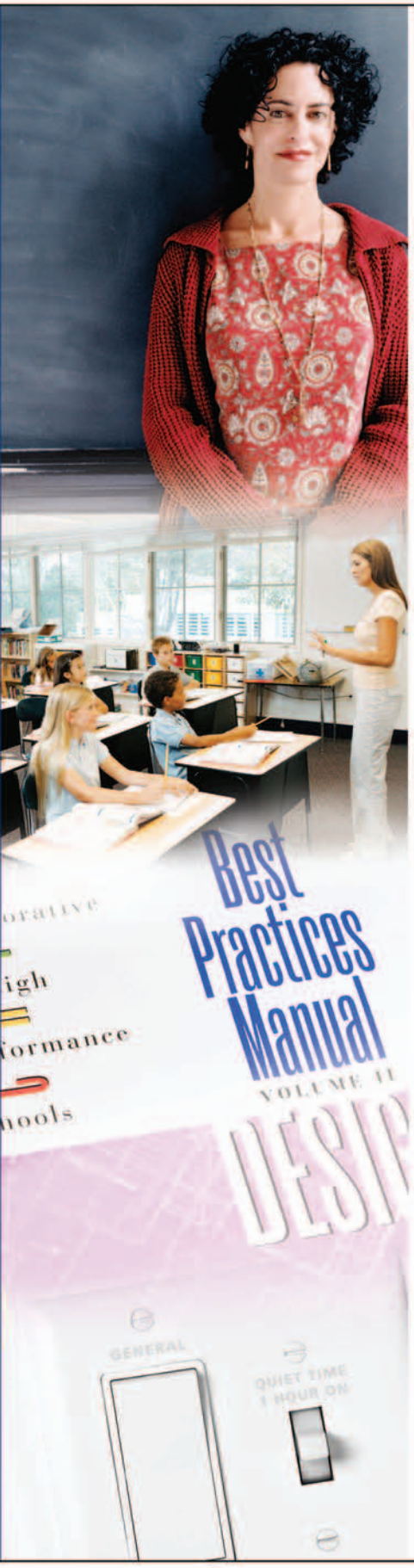
- Daylight harvesting is easily added to an existing system.
- Additional occupancy sensors are simply "daisy-chained" to accommodate space changes.
- New technologies are easily integrated into the ICLS system.

ICLS Integrated Classroom Lighting System

Meaningful product development results in concepts created with the intent to drive change in the marketplace. Years of combined knowledge and practice in the art of lighting built the foundation for research and development that resulted in ICLS. This system will change how the industry illuminates classrooms!

Foundations That Ensure GREAT → Classroom Lighting





Established Electric Lighting Practices

For more than 50 years leaders in the IESNA, IALD, and AIA have sought to establish tenets of good school lighting design, including:

- Increased control leads to increased satisfaction
- Light surfaces uniformly and reduce glare
- Pay special attention to the teaching wall
- Light faces
- Provide layout flexibility

daylighting Study and Practices

A great deal of quality research has been conducted to establish the importance of daylight in school design:

- Proper daylighting design improves student performance
- Direct sunlight is not daylighting
- Use north and south facing windows
- Use side and top lighting

Collaborative for High Performance Schools

CHPS seeks to facilitate the design of learning environments that are resource efficient, healthy, comfortable, well lit and contain the amenities needed for a quality education. To enhance visual comfort:

- Integrate natural and artificial lighting strategies
- Balance the quantity and quality of light in each room
- Control and eliminate glare
- Reduce energy to less than 1 w/ft^2

Pier 4.5 Research

Pier 4.5 is a real world research project focused on improving classroom lighting and reducing energy consumption.

- Provide more instructor control
- Include lighting for A/V presentations
- Use 30 real world test classrooms to gauge teacher preference
- Make it affordable for every school district
- Work with specific municipality and school districts to tailor lighting system to meet specific daylighting goals

ICLS Integrated Classroom Lighting System

Sustainable Design Meets Flexibility

Learn More About ICLS...

Visit Our Website At
www.finelite.com

FINELITE

Better Lighting For A Better Workplace

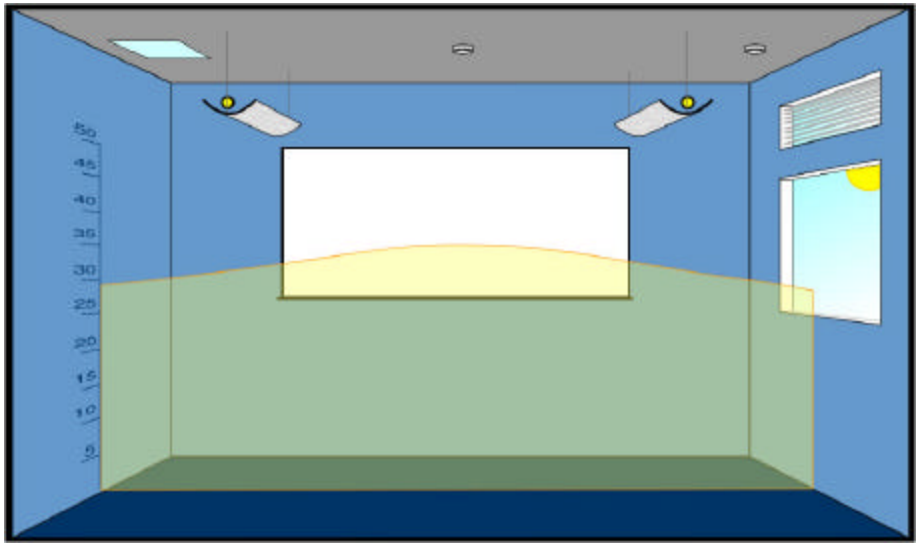
Finelite, Inc.
30300 Whipple Road
Union City, CA 94587-1525
Phone 510/441-1100
Fax 510/441-1510
www.finelite.com

Form No. CPI0022

Photography & Art Credits:
Product shots; cover, pgs. 4 & 7 – © Steve Talmadge Photography
Product renderings; pg. 9 – © Architectural Imaging, San Francisco

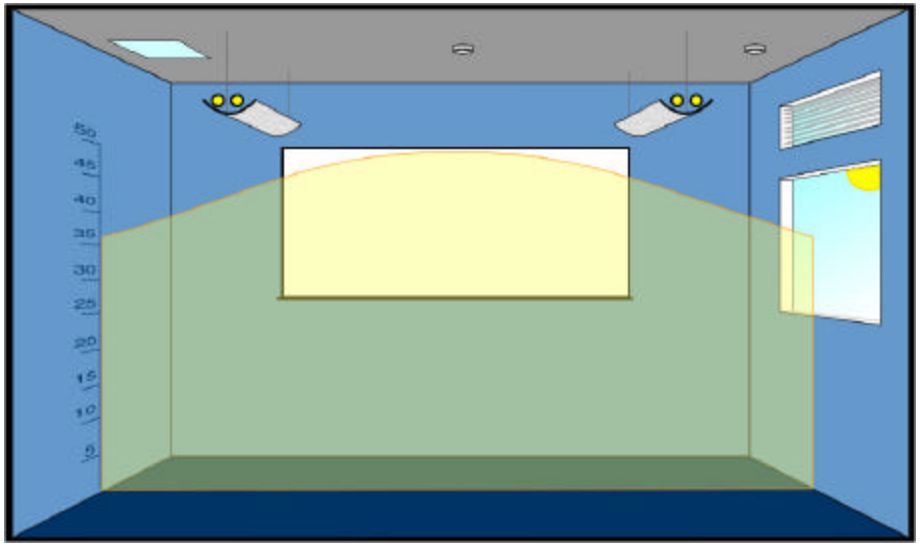
APPENDIX G: SCE DAYLIT CLASSROOM ILLUMINANCES

Lighting Alternatives



1 lamp, T5-HO

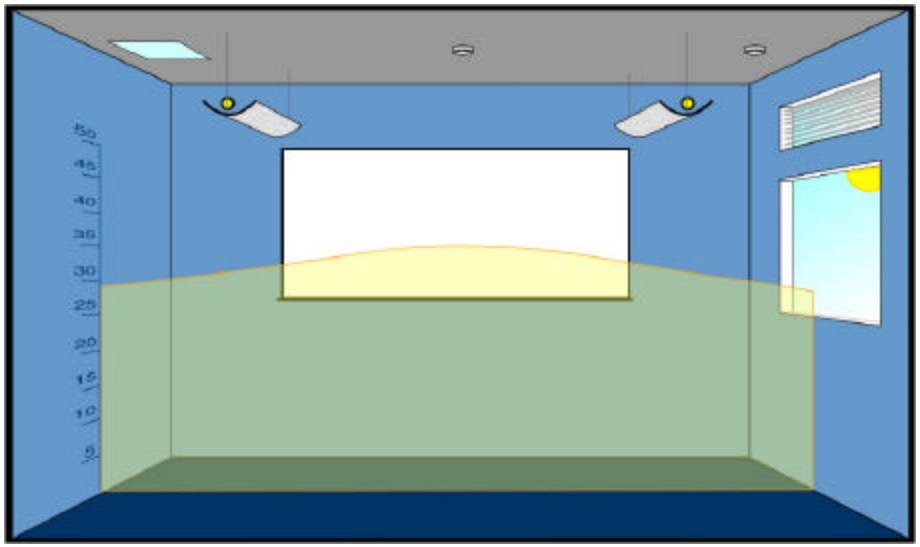
Average
Illuminance: 33 FC



2 lamp, T8

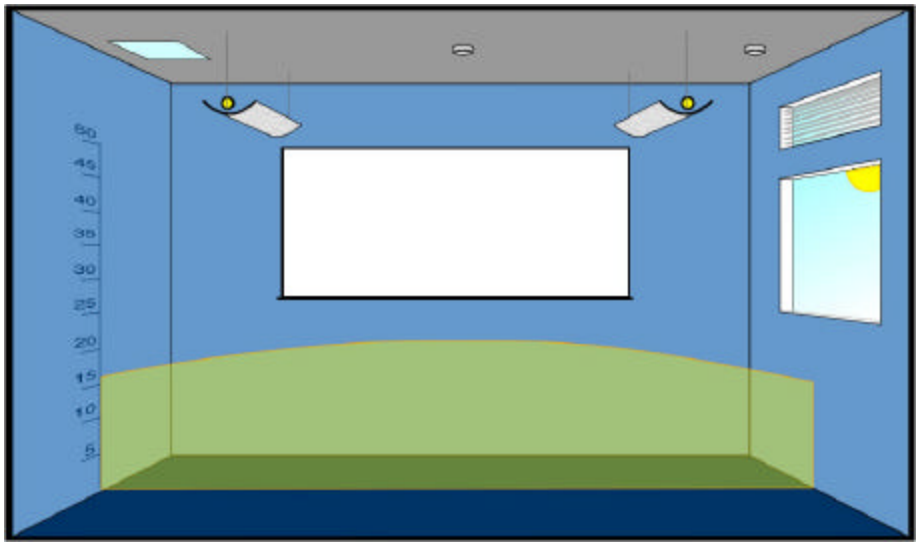
Average
Illuminance: 45 FC

Lighting Control Systems: T5 HO Dimming



1 lamp, T5-HO

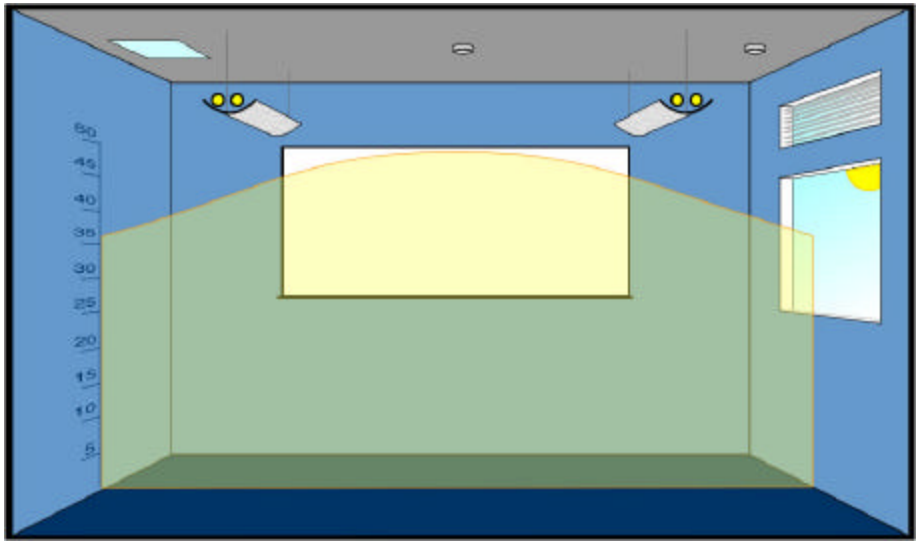
Full-on Average
Illuminance: 33 FC



1 lamp, T5-HO

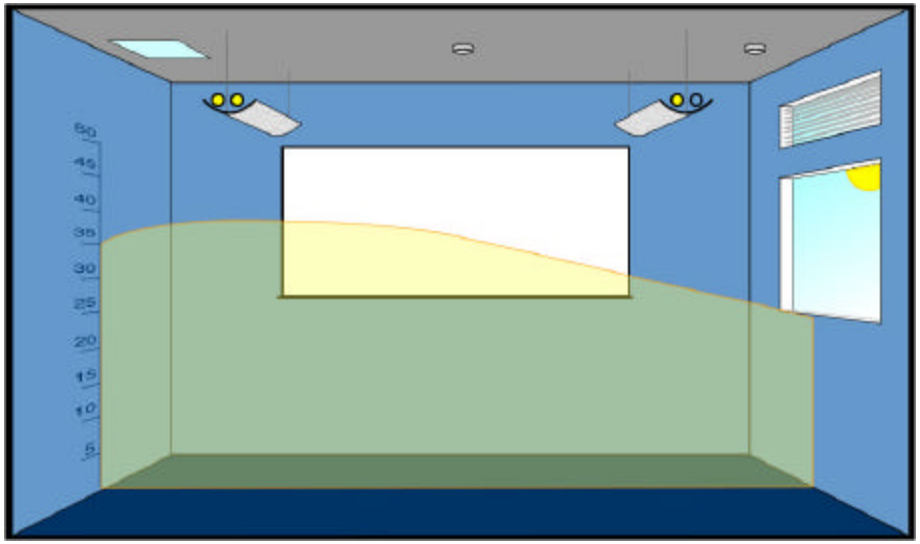
50% Dimming Avg
Illuminance: 18 FC

Lighting Control Systems: T8 Stepped Control



2 lamp, T8 OO-OO

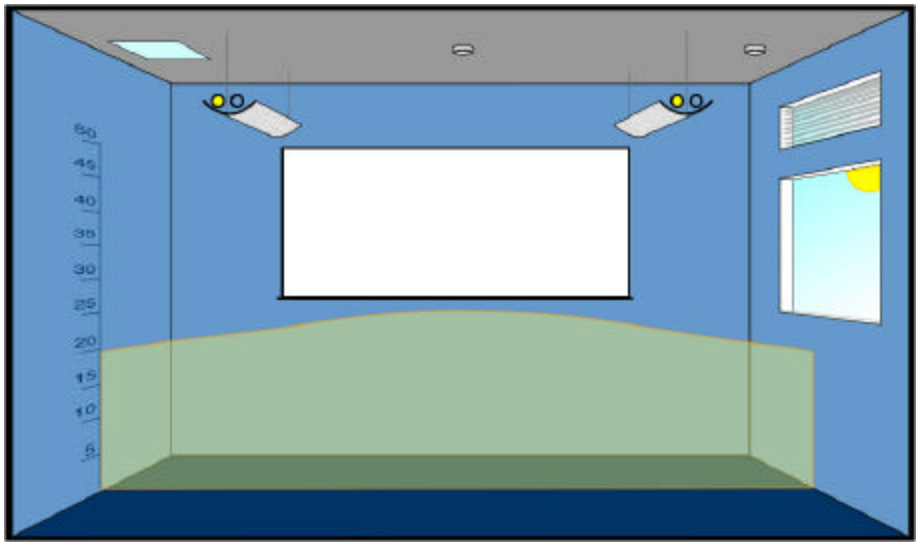
Average
Illuminance: 45 FC



2 lamp, T8 OO-OX

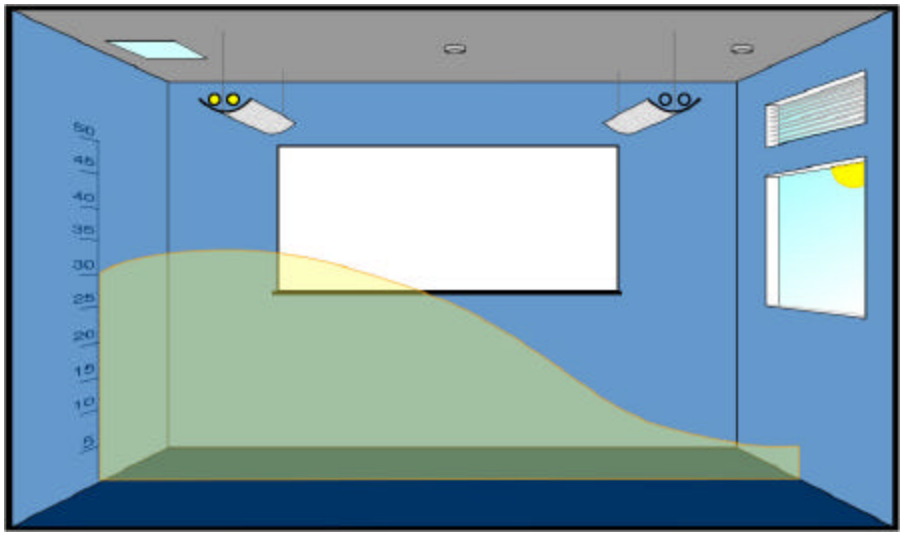
Average
Illuminance: 34 FC

Lighting Control Systems: T8 Stepped Control



2 lamp, T8 OX-OX

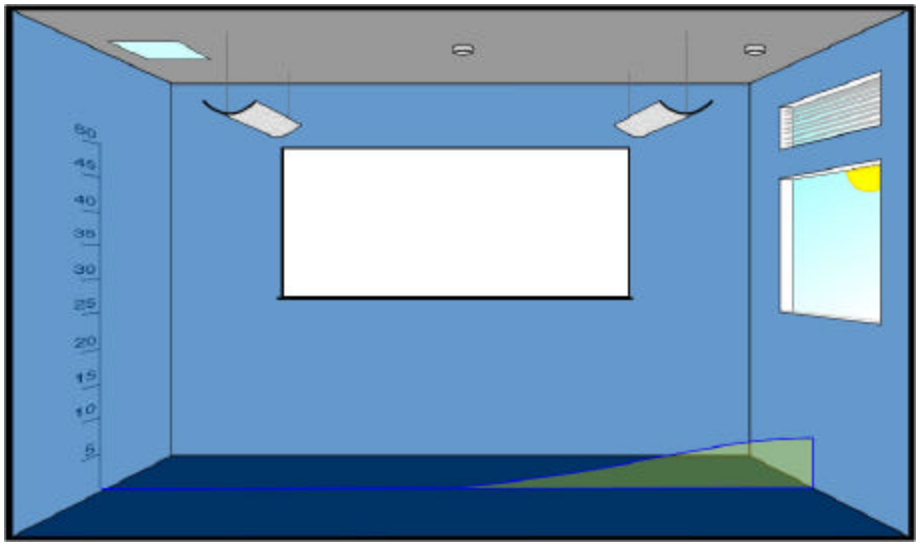
Average
Illuminance: 22 FC



2 lamp, T8 OO-XX

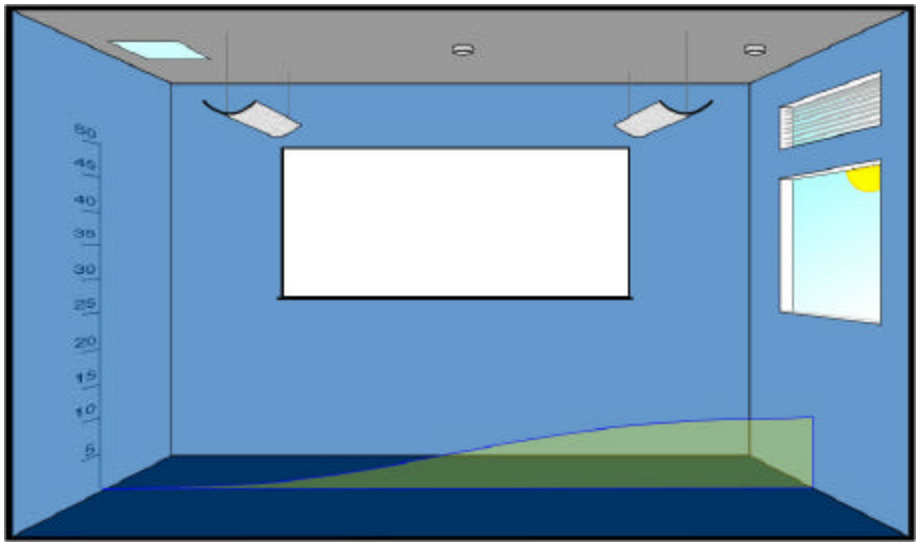
Average
Illuminance: 23 FC

Daylight Contribution



8:00 am

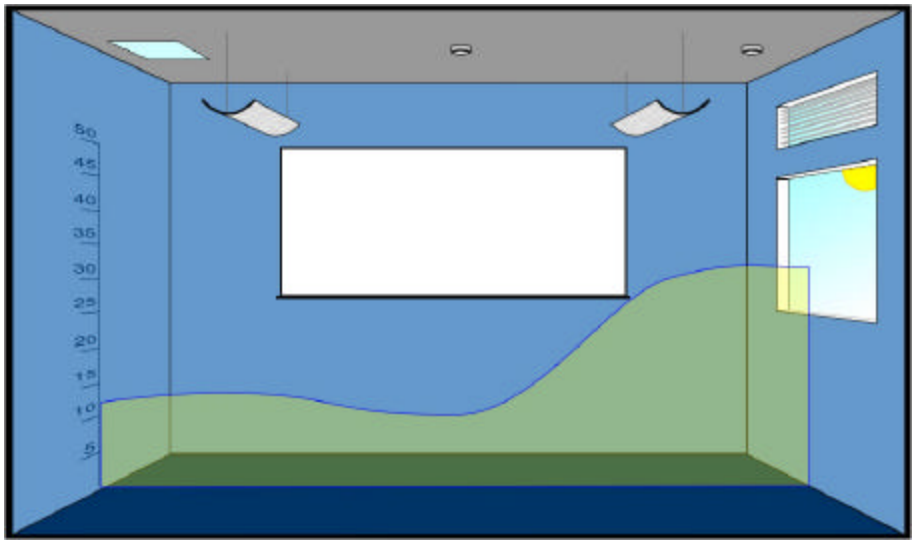
Maximum
Illuminance: 5 FC



10:00 am

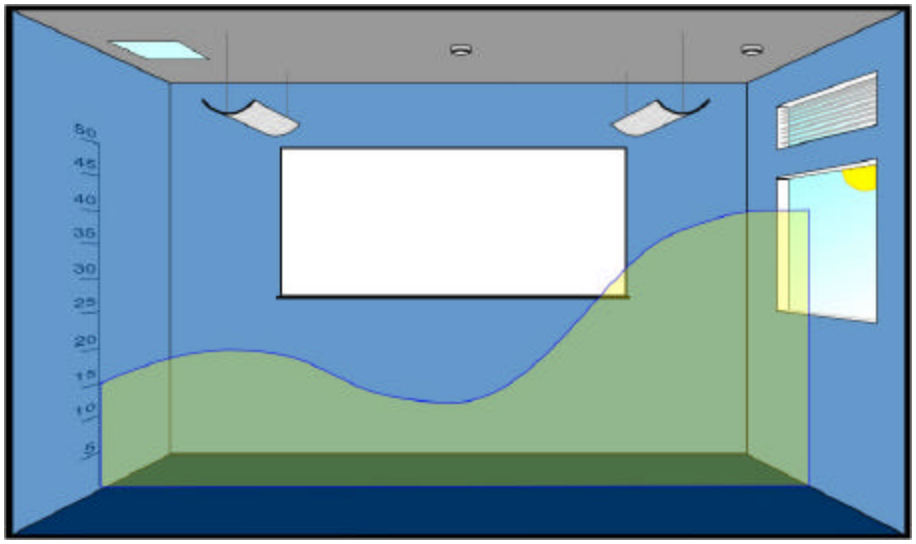
Maximum
Illuminance: 10 FC

Daylight Contribution



12:00 pm

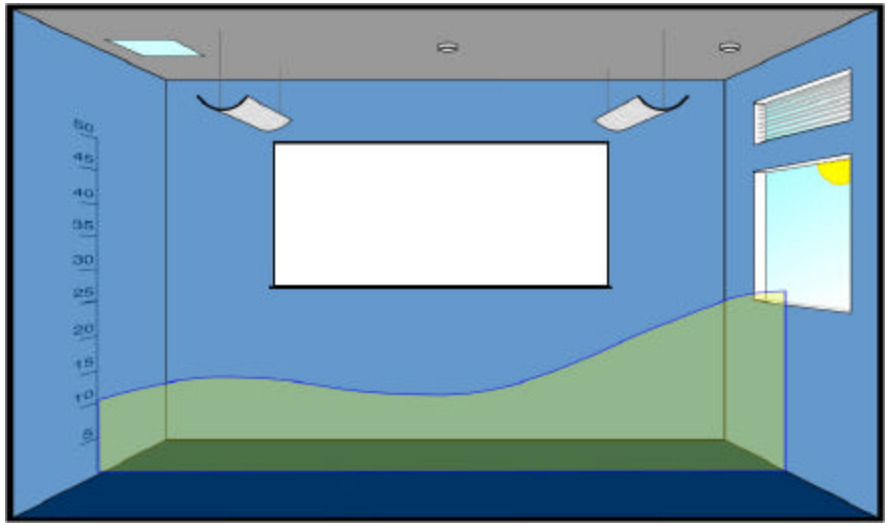
Maximum
Illuminance: 36 FC



2:00 pm

Maximum
Illuminance: 40 FC

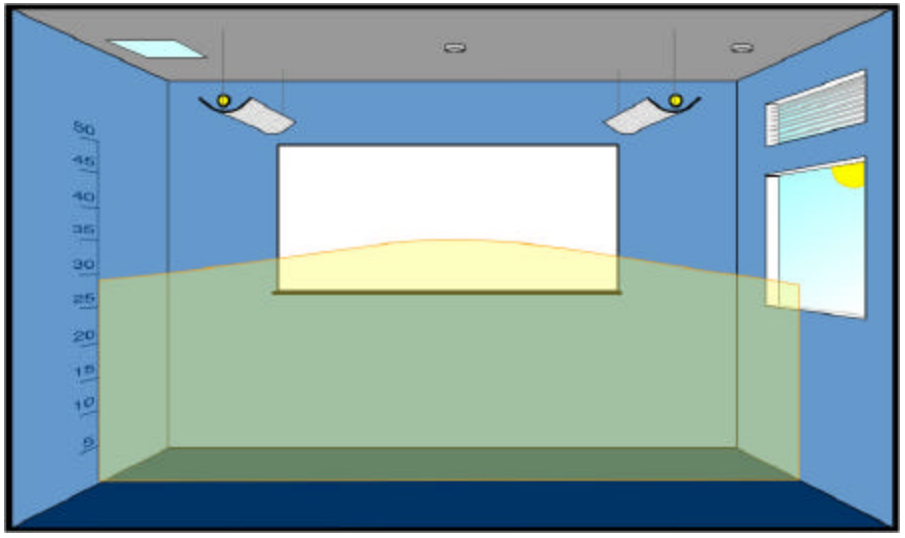
Daylight Contribution



4:00 pm

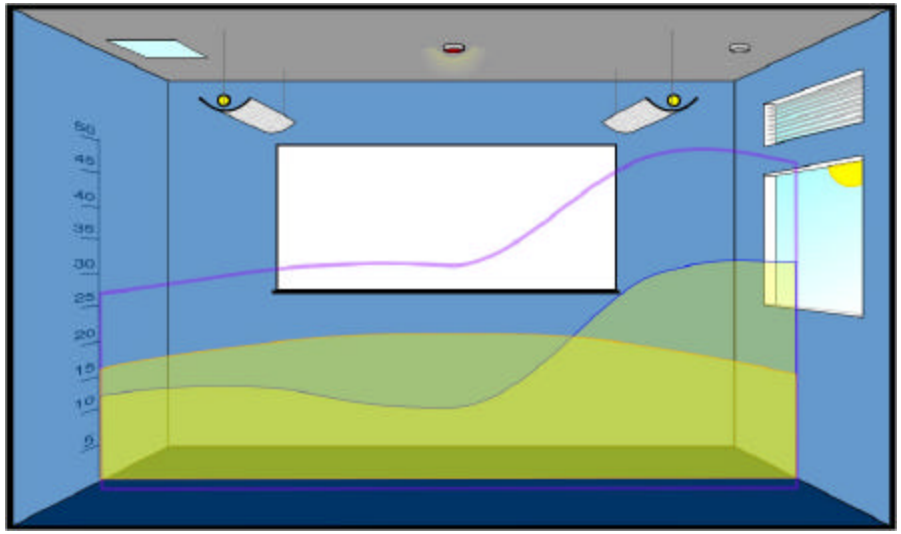
Maximum
Illuminance: 25 FC

Integrated Daylighting: T5 HO



T5 HO - full on

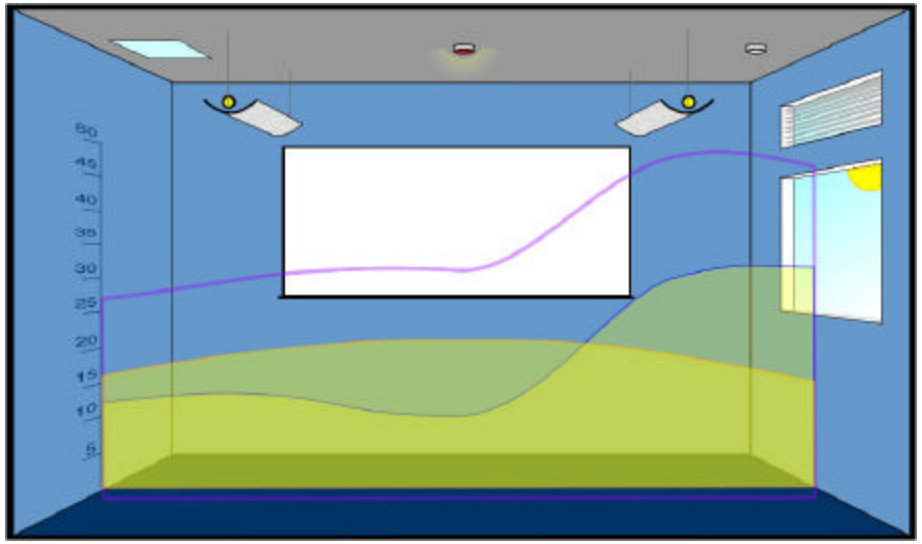
Maximum
Illuminance: 33 FC



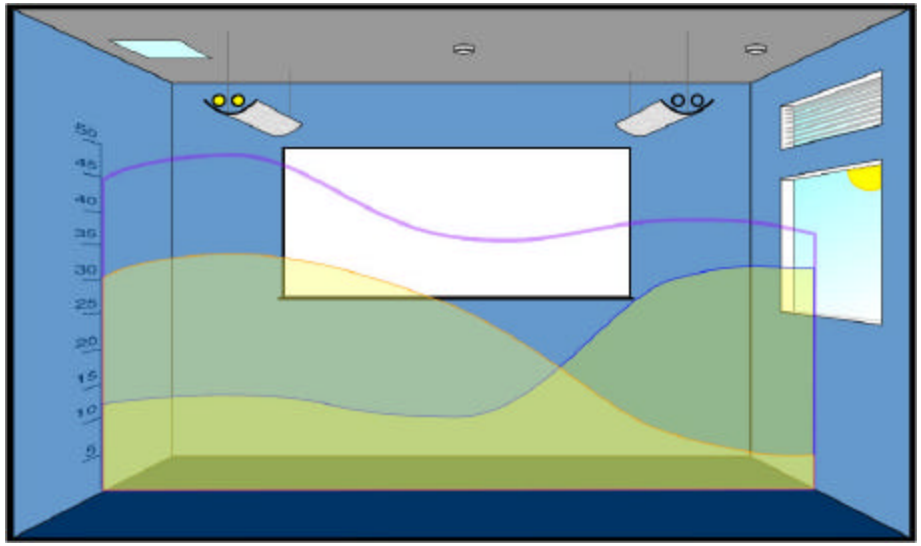
12:00 pm

T5 HO - 50% Dimming
Average Illuminance: 40 FC

Integrated Daylighting: T5 HO and T8 Stepped



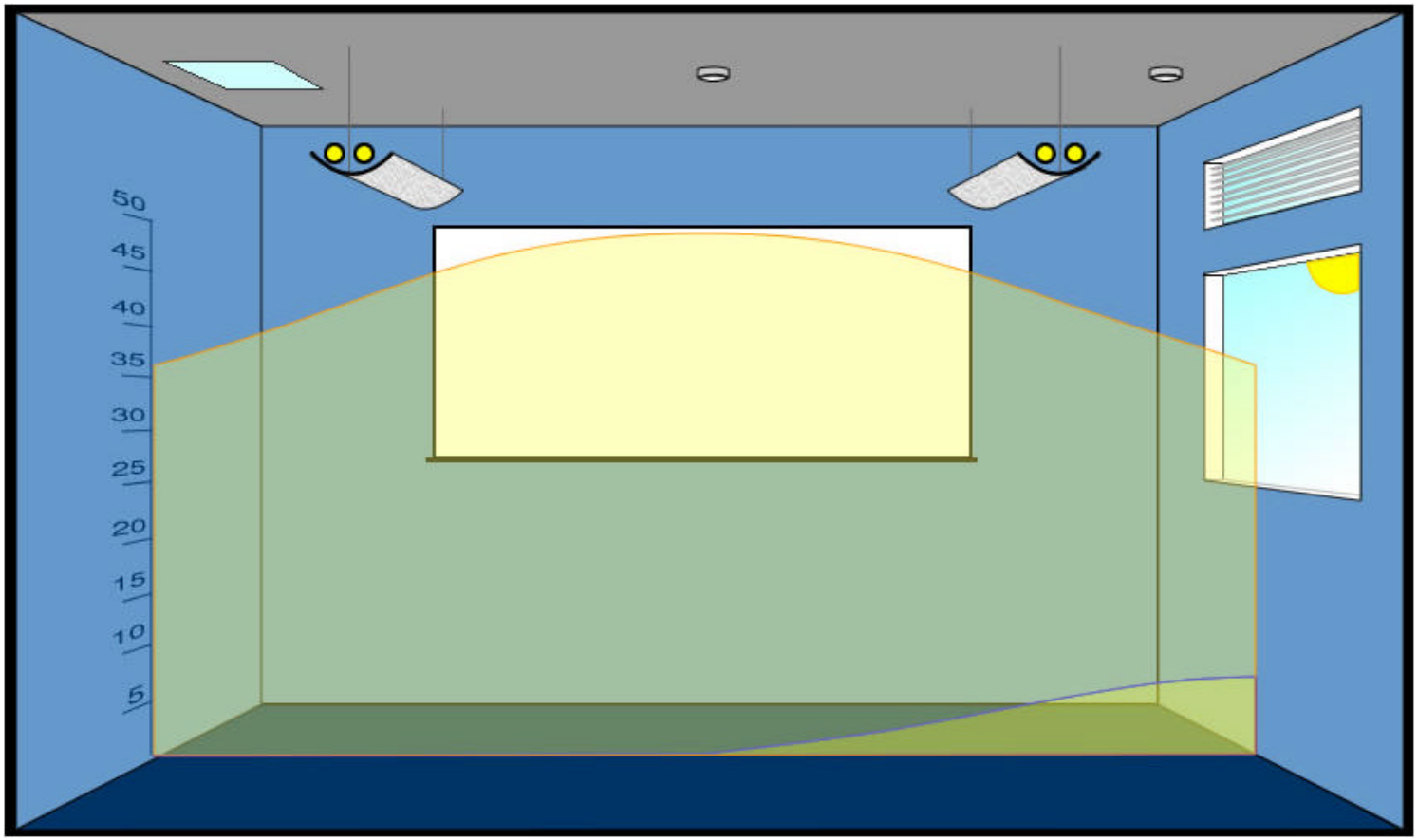
T5 HO - 50%



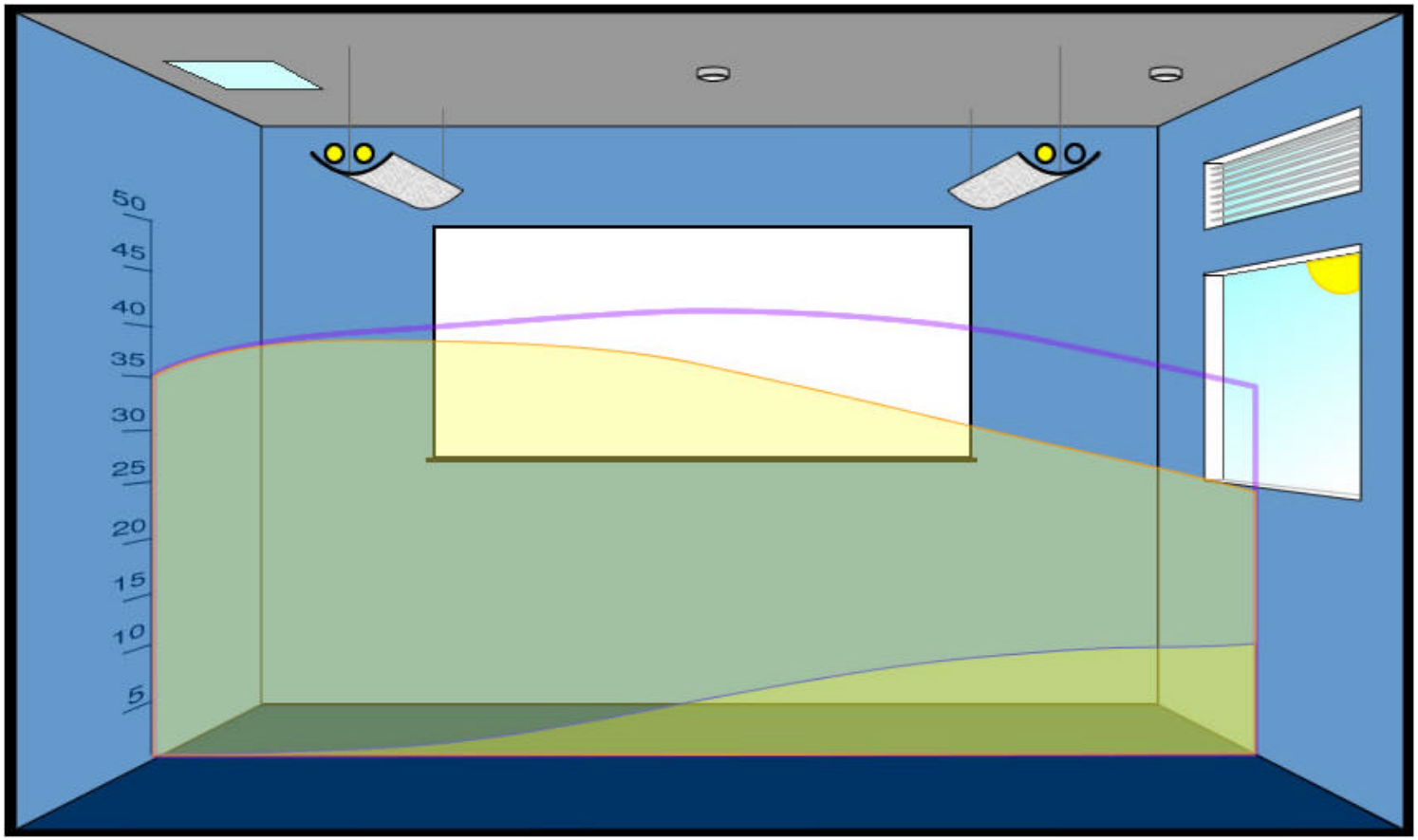
T8 00-XX

12:00 pm

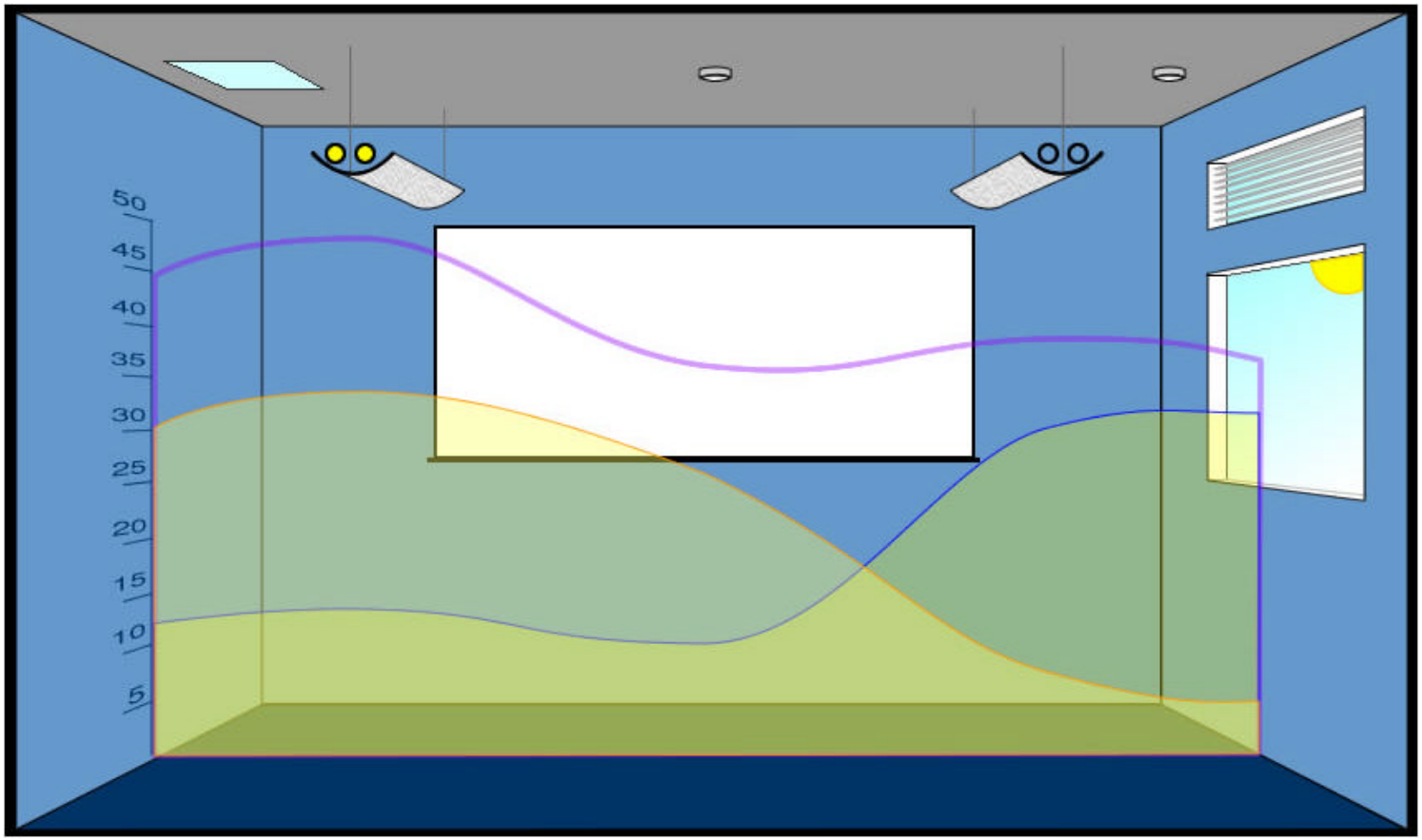
T8 Stepped Control 8 a.m.



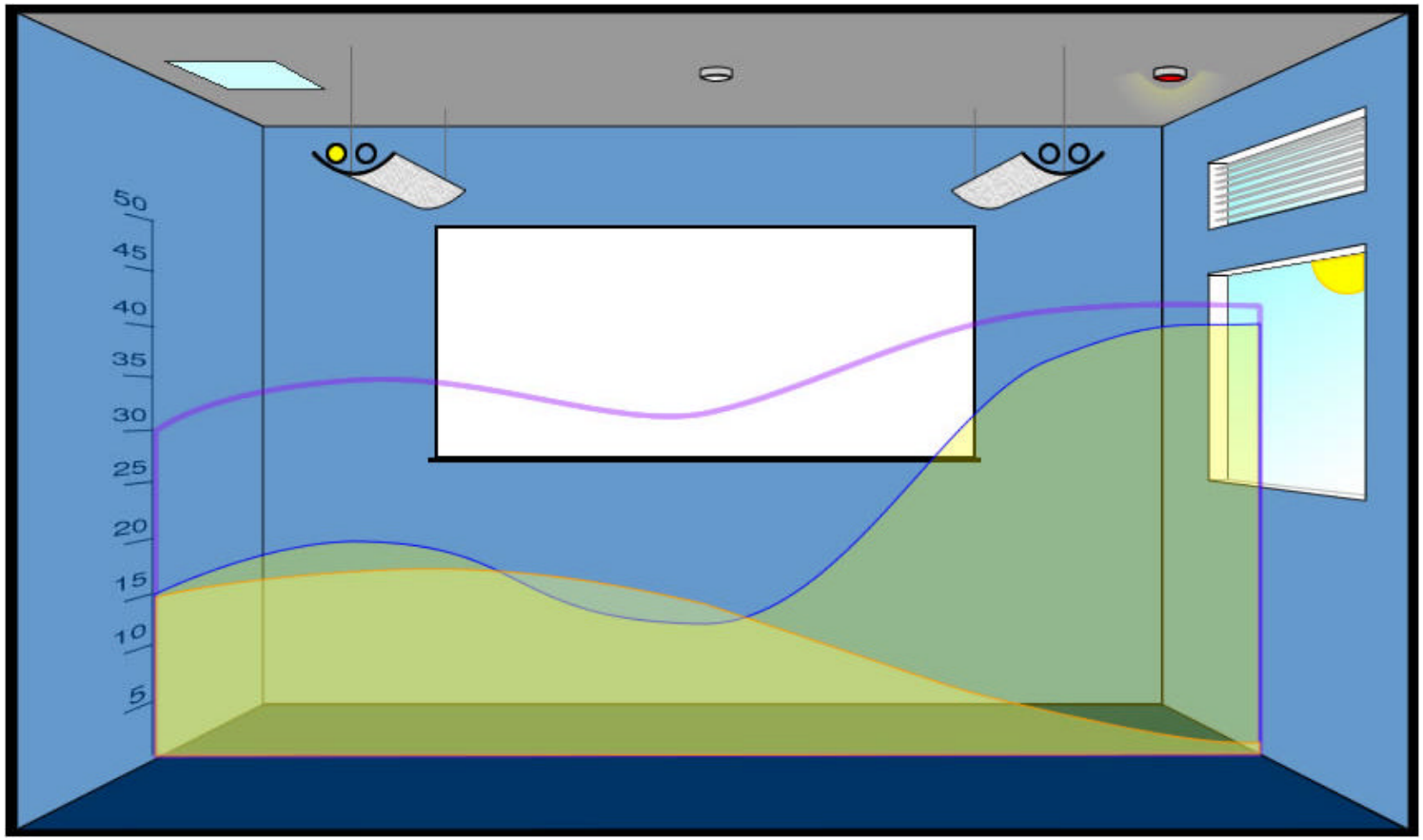
T8 Stepped Control 10 a.m.



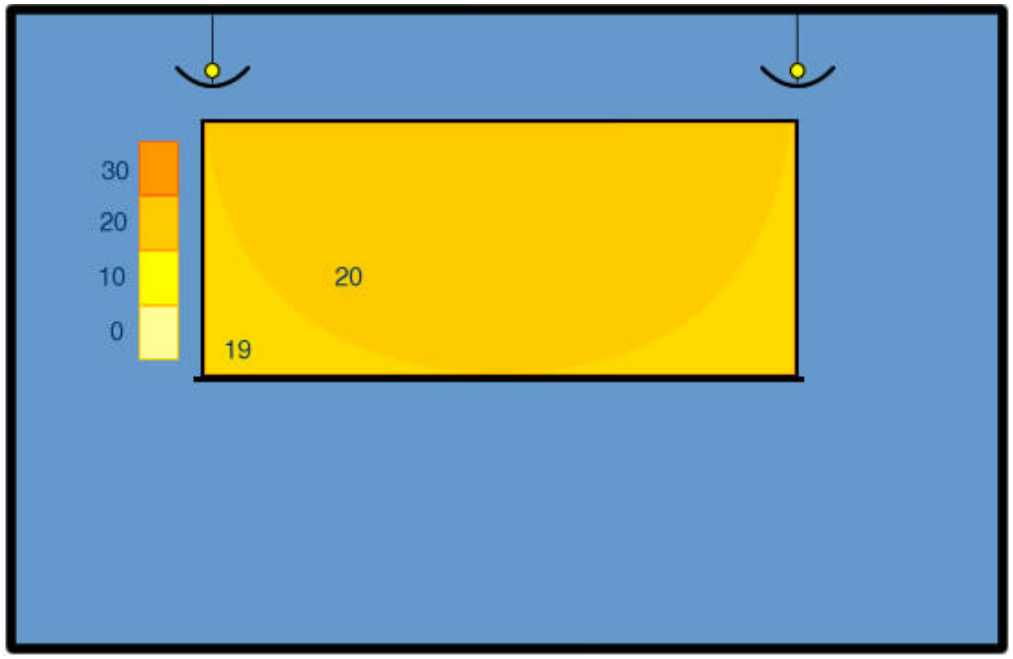
T8 Stepped Control Noon



T8 Stepped Control 2 p.m.



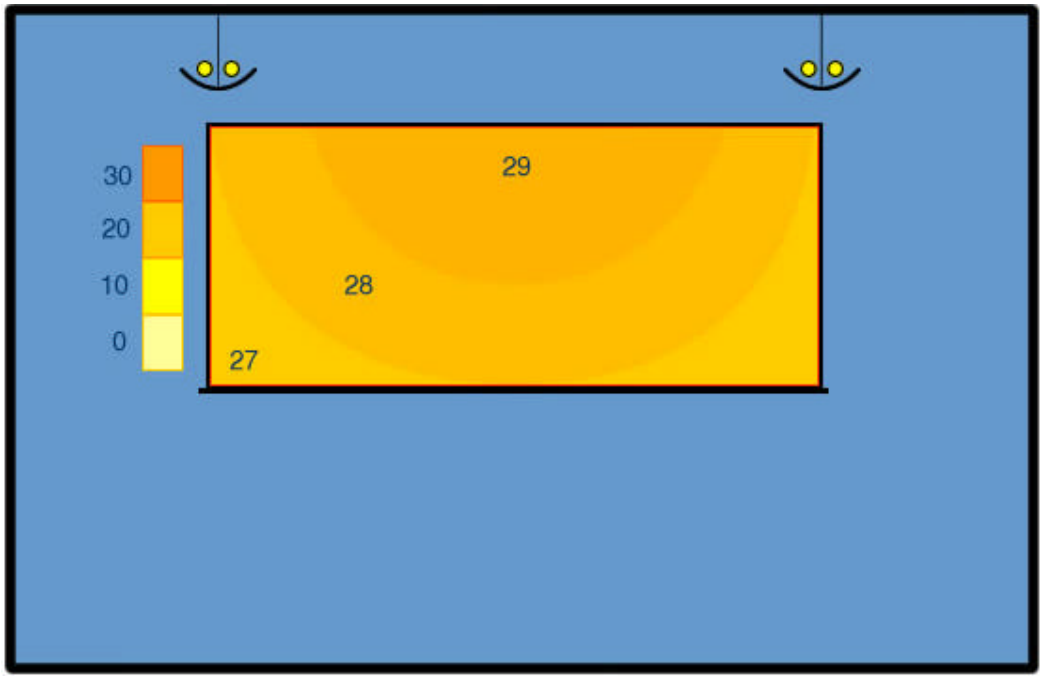
Whiteboard Illuminance



T-5 HO Light Only
(daylighting not included)

Maximum
Illuminance: 20 FC

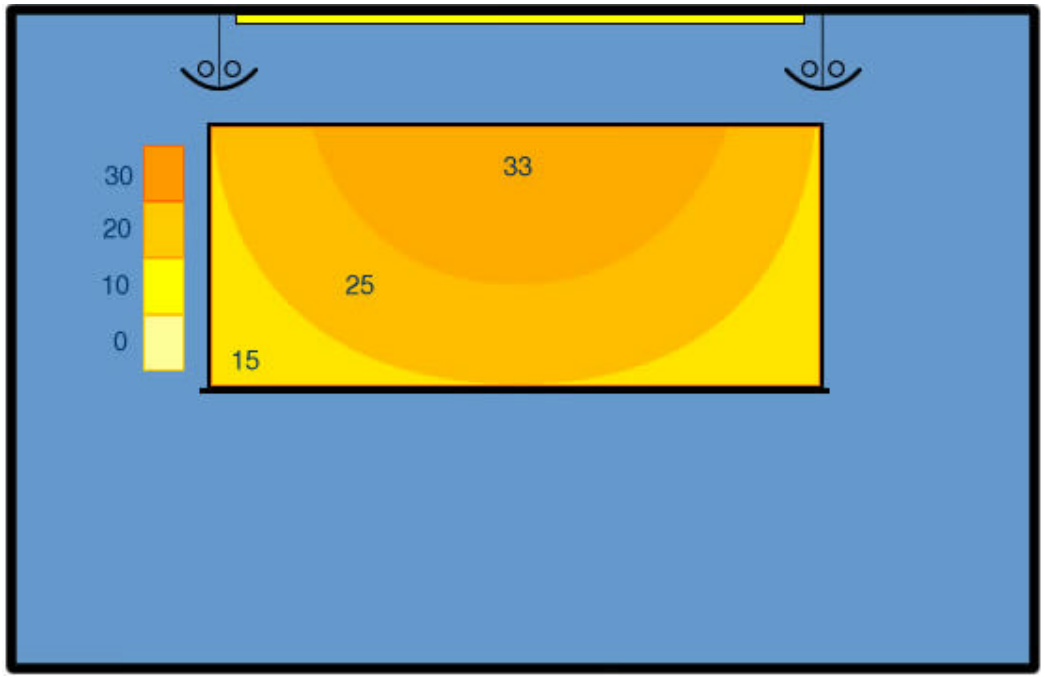
Whiteboard Illuminance



T-8 Lighting Only
(daylighting not included)

Maximum
Illuminance: 29 FC

Whiteboard Illuminance



Whiteboard Light Only
(daylighting not included)

Maximum Illuminance:
33 FC

Decision Matrix

Issues	T-5 HO Dimming	T-8 Stepped
Initial Cost	high	moderate
Acceptability	high	moderate
Maintenance/Operation	moderate	moderate
Commissioning	low to medium	med to high
Energy Use	low	low to med

APPENDIX H: SCE CLASSROOM LIGHTING EXAMPLES

EXAMPLE 1

Design Description

In this design, the ambient lighting system uses two, twenty foot of semi-indirect luminaires that are suspended in 2 rows of 5 each. Each luminaire employs (2) high lumen T8 lamps, all powered from high ballast factor electronic ballasts. The whiteboard task light is a linear wallwasher about 12 feet long that uses (3) Super T8 lamps. This design is appropriate for elementary schools where adult night classes are not held.

Lighting Controls

To reduce the power consumption of the lighting system, each row of luminaires has one row of lamps that is automatically switched off when there is adequate daylight in the room. There are two daylighting zones, one at the window side and one at the interior side. When the room is unoccupied, an occupancy sensor automatically switches off all lamps.

There are two locations for classroom lighting controls. The first is adjacent to the classroom door. Here two switches labeled "Row 1" and "Row 2" allow the teacher to energize the two rows of ambient lighting when entering the room. The second control location is on the teaching wall. Here the Teacher Control Center or TCC houses the whiteboard luminaire on/off switch, manual overrides for A/V mode and a one hour quiet time override switch.

Pros

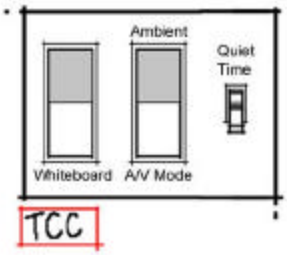
The luminaire used in this example is widely available from many manufacturers and has a variety of styles. It is also likely to be the least expensive and have the lowest life cycle cost of all examples.

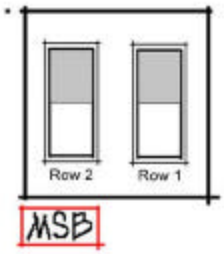
Cons

The A/V control in this example is most basic and will have less uniform desk-level illuminance than Examples 2 or 3. Also, the stepped switching control to daylight control may cause some classroom disruption and may not provide maximum energy savings.

EXAMPLE 1 Reflected Ceiling Plan & Controls

2-LAMP T8 INDIRECT





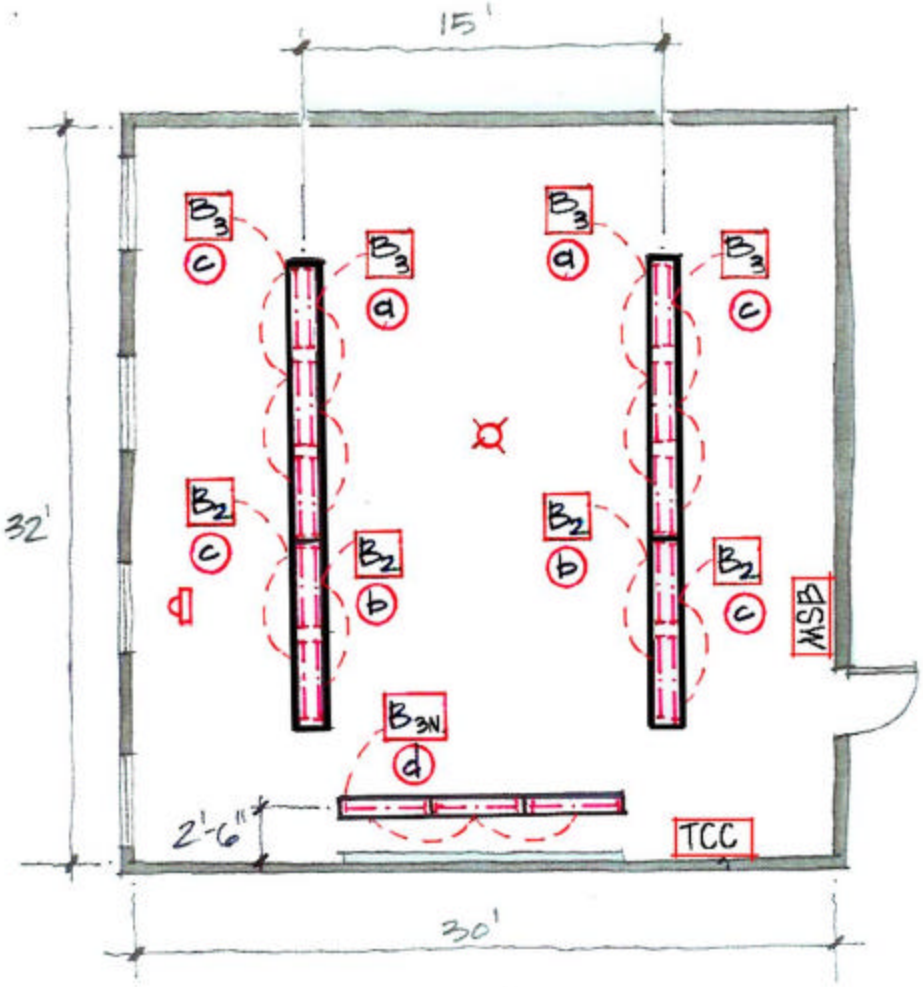
CONTROL STRATEGIES

Ambient - Activates (a) (b) (c)

A/V Mode - Disconnects (b) (c)

Quiet Time - Momentary switch overrides occupancy sensor for one hour.

Whiteboard - Manually operates (d)



LUMINAIRES

(20') 2-lamp Super T8 profile

Perforated Bottom
90% indirect / 10% direct
- 3150 lumens per lamp
- 35 watts per lamp
- 1.2 Ballast Factor

(12') 1-lamp Super T8 profile
Asymetric Wallwash

- 3150 lumens per lamp
- 28 watts per lamp
- 0.88 Ballast Factor

BALLASTS

B_2 2-lamp Ballast (high B.F.)
B.F. - 1.2

B_3 3-lamp Ballast (high B.F.)
B.F. - 1.2

B_{3N} 2-lamp Ballast (normal B.F.)
B.F. - 0.88

CONTROL DEVICES

Occupancy Sensor (O.S.)
locations & quantity per manufacturer

Daylight Sensor (D.S.)
locations & quantity per manufacturer

MSB Main Switch Bank (MSB)
Located near door

TCC Teacher Control Center (TCC)
Located near Whiteboard

CONTROL CIRCUITS

(a) - MSB (manual-ON/OFF)
- O.S. (auto-OFF)
when unoccupied

(b) - MSB (manual-ON/OFF)
- TCC A/V mode (OFF)
- O.S. (auto-OFF)
when unoccupied

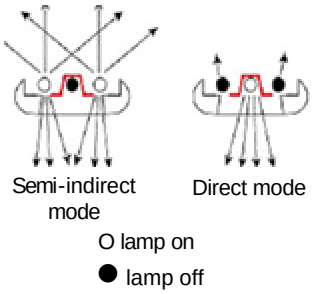
(c) - MSB (manual-ON/OFF)
- TCC A/V mode (OFF)
- O.S. (auto-OFF)
when unoccupied
- D.S. (auto-OFF)
with sufficient daylight

(d) - (manual-ON)
- O.S. (auto-OFF)
when unoccupied
- A/V (manual-OFF)

EXAMPLE 2: Dual Mode Fixture

Design Description

The California Energy Commission has invested in the development of a prototype high performance classroom lighting system as part of its PIER (Public Interest Energy-Efficiency Research) program. This lighting system uses a (3) lamp Super T8 luminaire. The two outer lamps are used for a semi-indirect ambient lighting scene, and the third inner lamp is separately switched for use as a task light during projection and AV presentation. In this design, two, twenty foot PIER luminaires are suspended in 2 rows of 5 each. Each luminaire employs (3) high lumen T8 lamps. The 2 outer lamps are powered from high ballast factor electronic ballasts and the 1 inner lamp is powered from a dimmable electronic ballast. The whiteboard task light is a linear wall-washer about 12 feet long that uses (3) Super T8 lamps.



Lighting Controls

To reduce the power consumption of the lighting system, each row of luminaires has one row of lamps that are automatically switched off when there is adequate daylight in the room. There are two daylighting zones, one at the window side and one at the interior side. When the room is unoccupied, an occupancy sensor automatically switches off all lamps. The inner lamp is dimmed for AV presentations. When the inner lamp is on, the outer 2 lamps are automatically switched off. The switches for the whiteboard are located near the whiteboard.

There are two locations for classroom lighting controls. The first is adjacent to the classroom door. Here two switches labeled “Row 1” and “Row 2” allow the teacher to energize the two rows of ambient lighting when entering the room. The second control location is on the teaching wall. Here the Teacher Control Center or TCC houses the whiteboard luminaire on/off switch, downlight/uplight switch, downlight manual dimmer for A/V mode and a one hour quiet time override switch.

Pros

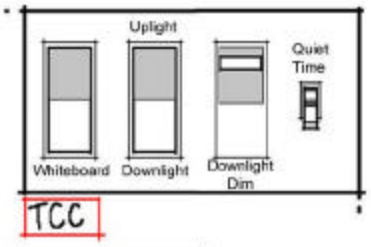
This example provides the most flexibility for different lighting scenes, especially for projection and AV presentations.

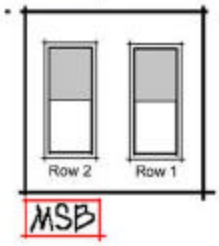
Cons

The life cycle cost is higher for this design because of the extra lamps and ballasts.

EXAMPLE 2 Reflected Ceiling Plan & Controls

PIER LUMINAIRE
2-LAMP T8 - SEMI-INDIRECT
1-LAMP T8 - DIRECT





CONTROL STRATEGIES

Uplight - Activates (a) (b)

Disconnects (c)

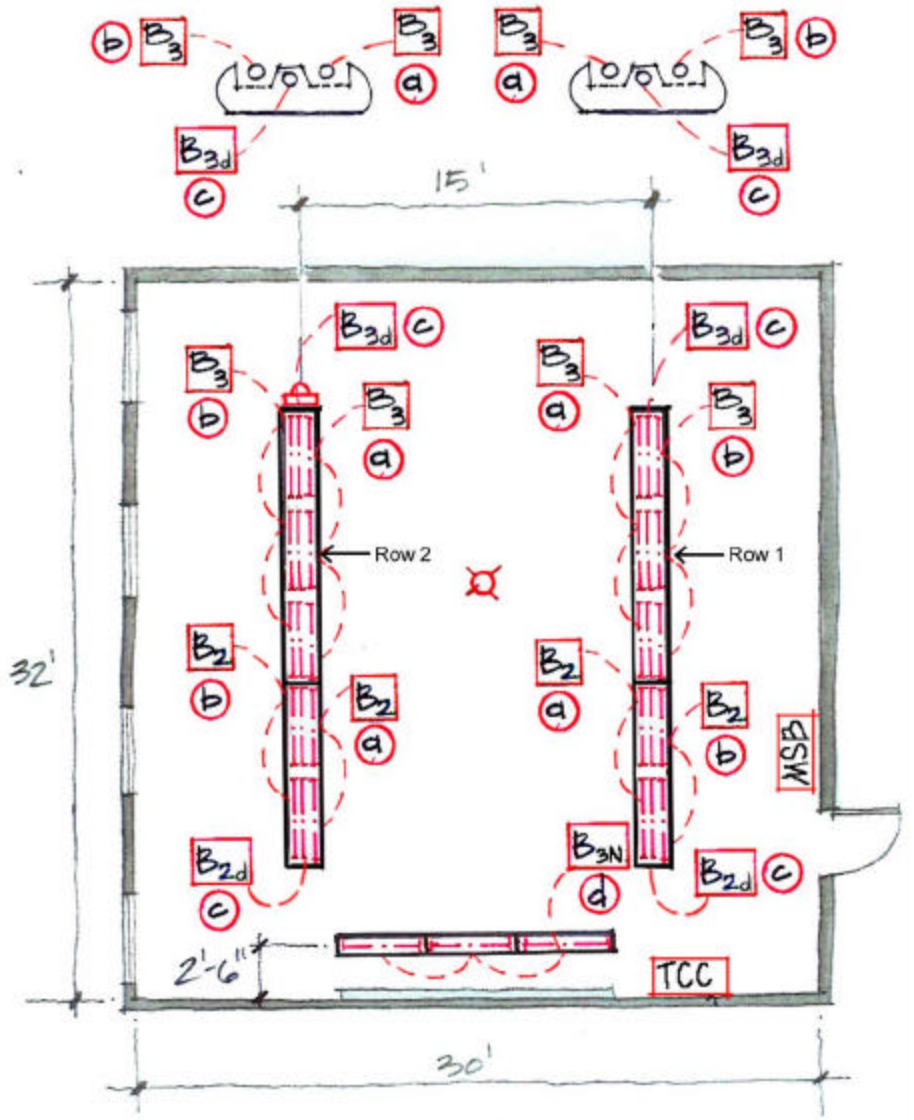
Downlight - Activates (c)

Disconnects (a) (b)

Downlight Dim - Manually Dims (c)

Quiet Time - Momentary switch overrides occupancy sensor for one hour.

Whiteboard - Manually operates (d)



LUMINAIRES

(20') 3-lamp Super T8 profile PIER Luminaire

Semi Indirect Mode - outer 2 lamps
75% indirect / 25% direct
- 3150 lumens
- 35 watts per lamp
- 1.2 Ballast Factor

Direct Mode - middle lamp
100% direct
- 3150 lumens
- 28 watts per lamp
- 0.88 Ballast Factor (dimming)

(12') 1-lamp Super T8 profile Asymetric Wallwash

- 3150 lumens per lamp
- 28 watts per lamp
- 0.88 Ballast Factor

BALLASTS

B_{3N} 2-lamp Ballast (Normal B.F.) B.F. - 0.88

B_2 2-lamp Ballast (high B.F.) B.F. - 1.2

B_{2d} 2-lamp Ballast (dimming) B.F. - 0.88

B_3 3-lamp Ballast (high B.F.) B.F. - 1.2

B_{3d} 3-lamp Ballast (dimming) B.F. - 0.88

CONTROL DEVICES

Occupancy Sensor (O.S.) locations & quantity per manufacturer

Daylight Sensor (D.S.) locations & quantity per manufacturer

MSB Main Switch Bank (MSB) Located near door

TCC Teacher Control Center (TCC) Located near Whiteboard.

CONTROL CIRCUITS

(a) - TCC Uplight (manual-ON)
- O.S. (auto-OFF) when vacant
- TCC Downlight (OFF)

(b) - TCC Uplight (manual-ON)
- O.S. (auto-OFF) when vacant
- D.S. (auto-OFF) with sufficient daylight
- TCC Downlight (OFF)

(c) - TCC Downlight (ON)
- TCC Downlight Dim (manual-DIM)
- O.S. (auto-OFF) when vacant

(d) - TCC Whiteboard (manual-ON)
- O.S. (auto-OFF) when vacant
- TCC Downlight (OFF)

EXAMPLE 3

Design Description

In this design, the ambient lighting system uses two rows of twenty foot direct-indirect luminaires are suspended in 2 rows of 5 each. Each luminaire employs (1) high lumen T5HO lamp, powered from high ballast factor electronic dimming ballast. The whiteboard task light is a linear wall-washer about 12 feet long that uses (3) Super T8 lamps. This design is appropriate for elementary schools where adult night classes are not held.

Lighting Controls

To reduce the power consumption of the lighting system, each row of luminaires is continuously dimmed according to the daylight in the room. There are two daylighting zones, one at the window side and one at the interior side. When the room is unoccupied, an occupancy sensor automatically switches off all lamps. The switches for the whiteboard are located near the whiteboard.

There are two locations for classroom lighting controls. The first is adjacent to the classroom door. Here two switches labeled "Row 1" and "Row 2" allow the teacher to energize the two rows of ambient lighting when entering the room. The second control location is on the teaching wall. Here the Teacher Control Center or TCC houses the whiteboard luminaire on/off switch, manual dimming for A/V mode and a one hour quiet time override switch.

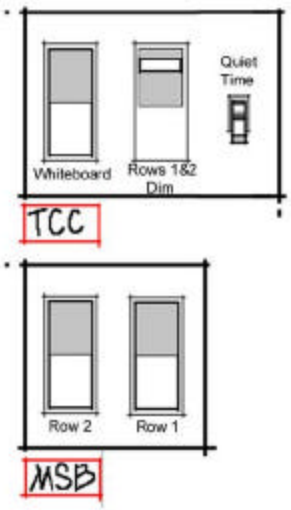
Pros

This example has the simplest controls that save energy and will be the easiest for teachers to use.

Cons

The life cycle cost is higher because of the lamp and dimming technology. Also, a single T5HO lamp provides end of illuminance levels of a classroom.

EXAMPLE 3 Reflected Ceiling Plan & Controls
1-LAMP T5HO
SEMI-INDIRECT

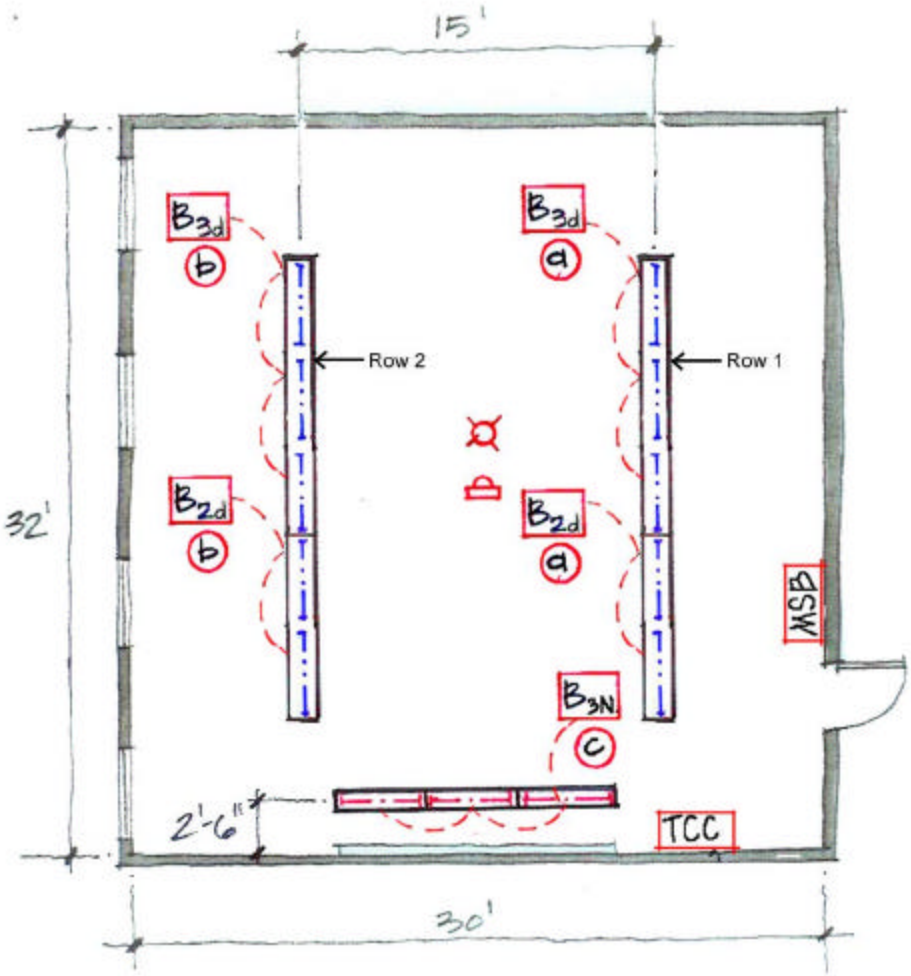


CONTROL STRATEGIES

Rows 1&2 Dim - Manually dims Rows 1&2 Manual dimmer sets upper limit for daylight dimming.

Quiet Time - Momentary switch overrides occupancy sensor for one hour.

Whiteboard - Manually operates (c)



LUMINAIRES

(20') 1-lamp T5HO profile

82% indirect / 18% direct
- 4750 lumens per lamp
- 60 watts per lamp
- 1.0 Ballast Factor

(12') 1-lamp Super T8 profile
Asymetric Wallwash

- 3150 lumens per lamp
- 28 watts per lamp
- 0.88 Ballast Factor

BALLASTS

B_{2d} 2-lamp Ballast (dimming) B.F. - 1.0

B_{3N} 3-lamp Ballast (normal B.F.) B.F. - 0.88

B_{3d} 3-lamp Ballast (dimming) B.F. - 1.0

CONTROL DEVICES

Occupancy Sensor (O.S.)
locations & quantity per manufacturer

Daylight Sensor (D.S.)
locations & quantity per manufacturer

MSB Main Switch Bank (MSB) Located near door

TCC Teacher Control Center (TCC) Located near Whiteboard

CONTROL CIRCUITS

(a) - MSB - Row 1 (manual-ON)
- O.S. (auto-OFF) when unoccupied
- D.S. (daylight dimming)
- TCC - Dim (manual dimming)

(b) - MSB - Row 2 (manual-ON)
- O.S. (auto-OFF) when unoccupied
- D.S. (daylight dimming)
- TCC - Dim (manual dimming)

(c) - TCC - Whiteboard (manual-ON/OFF)
- O.S. (auto-OFF) when unoccupied